



TITLE OF THE INVENTION

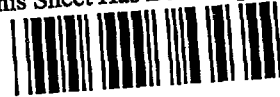
PLASMA DISPLAY, DRIVING APPARATUS OF PLASMA
DISPLAY PANEL AND DRIVING SYSTEM THEREOF

5 BACKGROUND OF THE INVENTION

The invention relates to plasma display, driving
apparatus of plasma display panel and driving system
thereof for , for example, display apparatus of personal
computer or workstation, a flat type wall hanging
10 television receiver and a display apparatus for
advertising and information. This invention is
preferably applicable to AC type plasma display.

In plasma display, one field is divided into
several sub-fields, and each pixel (cell) is given forth
15 light by exciting a phosphor by ultraviolet rays that
are generated by a electric discharge carried out in the
cell. The cell that emits light is practiced by an
address electric discharge between two set of electrodes
which are provided perpendicular to each other on a
20 front side glass substrate and a back side glass
substrate respectively and are capable of driving
independently.

A first prior art relating to a plasma display
is disclosed ,for example, Japanese Patent Application
25 Laid-Open No.1994/186927. In the prior art , the
condition of the electric charge particles in all cells
is equalized for surely prohibiting lighting for some



cells which are not intended to emit light, and two sets of light emitting discharges, that is, a full writing electric discharge and a full erasing electric discharge in each sub-field are carried out so as to be able to
5 use low voltage for an address electric discharge.

Therefore, the contrast is deteriorated because light emitting occurs on full panel when black is displayed.

A second prior art is disclosed ,for example, Japanese Patent Application Laid-Open No. 1995/49663.

10 In the prior art, the plurality of the sub-fields having the same brightness gradations are arranged to construct a sub-field block, and several blocks are provided. In sub-field blocks, a preliminary discharge including a full writing electric discharge and a fine line erasing
15 electric discharge is performed in one sub-field, and a writing electric discharge and a erasing electric discharge to a pixel is carried out one time. Therefore, deterioration of a panel is reduced and contrast of a display is improved. The second prior art discloses one
20 of the solution to improve the contrast, but no prior art is shown to improve the contrast in which plural sub-fields having different brightness gradations for constructing one sub-field block.

About 3 μ sec to 4 μ sec is needed to write one
25 line of plasma panel, and an ordinal television display has 480 lines. A writing period of a screen is 1.44 msec if a writing period of one line is 3 μ sec, so that



1.44 msec $\times$ 9 $\div$ 13 msec is needed for one field. The period of one field is 16.7 msec. A sustaining period is 16.7 msec minus a writing period and preliminary discharge period, and this period is not so long enough. Further, 5 if a display has 760 lines per a screen like a high definition display, or if a display has 8 sub-fields for constructing 256 gradations, period for writing is not sufficient.

10 SUMMARY OF THE INVENTION

It is an object of the present invention to improve contrast.

It is another object of the present invention to improve contrast by reducing a full erasing electric 15 discharge and full writing electric discharge.

It is still another object of the invention to improve contrast by reducing preliminary discharge without changing the number of sub-fields.

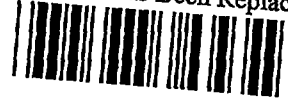
According to a feature of the present invention, 20 to achieve the above object, a plasma display and a plasma display driving system include a first electrode group arranged on a permeable substrate and being capable of driving in common, a second electrode group arranged in parallel with the first electrode group on 25 the permeable substrate and being capable of driving independently, a third electrode group arranged perpendicular to the first and second electrode groups



on the other substrate and being capable of driving independently, and the plasma panel and the driving system comprising means for performing at least one electric discharge for equalizing electric charge particles in a cell in which another electric charge particle is caused beforehand.

According to another feature of the present invention, to achieve the above object, a plasma display, and a plasma display panel driving system and circuit include a first electrode group driven in common, a second electrode group driven independently, a third electrode group for an address electric discharge, means for erasing and polarizing electric charge particles by a find line erasing pulse after sustaining period and for supplying an equalizing pulse to one of the electrode group of the first and second electrode group to which the last fine line erasing pulse is supplied and for supplying a regulating pulse to the other electrode of the first and the second electrode groups after supply of the equalizing pulse, thereby controlling the electric charge particles without full erasing electric discharge and full writing electric discharge and improving contrast without light emitting discharge in case of displaying of black color.

According to still another feature of the present invention, to achieve the above object, a plasma display and a plasma display panel driving system and



circuit include means for constructing a field block
from plurality of sub-fields and for performing a full
writing electric discharge and a fine line erasing
electric discharge in first sub-field of the field block
5 for decreasing number of electric discharge, means for
gathering positive electric charge particles in the
vicinity of an address electrode by the full writing
electric discharge and fine line erasing electric
discharge thereby decreasing a voltage of an address
10 pulse, and means for reproducing the condition of
electric charge particles the same as the condition
after performing full writing electric discharge and
fine line erasing electric discharge are performed by
utilizing a sustaining electric discharge in a cell in
15 which the address electric discharge occurred, thereby
reducing the voltage of a address electric discharge in
the next field without the full writing electric
discharge and the fine line electric discharge.
In a cell having no address electric discharge, the
20 condition of electric charge particles after the full
writing electric discharge and fine line erasing
electric discharge are performed is maintained during
one field, so that it is sufficient to perform one time
of the full writing electric discharge and fine line
25 electric discharge.

These and other objects, features and advantages
of the present invention will become more apparent form

the following description when taken in conjunction with the accompanying drawings

BRIEF DESCRIPTION OF THE DRAWINGS

5 Fig. 1 is a exploded perspective view illustrating a plasma display panel of the present invention.

 Fig. 2 is a sectional view of a plasma display panel which is illustrated from a direction in
10 accordance with an arrow A of Fig. 1.

 Fig. 3 is a sectional view of a plasma display panel which is illustrated from a direction in accordance with an arrow of Fig. 1.

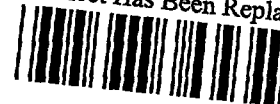
 Fig. 4 illustrates electrodes and circuits
15 connected to the electrodes of the plasma display panel of Fig. 1.

 Fig. 5(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the first embodiment of the present invention.

20 Fig. 5(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the first embodiment of the present invention.

 Fig. 5(c) illustrates a driving wave-form supplied to an address A electrode in accordance with
25 the first embodiment of the present invention.

 Fig. 5(d) illustrates a driving wave-form supplied to a first independent Y electrode in



accordance with the first embodiment of the present invention.

Fig. 5(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the first embodiment of the present invention.

Fig. 6 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell is illustrated immediately after a power is supplied and then a equalizing pulse and a protecting pulse are supplied.

Fig. 7 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after performing an address electric discharge is illustrated.

Fig. 8 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a fine line erasing pulse is illustrated.

Fig. 9 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a equalizing pulse in a second field is illustrated.

Fig. 10 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a regulating pulse in a second field is illustrated

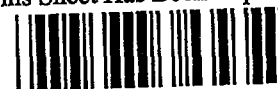


Fig. 11(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 11(b) illustrates a driving wave-form
5 supplied to a common X electrode in accordance with the second embodiment of the present invention.

Fig. 11(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the second embodiment of the present invention.

10 Fig. 11(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the second embodiment of the present invention.

Fig. 11(e) illustrates a driving wave-form
15 supplied to a second independent Y electrode in accordance with the second embodiment of the present invention.

Fig. 12(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance
20 with the present invention.

Fig. 12(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the third embodiment of the present invention.

Fig. 12(c) illustrates a driving wave-form
25 supplied to an address A electrode in accordance with the third embodiment of the present invention.

Fig. 12(d) illustrates a driving wave-form



supplied to a first independent Y electrode in accordance with the third embodiment of the present invention.

5 Fig. 12(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the third embodiment of the present invention.

10 Fig. 13(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the invention.

Fig. 13(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the fourth embodiment of the present invention.

15 Fig. 13(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the fourth embodiment of the present invention.

20 Fig. 13(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the fourth embodiment of the present invention.

Fig. 13(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the fourth embodiment of the present invention.

25 Fig. 14(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the invention.

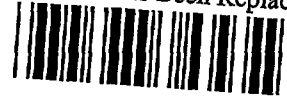


Fig. 14(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the fifth embodiment of the present invention.

5 Fig. 14(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the fifth embodiment of the present invention.

Fig. 14(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the fifth embodiment of the present
10 invention.

Fig. 14(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the fifth embodiment of the present invention.

15 Fig. 15(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 15(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the
20 sixth embodiment of the present invention.

Fig. 15(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the sixth embodiment of the present invention.

25 Fig. 15(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the sixth embodiment of the present invention.



Fig. 15(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the sixth embodiment of the present invention.

5 Fig. 16(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the invention.

Fig. 16(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the
10 seventh embodiment of the present invention.

Fig. 16(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the seventh embodiment of the present invention.

Fig. 16(d) illustrates a driving wave-form
15 supplied to a first independent Y electrode in accordance with the seventh embodiment of the present invention.

Fig. 16(e) illustrates a driving wave-form supplied to a second independent Y electrode in
20 accordance with the seventh embodiment of the present invention.

Fig. 17(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

25 Fig. 17(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the eighth embodiment of the present invention.



Fig. 17(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the eighth embodiment of the present invention.

5 Fig. 17(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the eighth embodiment of the present invention.

Fig. 17(e) illustrates a driving wave-form supplied to a second independent Y electrode in
10 accordance with the eighth embodiment of the present invention.

Fig. 18(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

15 Fig. 18(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the ninth embodiment of the present invention.

Fig. 18(c) illustrates a driving wave-form supplied to an address A electrode in accordance with
20 the ninth embodiment of the present invention.

Fig. 18(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the ninth embodiment of the present invention.

25 Fig. 18(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the ninth embodiment of the present



invention.

Fig. 19 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell is illustrated immediately after a power is supplied and then a equalizing pulse and a regulating pulse are supplied in accordance with the ninth embodiment.

Fig. 20 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after performing a address electric discharge is illustrated in accordance with ninth embodiment of the present invention.

Fig. 21 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a fine line erasing pulse is illustrated in accordance with the ninth embodiment of the present invention.

Fig. 22 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a equalizing pulse in a second field is illustrated in accordance with the ninth embodiment of the present invention.

Fig. 23 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a regulating pulse in a second field is illustrated in accordance with the ninth embodiment of the present invention.



Fig. 24(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 24(b) illustrates a driving wave-form
5 supplied to a common X electrode in accordance with the tenth embodiment of the present invention.

Fig. 24(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the tenth embodiment of the present invention.

10 Fig. 24(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the tenth embodiment of the present invention.

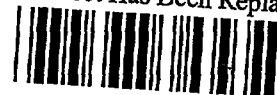
Fig. 24(e) illustrates a driving wave-form
15 supplied to a second independent Y electrode in accordance with the tenth embodiment of the present invention.

Fig. 25(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance
20 with the present invention.

Fig. 25(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the eleventh embodiment of the present invention.

Fig. 25(c) illustrates a driving wave-form
25 supplied to an address A electrode in accordance with the eleventh embodiment of the present invention.

Fig. 25(d) illustrates a driving wave-form



supplied to a first independent Y electrode in accordance with the eleventh embodiment of the present invention.

5 Fig. 25(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the eleventh embodiment of the present invention.

10 Fig. 26(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 26(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the twelfth embodiment of the present invention.

15 Fig. 26(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the twelfth embodiment of the present invention.

20 Fig. 26(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the twelfth embodiment of the present invention.

Fig. 26(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the twelfth embodiment of the present invention.

25 Fig. 27(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.



Fig. 27(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the thirteenth embodiment of the present invention.

5 Fig. 27(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the thirteenth embodiment of the present invention.

Fig. 27(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the thirteenth embodiment of the present invention.
10

Fig. 27(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the thirteenth embodiment of the present invention.

15 Fig. 28(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with a second embodiment of the present invention.

Fig. 28(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the
20 fourteenth embodiment of the present invention.

Fig. 28(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 28(d) illustrates a driving wave-form
25 supplied to a first independent Y electrode in accordance with the fourteenth embodiment of the present invention.



Fig. 28(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the fourteenth embodiment of the present invention.

5 Fig. 28(f) illustrates a driving wave-form supplied to a third independent Y electrode in accordance with the fourteenth embodiment of the present invention.

10 Fig. 28(g) illustrates a driving wave-form supplied to a fourth independent Y electrode in accordance with the fourteenth embodiment of the present invention.

15 Fig. 29 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying sustaining pulses is illustrated in accordance with a embodiment shown in Fig. 28(a)-28(g) of the present invention.

20 Fig. 30 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell during discharging by a selection electric discharge pulse is illustrated in accordance with the embodiment shown in Fig. 28(a)-28(g) of the present invention.

25 Fig. 31 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell during supplying electric charge particles control pulse is illustrated in accordance with the



embodiment shown in Fig. 28(a)-28(g) of the present invention.

Fig. 32 is a sectional view of a plasma display panel in which a condition of electric charge particles
5 in a cell after supplying a fine line erasing pulse is illustrated in accordance with the embodiment shown in fig. 28(a)-Fig. 28(g) of the present invention.

Fig. 33 is a time chart of sub-fields illustrating a driving system in accordance with a third
10 embodiment of the present invention.

Fig. 34 is a time chart of sub-fields illustrating a driving system in accordance with a fourth embodiment of the present invention.

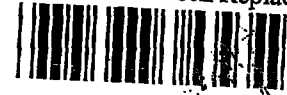
Fig. 35 is a time chart of sub-fields illustrating a driving system in accordance with a fifth
15 embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the present invention will be described with using drawings
20 hereinafter.

Fig. 1 illustrates a exploded perspective view of a plasma display panel relating to the first embodiment of the present invention.

A transparent common X electrode 22 and a
25 transparent independent Y electrode 23 are provided under a front glass substrate 21, and a X bus electrode 24 and a Y bus electrode 25 are laminated on respective



electrode 21 and 22. A dielectric layer 26 and a protecting layer 27 such as a acid magnesium (MgO) are provided on these electrodes 22, 23, 24 and 25. An address A electrode 29 provided on a back glass substrate 28 is arranged perpendicular to the common X electrode 22 and the independent Y electrode 23 on the front glass substrate 21. The address A electrode 29 is covered by a dielectric layer 30 and a partition wall 31 arranged parallel to the address A electrode 29 is provided on the electrode 29. A phosphor 32 is coated on the partition wall 31 and the address A electrode 29.

Fig. 2 is a sectional view of a plasma display panel which is illustrated from a direction in accordance with an arrow A of Fig. 1. The address A electrode 29 is arranged in the middle of the two partition walls. A discharge gas such as a neon gas or a xenon gas is filled in a space 33 that is provided between the front glass substrate 21 and the back glass substrate 38.

Fig. 3 is a sectional view of a plasma display panel which is illustrated from a direction in accordance with an arrow of Fig. 1. A border of each cell is shown by a dotted line, and the common X electrode 22 and the independent Y electrode 23 are arranged alternatively. In AC type plasma display panel, the electric charge particles on the dielectric layer in the vicinity of the common X electrode 22 and the

independent Y electrode 23 are divided into positive electric charge particles and negative electric charge particles for forming an electric field, so that a discharge is performed by using the electric field.

5 Fig. 4 illustrates electrodes and circuits connected to the electrodes of the plasma display panel of Fig. 1. The common X electrode 22 is connected to an output terminal or several terminals of a X electrode driving circuit 35 that generates a driving pulse for
10 supplying to the common X electrode 22. Each independent Y electrode 23 is connected respective output terminals of a Y electrode driving circuit 36. Each address A electrode 29 is connected respective output terminals of a A electrode driving circuit 37.

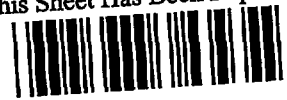
15 Fig. 5 illustrates a first driving system in accordance with a first embodiment of the present invention. Fig.(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the invention. In the figure, reference numeral 1
20 denotes one field, a horizontal axis illustrates time and a vertical axis illustrates a line of the cell. The one field is divided into eight sub-fields, that is, a first sub-field 2 to a eighth sub-field 9. A electric charge particle equalizing period 2a-9a, an address period 2b-9b and a sustaining period 2c-9c are arranged
25 in order in each sub-field. Numbers of electric discharges are allotted for each sub-field and display



gradations are determined by the total numbers of the discharges. The order for arranging the sub-fields having predetermined numbers of discharges is free, but in the embodiment, the sub-fields are arranged in order
5 from a sub-field having a fewer numbers of electric discharge.

Fig. 5(a)-Fig. 5(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y
10 electrode respectively. In the figure, a pulse wave-form 10 illustrates a part of driving wave-form supplied to the common X electrode 22 in one field. A pulse wave-form 11 illustrates a part of driving wave-form supplied to the one of the address A electric rode 29.
15 Pulse wave-forms 12 and 13 illustrate a parts of driving wave-form supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 10 which is supplied to the common X electrode 22 during first sub-field includes a
20 regulating pulse 40 lasting from the electric charge particle equalizing period 2a to the address period 2b and the sustaining pulses 41 in the sustaining period 2c. In this embodiment, the voltage of the regulating pulse 40 is lower than the voltage of the sustaining pulses 41.
25 The pulse wave-form 11 which is supplied to one of the address A electrodes 29 illustrates the address pulse 42 in the address period 2b and the address pulse 42



corresponds to the cell to be emitted light . The address pulse 42 is not supplied when there is no cell to be emitted. That is, the address pulses 42 are supplied to the cells to be emitted, and the address pulse 42 is not supplied to the other cells not to be emitted. The pulse wave-forms 12 and 13 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a electric charge particle equalizing pulses 43a, 43b,--- in the electric charge particle equalizing period 2a of the first sub-field, scan pulses 44a, 44b,---in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. In the embodiment, the voltage of the scan pulses 44a, 44b, --- is lower than the voltage of the sustaining pulses 45a, 45b,---. The fine line erasing pulses 46a, 46b,--and the equalizing pulses 43a, 43b,--- are supplied to the same electrodes. Further, it is preferable to select the pulse width of the fine line erasing pulses 46a, 46b,--- between 0.5 μ sec-2 μ sec.

The movements of the panel is explained hereinafter. In Fig. 5, electric discharges in all cells are performed between the independent Y electrodes 23 and the common X electrodes 22 by supplying the equalizing pulses 43a, 43b,--- to the independent Y electrodes 23, and negative electric charge particles



are formed on the dielectric layer 26 in the vicinity of the independent Y electrode 23 during electric charge particle equalizing period 2a occurring immediately after the power is supplied to the display. The
5 electric discharge by the equalizing pulses 43a, 43b,--- occurs only first one time, and the discharge is not occurred after this. That is, the discharge occurs only one time other than the space 33 of the cell becomes abnormal condition. The regulating pulse 40 is supplied
10 to the common X electrode 22 within the time between 0.3 μ sec-2 μ sec from the rising edge of the equalizing pulses 43a, 43b,---. The negative electric charge particles are formed in the vicinity of the common X electrode 22, and the positive electric charge particles
15 are formed in the vicinity of the address A electrode 29.

The reason the time between the rising edge of the equalizing pulses 43a, 43b,---and the rising edge of the regulating pulse 40 is determined as described the above is that : too many negative electric charge
20 particles are gathered in the vicinity of the independent Y electrode 23 and the negative electric charge particles gather in the common X electrode 22 when the time between edges of both pulses 43a, 43b,-- and 40 is selected too long. When the time is too short,
25 the negative electric charge particles are not gathered on the independent Y electrode 23 and also the positive electric charge particles are not gathered on the



address A electrode 22.

The main purpose for supplying the regulating pulse 40 is to attract the negative electric charge particles toward the common X electrode 22 and to form the positive electric charge particles on the address A electrode 29. Another purpose is to assist electric discharges between the common X electrode 22 and the independent Y electrode 23 when the address electric discharge is performed between the address A electrode 29 and the independent Y electrode 23.

The address electric discharges is performed in the cell which is formed at the cross point of the first line of the independent Y electrode 23 and one of the address A electrode 22 when the scan pulses 44a is supplied to the first line of the independent Y electrode 23 and the address pulse 42 is supplied to one of the address A electrode 29 at the same time, as a result, the positive electric charge particles are gathered on the independent Y electrode 23. On the other hand, no discharge is occurred when the address pulse 42 which corresponds to the scan pulses 44b is not supplied to the second line of the independent Y electrode 23, therefore, no electric charge particle is gathered on the independent Y electrode 23. The address pulses 42 are supplied to the address A electrodes 29 which correspond to the cell to be emitted and are selected all the cells at the cross points of all



address A electrodes 29 and the scan pulses 44a or 44b
is supplied to the independent Y electrodes 23, so that
the electric discharges are performed between the
address A electrode 29 and the independent Y electrodes
5 23.

Next, in the sustaining period 2c, the electric
discharges for light emitting are performed by the
sustaining pulses 41, 45a, 45b,---between the common X
electrode 22 and the independent Y electrodes 23 in the
10 cell in which the positive electric charge particles are
gathered on the independent Y electrodes 23 side by the
electric discharges performed during address period 2b.
After that, electric discharges occur between the
independent Y electrodes 23 and the common X electrode
15 22 by supplying the fine line erasing pulses 46a, 46b,--
- to the independent Y electrodes 23 and the electric
charge particles in the cells are erased, so that the
all electric charge particles generated for light
emitting in the cell are erased. The pulse width of the
20 fine line erasing pulses 46a, 46b,---is a little longer
than the electric discharge continuation time, therefore,
the negative electric charge particles are gathered on
the dielectric layer in the vicinity of the independent
Y electrodes 23. In the cells in which no electric
25 discharge is occurred, the erasing discharges are not
performed because no electric charge particle is in the
cell. Therefore, the negative electric charge particles



formed in the vicinity of the independent Y electrodes
23 are kept unchanged.

In this situation, no electric discharge occurs
by supplying the equalizing pulses 43a, 43b, --- to the
5 independent Y electrodes 23 because the negative
electric charge particles in the cell negate the voltage
of the equalizing pulses 43a, 43b, ---and sufficient
electric fields needed for electric discharge are not
formed. After that, no electric discharge is performed
10 through all sub-fields even if the equalizing pulses are
supplied. Therefore, the electric discharges are not
performed except the first sub-field immediately after
the power on, therefore no light emitting occurs in
black display.

15 Further, for the linearity of display gradations
determined by the numbers of sustaining pulses, one
electric discharge have less influence more than two
electric discharges. According to the present invention,
the equalization of electric charge particles is
20 effected by one electric discharge in the cell in which
the sustaining electric discharge is performed,
therefore, the influence to the linearity for display
gradations is very small.

The same driving system is performed during the
25 second sub-field 3 to the eighth sub-field 9 and a
screen of one field is formed.

Fig. 6-Fig. 10 are sectional views of the plasma



display panel in which the condition of electric charge particles in the cell performed sustaining electric discharge are illustrated from the first sub-field after the power is supplied to the second sub-field until the equalizing pulses and the regulating pulse are supplied. In these figure, reference numeral 60 denotes a positive electric charge particles, reference numeral 61 denotes a negative electric charge particles. Further the condition of electric charge particles is illustrated in a cell at center position of Fig. 6-Fig. 7.

Fig. 6 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell is illustrated immediately after a power is supplied and then a equalizing pulse and a regulating pulse are supplied. The figure illustrate the condition of electric charge particles in the first sub-field after power is supplied at first and then the equalizing pulses 43a, 43b are supplied to the independent Y electrodes 23 and finally the regulating pulse 40 is supplied. The electric discharges in all cells occur between the common X electrode 22 and the independent Y electrodes 23 by supplying the equalizing pulses 43a, 43b,---to the independent Y electrodes 23, and the negative electric charge particles 61 are gathered on the dielectric layer in the vicinity of the independent Y electrodes 23a and the common X electrode 22 and the positive electric charge particles 60 are gathered on



the address A electrodes 29 side.

Fig. 7 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after performing an address electric discharge is illustrated. In Fig. 7, the condition of electric discharges is illustrated after the address pulses 42 is supplied to the address A electrodes 29 and address electric discharges occur between the address A electrode 29 and the independent Y electrode 23. The positive electric charge particles 60 are gathered on the dielectric layer in the vicinity of the independent Y electrode 23 because the voltage of the independent Y electrode 23 is lower than the voltages of the address A electrode 29 and the common X electrode 22. The condition of the electric charge particles are shown in Fig. 7. The electric discharge occurs between the independent Y electrode 23 and the common X electrode 22 by the positive electric charge particles 60 and the first pulse of the sustaining pulses 45a, 45b,--- supplied to the independent Y electrode 23. This is a sustain discharge. This time, the negative electric charge particles 61 are gathered around the independent Y electrode 23 and the positive charges 62 are gathered around the common X electrode 22 by the electric discharge generated by the sustaining pulses 45a, 45b. As a result, the sustaining electric discharges occur between the independent Y electrode 23 and the common X



electrode 22 by the first pulse of sustaining pulses 41.
This electric discharges are repeated during sustaining
period 2c.

Fig. 8 is a sectional view of a plasma display
5 panel in which a condition of electric charge particles
in a cell after supplying a fine erase pulse is
illustrated. In Fig. 8, the condition of electric
discharge after the last sustaining pulses 41 is
supplied to the common X electrode 22 and then the fine
10 line erasing pulses 46a, 46b,---are supplied is
illustrated.

The condition of the electric charge particles
after the discharges are occurred by the final
sustaining pulses 41 is the same with the condition
15 shown in Fig. 7.

The pulse width of the fine line erasing pulses
46a, 46b,---is longer than the discharge continuation
time, so that negative electric charge particles 61
which move so quickly are gathered on the dielectric
20 layer in the vicinity of the independent Y electrode 23.
As a result, separation of the electric charge particles
is performed. The positive electric charge particles
that move slowly in space float in the cell. The
negative charges float discharge space for a while.

25 Fig. 9 is a sectional view of a plasma display
panel in which a condition of electric charge particles
in a cell after supplying a equalizing pulse in a second



field is illustrated. In Fig. 9, a condition of electric discharge after the equalizing pulses 43a, 43b,---in the second sub-field are supplied is illustrated. The voltage of the equalizing pulses 43a, 43b, ---are canceled by the negative charges and is not reached to the discharge voltage, so that any discharges is not performed. The voltage of the independent Y electrode 23 is higher than the voltage of the other electrodes, so the negative charges are attracted towered the independent Y electrode 23.

Fig. 10 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a regulating pulse in a second field is illustrated.

Referring to the drawing, the condition of electric charge particles after the regulating pulse 40 is supplied to the common X electrode 22 is illustrated. The negative electric charge particles are gathered on the dielectric layer in the vicinity of the common X electrode 22 and the positive charges are gathered at the address A electrode 29. By this, the same driving as the first sub-field is performed without electric discharge by the equalizing pulses 43a, 43b,---. In this case, the voltage of the equalizing pulses 43a, 43b,--- is reduced by the negative electric charge particles at the independent Y electrode 23, so that the electric discharge between the independent Y electrode



23 and the common X electrode 22 is not performed.

The driving of the panel is capable of performing without using the full writing electric discharge and fine line erasing electric discharge for each sub-field. As a result, unnecessary light emitting is erased for displaying black brightness so that the contrast is improved.

The second embodiment of the present invention is described hereinafter. Fig. 11 illustrates a second driving system in accordance with a second embodiment of the present invention. Fig.(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis shows time and a vertical axis shows lines of cells.

Fig. 11(b)-Fig. 11(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 70 illustrates a part of driving wave-form supplied to the common X electrode 22 in one field. A pulse wave-form 71 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 72 and 73 illustrate parts of driving wave-form supplied, for example, to a first and a second independent Y electrodes 23.



The pulse wave-form 70 which is supplied to the common X electrode 22 during first sub-field includes a regulating pulse 40 lasting from the electric charge particle equalizing period 2a to the address period 2b and the sustaining pulses 41 and a fine line erasing pulse 74 in the sustaining period 2c. The pulse wave-form 71 which is supplied to one of the address A electrodes 29 illustrates the address pulse 42 in the address period 2b which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 71 and 72 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a electric charge particle equalizing pulse 43a 43b,--- in the electric charge particle equalizing period 2a of the first sub-field, scan pulse 44a, 44b,---in the address period 2b, sustaining pulses 45a, 45b,--- and a first fine line erasing pulses 75a, 75b,--- in the sustaining period 2c.

Under these circumstances, the pulse width of the first fine line erasing pulses 75a, 75b,---is the same with or shorter than a pulse width of a second fine line erasing pulse 74. The number of the fine line erasing pulses is an even number as shown in Fig. 11, that is, the first and the second fine line erasing pulses 75a, 75b and 74, the first fine line erasing



pulses 75a, 75b,---which are the last erasing pulses and the equalizing pulses 43a, 43b,---are supplied to the same electrodes, that is, the independent Y electrode 23 of Fig. 11. The second fine line erasing pulse 74 is
5 supplied to the other electrode, that is, the common X electrode 22.

In the embodiment, the last sustaining pulse is supplied to the independent Y electrode 23. A condition of electric charge particles after supplying the first
10 fine line erasing pulses 75a, 75b,---is almost same as the condition shown in Fig. 8. in accordance with the first embodiment. The condition of electric discharges in the other sub-fields 3-9 are the same condition. Further, the erasing and polarizing of electric charge
15 particles are performed by these fine line erasing pulses, so these erasing pulses are called polarization pulse group. In this embodiment, by using the first and the second fine line erasing pulses 75a, 75b and 74, the erasing and polarization are effectively performed, and
20 electric discharging time during address discharging time is maintained constant.

The third embodiment of the present invention is described hereinafter. Fig. 12 illustrates a third driving system in accordance with a third embodiment of
25 the present invention. Fig. 12(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure

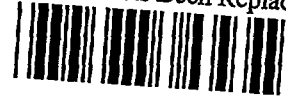


illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells.

5 Fig. 12(b)-Fig. 12(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 80 illustrates a part of
10 driving wave-form supplied to the common X electrode 22 in first sub-field. A pulse wave-form 81 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 82 and 83 illustrate parts of driving wave-forms supplied, for
15 example, to a first and a second independent Y electrodes 23.

The pulse wave-form 80 which is supplied to the common X electrode 22 during the first sub-field includes a regulating pulse 40 lasting from the electric
20 charge particle equalizing period 2a to the address period 2b and the sustaining pulses 41 in the sustaining period 2c and second fine line erasing pulse 84. The pulse wave-form 81 which is supplied to one of the address A electrodes 29 illustrates the address pulse 42
25 in the address period 2b which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-



forms 82 and 83 which are supplied to the first
electrode of the independent Y electrodes 23 and
adjacent second electrode of the independent Y
electrodes 23 includes electric charge particles
5 equalizing pulse 43a 43b,--- in the electric charge
particles equalizing period 2a of the first sub-field,
scan pulses 44a, 44b,---in the address period 2b,
sustaining pulses 45a, 45b,--- and a third fine line
erasing pulses 85a, 85b,--- and a first fine line
10 erasing pulses 86a, 86b,--- in the sustaining period 2c.

Under these circumstances, the pulse width of
the second fine line erasing pulses 84 is the same as
or shorter than a pulse width of a third fine line
erasing pulses 85a, 85b,---.

15 And a pulse width of the first fine line erasing
pulses 86a, 86b,--is the same as or shorter than a pulse
width of the second fine line erasing pulse 84

If the numbers of the fine line erasing pulses
are an odd number as shown in Fig. 12, that is, the
20 first to the third fine line erasing pulses, the first
fine line erasing pulses 86a, 86b,---which are the last
supplied erasing pulses and the equalizing pulses 43a,
43b,---are supplied to the same electrodes, that is, the
independent Y electrode 23 of Fig. 12. The third fine
25 line erasing pulse 85 which is first supplied fine line
erasing pulse is supplied to the same electrode to which
first supplied fine line erasing pulses 86a and 86b are



supplied, that is, the independent Y electrode 23. Therefore, the last sustaining pulse is supplied to the common X electrode 22. A condition of electric charge particles after supplying the first fine line erasing pulses 86a, 86b,---is almost same condition as shown in Fig. 8 in accordance with the first embodiment. The condition of electric discharges in the other sub-fields 3-9 is the same condition. In the embodiment, by using the first, the second and the third fine line erasing pulses 86a, 86b, 84, 85a and 85b, the erasing and polarization are more effectively performed, and electric discharging time during address discharging time is maintained constant. According to an experiment by present inventors, it is effective for erasing up to three fine line erasing pulses and using more than four fine line erasing pulses is not so effective.

The fourth embodiment of the present invention is described hereinafter. Fig. 13 illustrates a fourth driving system in accordance with a fourth embodiment of the present invention. Fig. 13(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells.

Fig. 13(b)-Fig. 13(e) illustrate wave-forms of



pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

5 A pulse wave-form 90 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub- field. A pulse wave-form 91 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 92 and 93 illustrate parts of driving wave-forms supplied,
10 for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 90 which is supplied to the common X electrode 22 during the first sub-field includes a regulating pulse 94 lasting from the electric
15 charge particles equalizing period 2a to the address period 2b and the sustaining pulses 41 in the sustaining period 2c.

The voltage of the regulating pulse 94 and the voltage of the sustaining pulses 41 are the same,
20 thereby a driving circuit is simplified because the same power is used.

The pulse wave-form 91 which is supplied to one of the address A electrodes 29 illustrates the address pulses 42 in the address period 2b which corresponds to the
25 light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 92 and 93 which are supplied to the first



5 wave-forms 92 and 93 which are supplied to the first
electrode of the independent Y electrodes 23 and
adjacent second electrode of the independent Y
electrodes 23 includes a electric charge particle
equalizing pulse 43a 43b,--- in the electric charge
particle equalizing period 2a of the first sub-field,
scan pulse 44a, 44b,---in the address period 2b,
sustaining pulses 45a, 45b,--- and fine line erasing
pulses 46a, 46b,--- in the sustaining period 2c. A
10 condition of electric charge particles after supplying
the fine line erasing pulses 46a, 46b,---is almost same
condition as shown in Fig. 8 which illustrates the
condition of electric charge particles in accordance
with the first embodiment. The condition of electric
15 discharge in the other sub-fields 3-9 is the same
condition. In the embodiment, the voltage of the
regulating pulse 94 supplied to the common X electrode
22 and the voltage of the sustaining pulses are the same,
therefore simplifying the driving circuit construction.

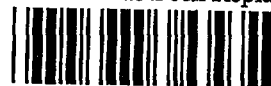
20 The fifth embodiment of the present invention is
described hereinafter. Fig. 14 illustrates a fifth
driving system in accordance with a fifth embodiment of
the present invention. Fig. 14(a) is a time chart
illustrating an arrangement of sub-fields in one field
25 in accordance with the present invention. The figure
illustrates a division of one field into several sub-
fields such as the case of Fig. 5. A horizontal axis



illustrates time and a vertical axis illustrates line of cells. Fig. 14(b)-Fig. 14(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 100 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 101 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 102 and 103 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 100 which is supplied to the common X electrode 22 during the first sub-field includes a regulating pulse 94 lasting from the electric charge particle equalizing period 2a to the address period 2b and the sustaining pulses 41 in the sustaining period 2c. The voltage of the regulating pulse 94 and the voltage of the sustaining pulses 41 are the same as the fourth embodiment shown in Fig. 13, thereby a driving circuit is simplified because the same power is used. The pulse wave-form 101 which is supplied to one of the address A electrodes 29 illustrates the address pulses 42 in the address period 2b which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse



5 wave-forms 102 and 103 which are supplied to the first
electrode of the independent Y electrodes 23 and
adjacent second electrode of the independent Y
electrodes 23 includes electric charge particles
equalizing pulse 43a 43b,--- in the electric charge
particle equalizing period 2a of the first sub-field,
scan pulses 104a, 104b,---in the address period 2b,
sustaining pulses 45a, 45b,--- and fine line erasing
pulses 46a, 46b,--- in the sustaining period 2c. The
10 voltage of the independent Y electrode 23 during the
address period 2c and the voltage of the sustaining
pulses 45a, 45b,--- are the same, thereby a driving
circuit is simplified because the same power is used. A
condition of electric charge particles after supplying
15 the fine line erasing pulses 46a, 46b,---is almost same
condition as shown in Fig. 8 which illustrates the
condition of electric charge particles in accordance
with the first embodiment. The condition of electric
charge particles in the other sub-fields 3-9 is the same
20 the condition.

The sixth embodiment of the present invention is
described hereinafter. Fig. 15 illustrates a sixth
driving system in accordance with a fifth embodiment of
the present invention. Fig. 15(a) is a time chart
25 illustrating an arrangement of sub-fields in one field
in accordance with the present invention. The figure
illustrates a division of one field into several sub-



fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 15(b)-Fig. 15(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 110 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 111 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 112 and 113 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 111 which is supplied to the common X electrode 22 during the first sub-field includes a first regulating pulse 114 in the electric charge particle equalizing period 2a, a second regulating pulse 115 in the address period 2b and the sustaining pulses 41 in the sustaining period 2c. In the embodiment, the regulating pulse supplied to the common X electrode 22 is divided into the first regulating pulse 114 in the electric charge particle equalizing period 2a and the second regulation pulse 115 in the address period 2b. The pulse wave-form 111 which is supplied to one of the address A electrodes 29 includes the address pulses 42 in the address period 2b



which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 112 and 113 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a electric charge particle equalizing pulses 43a 43b,--- in the electric charge particle equalizing period 2a of the first sub-field, a scan pulse 114a, 114b,---in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same condition. In Fig. 15, the falling edge of the first regulating pulse is slightly earlier than that of the equalizing pulse 43a, thereby preventing electric discharging by mistake between the common X electrode 22 and the independent Y electrode. Further, a rising edge of the second regulating pulse and a rising edge of the scan pulses 115 is effected at the same time, thereby preventing electric discharge by mistake between the common X electrode 22 and the independent Y electrode 23.

The first regulating pulse 114 supplied to the



common X electrode 22 and the sustaining pulses 41 may use the same voltage.

The seventh embodiment of the present invention is described hereinafter. Fig. 16 illustrates a seventh driving system in accordance with a seventh embodiment of the present invention. Fig. 16(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 16(b)-Fig. 16(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

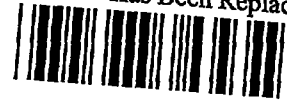
A pulse wave-form 130 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 131 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 132 and 133 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 131 which is supplied to the common X electrode 22 during the first sub-field includes a first regulating pulse 134 in the electric charge particle equalizing period 2a, a second



regulating pulse 135 in the address period 2b and the sustaining pulses 41 in the sustaining period 2c. The pulse wave-form 131 which is supplied to one of the address A electrodes 29 includes the address pulses 42
5 in the address period 2b of the first sub-field which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 132 and 133 which are supplied to the first electrode of the independent Y
10 electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a electric charge particle equalizing pulse 136a 136b,--- in the electric charge particle equalizing period 2a of the first sub-field, a scan pulse 137a, 137b,---in the address period
15 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c.

A falling edge of the equalizing pulse 136a, 136b,---becomes zero voltage within the time less than 1 μ s in accordance with the present embodiment which is
20 different from above mentioned embodiment. As the voltage of the second regulating pulse 135 and the scan pulses 137a, 137b, the same voltage of the sustaining pulses 41, 45a, 45b,---is able to apply. A condition of electric charge particles after supplying the fine line
25 erasing pulses 46a, 46b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first

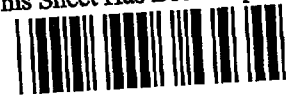


embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same condition.

In the embodiment, the edge of the first regulating pulse 139 falls before the edge of the equalizing pulse falls as shown in Fig. 16, thereby preventing electric discharge by mistake between the common X electrode 22 and the independent Y electrode.

The eighth embodiment of the present invention is described hereinafter. Fig. 17 illustrates a eighth driving system in accordance with a eighth embodiment of the present invention. Fig. 17(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 17(b)-Fig. 17(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 140 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 141 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 142 and 143 illustrate part of driving wave-form supplied, for example, to a first and a second independent Y



electrodes 23.

The pulse wave-form 141 which is supplied to the common X electrode 22 during the first sub-field includes a first regulating pulse 144 in the electric charge particle equalizing period 2a, a second
5 regulating pulse 145 in the address period 2b and the sustaining pulses 41 in the sustaining period 2c.

According to the present embodiment, the voltage of the first regulating pulse 144 is set higher than the
10 voltage of the sustaining pulses 41. The pulse wave-form 141 which is supplied to one of the address A electrodes 29 includes the address pulses 42 in the address period 2b of the first sub-field which corresponds to the light emitting cell. The address
15 pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 142 and 143 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a electric charge
20 particle equalizing pulse 136a 136b,--- in the electric charge particle equalizing period 2a of the first sub-field, a scan pulse 137a, 137b,---in the address period 2b, a sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c.

25 The voltage of the second regulating pulse 144 and the scan pulses 137a, 137b,---can be set the same voltage of the sustaining pulses 41, 45a, 45b,---. A



condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same with the condition.

According to the present embodiment, the voltage of the first regulating pulse 144 is higher than that of the sustaining pulses 41. By using higher voltage of the first regulating pulse 144, a lot of negative electric charge particles can be collected, and as a result, a lot of positive electric charge particles are collected on the address electrode 29 side, thereby address discharging is performed so easily.

The ninth embodiment of the present invention is described hereinafter. Fig. 18 illustrates a ninth driving system in accordance with a ninth embodiment of the present invention. Fig. 18(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 18(b)-Fig. 18(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y



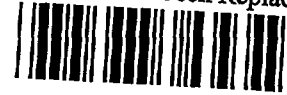
electrode respectively.

A pulse wave-form 150 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 151
5 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 152 and 153 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

10 The pulse wave-form 151 which is supplied to the common X electrode 22 during the first sub-field includes a equalizing pulse 153 in the electric charge particle equalizing period 2a, a second regulating pulse 154 in the address period 2b and the sustaining
15 pulses 41 and a fine line erasing pulse 155 in the sustaining period 2c.

According to the present embodiment, the only one fine line erasing pulse 155 is provided. The equalizing pulse 153 is supplied to the electrode to
20 which the fine line erasing pulse 155 is supplied such as the case of the fifth embodiment. In case the numbers of the fine line erasing pulses are two or three as shown in the second and the third embodiment (see Fig. 11 and Fig. 12), the equalizing pulses are supplied to
25 the electrode to which the last fine line erasing pulse is supplied.

The pulse wave-form 151 which is supplied to one



of the address A electrodes 29 includes the address
pulses 42 in the address period 2b of the first sub-
field which corresponds to the light emitting cell. The
address pulses 42 are not supplied when there is no cell
5 to be emitted. The pulse wave-forms 152 and 153 which
are supplied to the first electrode of the independent Y
electrodes 23 and adjacent second electrode of the
independent Y electrodes 23 include a first regulating
pulse 156a, 156b,--- in the electric charge particle
10 equalizing period 2a of the first sub-field, a scan
pulse 137a, 137b,---in the address period 2b, sustaining
pulses 45a, 45b,--- in the sustaining period 2c.

In the embodiment, the first regulating pulses
156a, 156b,---are supplied within the lapse of time 0.3
15 μ sec to 2 μ sec from the rising edge of the equalizing
pulse 153.

The voltage of the second regulating pulse 144
and the scan pulses 137a, 137b,---can be set the same
voltage of the sustaining pulses 41, 45a, 45b,---as
20 shown in the fifth embodiment (see Fig. 14) A condition
of electric charge particles after supplying the fine
line erasing pulses 46a, 46b,---is almost same condition
as shown in Fig. 8 which illustrates the condition of
electric charge particles in accordance with the first
25 embodiment. The condition of electric discharge in the
other sub-fields 3-9 is the same with the condition.

According to the present embodiment, the first



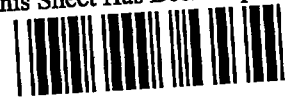
regulating pulse 43a, 43b,---are similar to the
equalizing pulse 43a, 43b,---as shown in Fig. 15, but a
equalizing pulse according to the present invention is a
pulse that rises first during electric charge particle
5 equalizing period. The reason for providing 0.3 μ sec to
2 μ sec period between the rising edge of the equalizing
pulse 153 and the rising edge of the first regulating
pulse 156a, 156b,---has already explained.

From Fig. 19 to Fig. 23 are sectional views of
10 the plasma display panel in accordance with the ninth
embodiment in which the condition of electric charge
particles in the cell performed electric discharge for
light emitting are illustrated from the first sub-field
after the power is supplied to the second sub-field
15 until the equalizing pulses and the regulating pulse are
supplied. In these drawings, reference numeral 60
denotes a positive electric charge particle, reference
numeral 61 denotes a negative electric charge particle.
Further the condition of electric charge particles is
20 illustrated in a cell at center position of Fig. 19
through Fig. 23.

Fig. 19 is a sectional view of a plasma display
panel in which a condition of electric charge particles
in a cell is illustrated immediately after a power is
25 supplied and then a equalizing pulse and a protecting
pulse are supplied. The figure illustrate the condition
of electric charge particles in first sub-field after

power is supplied at first and then the equalizing
pulses 153 are supplied to the common X electrode 22 and
finally the first regulating pulses 156a, 156b,--- are
supplied. The electric discharge occurs between the
5 common X electrode 22 and the independent Y electrodes
23 by supplying the equalizing pulses 153 to the
independent Y electrodes 23 in all cells, and the
negative electric charge particles 61 are gathered on
the dielectric layer in the vicinity of the independent
10 Y electrodes 23a and the common X electrode 22 and the
positive electric charge particles 60 are gathered on
the address A electrodes 29 side.

Fig. 20 is a sectional view of a plasma display
panel in accordance with the ninth embodiment in which a
15 condition of electric charge particles in a cell after
performing an address electric discharge is illustrated.
In Fig. 20, the condition of electric discharges is
illustrated after the address pulses 42 is supplied to
the address A electrodes 29 and address electric
20 discharges are performed between the address A electrode
29 and the independent Y electrode 23. The positive
electric charge particles 60 are gathered on the
dielectric layer in the vicinity of the independent Y
electrode 23 because the voltage of the independent Y
25 electrode 23 is lower than the voltages of the address A
electrode 29 and the common X electrode 22. The
negative electric charge particles 61 are gathered on



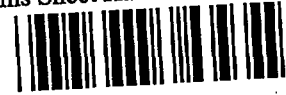
the other electrode side.

The condition of the electric charge particles is shown in Fig. 20. The sustaining electric discharge occurs between the independent Y electrode 23 and the common X electrode 22 by the positive electric charges particles 60 and the first pulse of the sustaining pulses 45a, 45b,---supplied to the independent Y electrode 23. This is a sustain discharge.

Fig. 21 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a fine line erasing pulse is illustrated. In Fig. 21, the condition of electric discharge after the last sustaining pulses 45a, 45b,--- are supplied to the independent Y electrode and then the fine line erasing pulses 155 are supplied to the common X electrode 22 is illustrated.

The pulse width of the fine line erasing pulse 155 is longer than the discharge continuation time, so that negative electric charges particles 61 which move so quickly are gathered on the dielectric layer in the vicinity of the common X electrode 22. The positive electric charge particles that move slowly in space float in the cell. The negative charges float discharge space for a while.

Fig. 22 is a sectional view of a plasma display panel in accordance with the ninth embodiment in which a condition of electric charge particles in a cell after



supplying a equalizing pulses in a second field is illustrated.

In Fig. 22, a condition of electric discharge after the equalizing pulse 153 in the second sub-field is supplied is illustrated. The voltage of the
5 equalizing pulse 153 is canceled by the negative charge particles 61 and is not reached to the discharge voltage, so that any electric discharge is not occurred.

Fig. 23 is a sectional view of a plasma display
10 panel in which a condition of electric charges in a cell after supplying a regulating pulse in a second field is illustrated.

In the figure, the condition of electric charge particles after the first regulating pulses 156a, 156b,--
15 -- are supplied to the independent Y electrode 23 is illustrated. The negative electric charge particles 61 are gathered on the dielectric layer in the vicinity of the common X electrode 22 and the independent Y electrode 23, and the positive electric charge particles
20 60 are gathered on the address A electrode 29. By this, the same driving as the first sub-field is performed without electric discharge by the equalizing pulses 153.

The tenth embodiment of the present invention is described hereinafter. Fig. 24 illustrates a tenth
25 driving system in accordance with a tenth embodiment of the present invention. Fig. 24(a) is a time chart illustrating an arrangement of sub-fields in one field



in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 18. A horizontal axis illustrates time and a vertical axis illustrates line of
5 cells. Fig. 24(b)-Fig. 24(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 160 illustrates a part of
10 driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 161 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 162 and 163 illustrate parts of driving wave-forms supplied,
15 for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 160 which is supplied to the common X electrode 22 during the first sub-field includes a equalizing pulse 163 in the electric charge
20 particle equalizing period 2a, a second regulating pulse 165 which continues from equalizing pulse 164 in the electric charge particle equalizing period 2a and the address period 2b and the sustaining pulses 41 and a fine line erasing pulse 155 in the sustaining period 2c.

25 According to the present embodiment, the only one fine line erasing pulse is provided. The equalizing pulse 164 is supplied to the electrode to which the fine



line erasing pulse 155 is supplied such as the case of the first embodiment. In case the numbers of the fine line erasing pulses are two or three as shown in the second and the third embodiment (see Fig. 11 and Fig. 12), the equalizing pulse is supplied to the electrode to which the last fine line erasing pulse is supplied. The pulse wave-form 161 which is supplied to one of the address A electrodes 29 includes the address pulses 42 in the address period 2b of the first sub-field which correspond to the light emitting cell. The address pulses 42 are not supplied when there is no cell to be emitted. The pulse wave-forms 162 and 163 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a first regulating pulse 156a, 156b,--- in the electric charge particle equalizing period 2a of the first sub-field, scan pulses 137a, 137b,---in the address period 2b, sustaining pulses 45a, 45b,--- in the sustaining period 2c. In the embodiment, the first regulating pulses 156a, 156b,--- are supplied within the lapse of time 0.3 μ sec to 2 μ sec from the rising edge of the equalizing pulse 153. The voltage of the second regulating pulse 165 and the scan pulses 137a, 137b,---can be set the same voltage of the sustaining pulses 41, 45a, 45b,---as shown in the ninth embodiment (see Fig. 18). The other sub-fields 3-9 are constructed the same as the first sub-field.



A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---are almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same condition.

According to the present embodiment, the reason for setting the voltage of the equalizing pulse 164 a higher voltage is to collect the negative electric charge particles on the common X electrode side, and to collect lots of positive electric charge particles on the address A electrode 29. Further, the reason for setting the voltage of the second regulating pulse 165 in the address period 2b is to protect electric discharging by mistake between the common X electrode 22 and the independent Y electrode 23.

The eleventh embodiment of the present invention is described hereinafter. Fig. 25 illustrates a eleventh driving system in accordance with a eleventh embodiment of the present invention. Fig. 25(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 25(b)-Fig. 25(e) illustrate wave-

forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

5 A pulse wave-form 170 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 171 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 172 and 173 illustrate parts of driving wave-forms supplied,
10 for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 170 which is supplied to the common X electrode 22 during the first sub-field includes a regulating pulse 40 in the period continuing
15 from the electric charge particles equalizing period 2a to the address period 2b and the sustaining pulses 41 in the sustaining period 2c. The pulse wave-form 171 which is supplied to one of the address A electrodes 29 includes a voltage holding pulse 174 whose voltage is
20 determined not to occur a discharge by the scan pulses 44a, 44b,--- and the address pulses 42 in the address period 2b of the first address period 2b which corresponds to the light emitting cell and between the address electrode 29 and the independent Y electrode 23.
25 The address pulses 42 is not supplied when there is no cell to be emitted. According to the present embodiment, the voltage needed for the address electric discharging



is the sum of the voltage of the voltage holding pulse 174 and the voltage of address pulses 175, thereby reducing the voltage of the address pulses 175. The address pulses 175 is not supplied when there is no cell
5 to be emitted. The pulse wave-forms 172 and 173 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 include equalizing pulses 43a, 43b,--- in the electric charge particle equalizing
10 period 2a of the first sub-field, a scan pulse 44a, 44b,---in the address period 2b, sustaining pulses 45a, 45b,--- in the sustaining period 2c. The voltage of the regulating pulse 40 and the scan pulses 44a, 44b,---can be determined to the same voltage of sustaining pulses
15 41, 45a, 45b,---.

A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost the same condition as shown in Fig. 8 which illustrates the condition of electric charge particles
20 in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same condition.

The twelfth embodiment of the present invention is described hereinafter. Fig. 26 illustrates a twelfth
25 driving system in accordance with a twelfth embodiment of the present invention. Fig. 26(a) is a time chart illustrating an arrangement of sub-fields in one field



in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 26(b)-Fig. 26(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 180 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 181 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. pulse wave-forms 182 and 183 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 180 which is supplied to the common X electrode 22 during the first sub-field includes a regulating pulse 184 in the electric charge particles particle equalizing period 2a, the sustaining pulses 41 in the sustaining period 2c.

The pulse wave-form 181 which is supplied to one of the address A electrodes 29 includes the address pulses 42 in the address period 2b of the first address period which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 182 and 183



which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 include a equalizing pulse 43a, 43b,--- in the electric charging
5 equalizing period 2a of the first sub-field, scan pulses 137a, 137b,---in the address period 2b, sustaining pulses 185a, 185b,---in the address period 2b and sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. The
10 voltage of the regulating pulse 184 can be determined the same the voltage of the sustaining pulses 41.

A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost same condition as shown in Fig. 8 which
15 illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same condition. According to the present embodiment, the voltage of the scan pulses 185a, 185b,---is minus
20 voltage and the voltage of the address pulses 42 is plus voltage, therefore the voltage differences becomes so large that the electric discharge is performed surely.

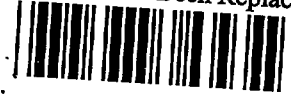
The thirteenth embodiment of the present invention is described hereinafter. Fig. 27 illustrates
25 a thirteenth driving system in accordance with a thirteenth embodiment of the present invention. Fig. 27(a) is a time chart illustrating an arrangement of



sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 18. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 27(b)-Fig. 27(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 190 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 191 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 192 and 193 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The wave-form 190 which is supplied to the common X electrode 22 during the eighth sub-field and the field blank period 9d thereafter includes a regulating pulse 40 in the electric charge particle equalizing period 2a and the address period 2b lasting from the equalizing period 2a, sustaining pulses 41 and a full writing pulse 194 in the sustaining period 2c. In the embodiment, the voltage of the full writing pulse 194 is higher enough to be discharged regardless the sustaining discharge is performed or not. As a result, the electric charge particles in all cells are equalized.



The field blank period 9d can be provided between the sub-fields. And also, the field blank period 9d is able to arrange several times in one field. The pulse waveform 191 which is supplied to one of the address A electrodes 29 includes the address pulses 42 in the address period 2b. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 192 and 193 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 include the equalizing pulses 43a, 43b,--- in the electric charging equalizing period 2a, the scan pulses 44a, 44b,---in the address period 2b, the sustaining pulses 45a, 45b,--- in the sustaining period 2c and fine line erasing pulses 195a, 195b,---in the field blank period 9d. The voltage of the regulating pulse 40 and the scan pulses 44a, 44b, --- can be determined the same as the voltage of the sustaining pulses 41. A condition of electric charge particles after supplying the fine line erasing pulses 195a, 195b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same as the condition.

According to the present embodiment , any electric charge particle in the cells is not remained



when black portion continues across several sub-fields,
and the address electric discharges are not performed
well in the coming address period. To prevent this
situation, a discharges are forced by the field full
5 writing pulse 194 between the common X electrode 22 and
the independent Y electrode 23.

As explained the above, the plasma display
driving system in accordance with the first through the
twelfth embodiments can drive the panel without using
10 the full writing electric discharge and erasing
discharge for all the cells for equalizing the electric
charge particles .

Still another embodiments of the present
invention will be explained hereinafter.

15 Fig. 28 illustrates driving system of a plasma
display panel in accordance with a fourteenth embodiment
of the present invention. Fig. 28(a) is a time chart
illustrating an arrangement of sub-fields in the first
sub-field. A horizontal axis illustrates time, and a
20 vertical axis illustrates lines of cells. Fig. 28(b)-
Fig. 28(g) are wave-forms illustrating pulse wave-forms
supplied to a common X electrode, address A electrode
and four independent Y electrode respectively. In the
figure, reference numeral 201 denotes a field, reference
25 numerals 202-203 denote sub-fields, reference numeral
202a-209a denote address periods, reference numeral
202b-209b denote sustaining periods, reference numeral



210-213 denote field blocks, reference numeral 210a-213a denote full writing periods. A wave-form 220 is a driving wave-form supplied to the common X electrode, A wave-form 221 is a driving wave-form supplied to the address A electrode 29, wave-forms 222-225 are driving wave-forms supplied to a first, a second, a third and a fourth electrodes of the independent Y electrodes 23.

In Fig. 28(a), one field period 201 is divided into eight sub-fields 202-209, one field block is arranged by two successive sub-fields, therefore one field period 201 is constructed by four field blocks.

In each field block, the full writing periods 210a, 211a, 212a and 213a which are arranged first period of sub-fields are provided in each first sub-field 202, 204, 206 and 208 of the field blocks 210-213, and following the writing period 210a-213a, the address period 202a, 204a, 206a and 208a and sustaining period 202b, 204b, 206b and 208b are provided. In the second sub-fields 203, 205, 207 and 209 which follow the first sub-fields 202-208, the address period 203a, 205a, 207a and 209a are provided first, and then the sustaining period 203b, 205b, 207b and 209b are provided.

The numbers of light emitting are allotted for each sustaining period 202b-209b, and display graduations are effected by the combinations of the numbers of the light emitting. The numbers of light emitting and the order of the sub-fields are optional.



In the embodiment, the numbers of light emitting of the sustaining periods 202b, 204b, 206b, 208b, 203b, 205b, 207b and 209b are arranged in this order from few numbers. The sustaining period 202b, 204b, 206b and 208b just before the sub-fields 203, 205, 207 and 209 in which the full writing erase period are not provided have fewer numbers of light emitting.

Fig. 28(b) illustrates the field block 210, and the other field blocks are constructed similarly. The driving wave-form 220 supplied to the common X electrode 22 includes in the first sub-field 202 a full writing pulse 240 and a polarizing pulse 241 in the first full writing erasing period 210a, a high pulse 242 in the succeeding address period 202a and sustaining pulses 243 and a electric charge particle control pulse 244 and a fine line erasing pulse 245 in the succeeding sustaining period 202b, and further include in the succeeding sub-field a high pulse 246 and sustaining pulses 247.

The voltage of the electric charge particle control pulse 244 and the fine line erasing pulse 245 is the same as or less than the voltage of the sustaining pulses 243. Next to the sustaining pulses 247 is the field block 211. The voltage of the full writing pulse 240 is stepped up a level. The voltage is usually determined about 300 volts, and the reason for stepping up a level is to construct the circuit simply, therefore the stepping up the voltage of full writing pulse 240 is

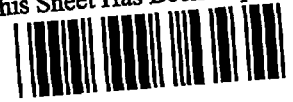


not always necessarily.

The driving wave-form 221 supplied to the address A electrode 29 shown in Fig. 28(a) includes, in the first sub-field, plurality of the address pulses 248a, 248b,--- which relates to the cells to be emitted in the address period 202a, and include, in the succeeding sub-field 203, plurality of address pulses 249a, 249b,--- in the address period 203a.

Fig. 28(d)-28(g) are wave-forms 222,223,224 and 225 supplied to four independent Y electrodes 23 whose electrodes 23 are arranged side by side include, in the first sub-field 202, scan pulses 250a, 250b, 250c, 250d,--- in the address period 202a, sustaining pulses 251a, 251b, 251c, 251d,--- selection electric discharge pulses 252a, 252b, 252c, 252d---, fine line erasing pulses 253a, 253b, 253c, 253d,--- in the sustaining period 222b and include, in the succeeding sub-field 203, scan pulses 254a, 254b, 254c, 254d,---, in the address period 203a, sustaining pulses 255a, 255b, 255c, 255d,-- - in the sustaining period 203b.

The voltage of selection electric discharge pulses 252a, 252b, 252c, 252d,--- is almost the same as the voltage of the electric charge particle control pulse 244, and the electric charge particle control pulse 244 rises with time lag from the rising edge of the selection electric discharge pulses 252a, 252b, 252c, 252d,---, and the delay time t_1 is 0.1 μsec -1.5 μsec .



The electric charge particle control pulse 244 falls earlier than the selection electric discharge pulses 252a, 252b, 245c, 252d,---. The time t_2 is about 0.1 μ sec-1.0 sec. The reason for setting the time lag from
5 the rising edge of the election electric discharge pulses 252a-252d to the rising edge of the electric charge particle control pulse 244 as above mentioned is that, if the time sets longer than that, a lot of negative electric charge particles gathers on the
10 independent Y electrode 23, and a few negative electric charge particles gathers on the common X electrode 22. Further, the reason for rising the selection electric discharge pulses 252a-252d a little earlier than the electric charge particles control pulse 244 is to cause
15 the electric discharge by the selection electric discharging between the common X electrode 22 and independent Y electrode 23. The reason for falling the electric charge particles 244 is to defends the electric charge between the common X electrode 22 and the
20 independent Y electrode 23 when the selection electric discharge pulses 252a-252d falls.

The selection electric discharge pulses 252a, 252b, 252c, 252d,---, the fine line erasing pulses 253a, 253b, 253c, 253d,--- and the electric discharge particle
25 control pulse 244 are not provided in the succeeded sub-field 203 of the field block 210 of Fig. 28(a).

The sustaining pulses of the sub-field 203



terminate with the sustaining pulses 255a, 255b, 255c, 255d,--- supplied to the independent Y electrodes 23.

The same driving wave-forms are used in the other field blocks 211-213, but the numbers of the sustaining pulses are different. The selection electric discharge pulses, the electric charge particle control pulse and the fine line erasing pulses are provided in the first sub-field 204, 206, 208 of the field blocks 210-213.

The function of the embodiment is explained with Fig. 29-Fig. 32.

The electric discharges occur in all the cells by the full writing pulse 240 supplied to the common X electrode 22 in the field block 210 of Fig. 28(a)-Fig. 28(b) and the electric charge particles are formed. Under these circumstances, the negative electric charge particles 61 are gathered on the address A electrode 29 side. The electric discharge for polarization occurs by the polarization pulse 241, and electric discharge particles on the common X electrode 22 side and the independent Y electrode 23 side are polarized.

The scan pulses 250a of the wave-form 222 are supplied to the first line of the independent Y electrode 23 and at the same time, the address pulses 248a are supplied to the predetermined address A electrode 29 in the succeeded address period 202a, thereby generating full writing electric discharge and

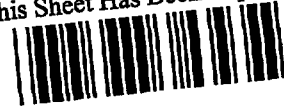


forming the electric charge particles in the cell positioned at the cross point of first line of the independent Y electrode 23 and the address A electrode 29, and the positive electric charge particles are gathered on the independent Y electrode 23 side in the cell.

In a similar way, when the scan pulses 250c of the driving wave-form 224 are supplied to the third independent Y electrode 23 and the address pulse 248b is supplied to predetermine address A electrode 29, thereby generating full writing electric discharge and forming the electric charge particles in the cell positioned at the cross point of the third line of the independent Y electrode 23 and the address A electrode 29, and the positive electric charge particles 60 are gathered on the independent Y electrode 23 side in the cell.

The address pulses which correspond to the scan pulses 250b, 250d of the driving wave-form 223, 225 supplied to the second and the fourth independent Y electrode 23 are not supplied when the predetermined cells are not emitted, therefore, writing electric discharges do not occur and electric charge particle is not formed on the independent Y electrode 23 side.

The sustaining discharge or light emitting discharge in the sustaining period 202b occurs by the sustaining pulses 234 of the driving wave-form 220 and the sustaining pulses 251a, 251b, 251c, 251d,---, of the



driving wave-forms 222, 223, 224, 225 in the cell in which the positive electric charge particles are gathered on the independent Y electrode 23 side.

5 The optional or selecting electric discharges occur by the selection electric discharge pulses 252a, 252b, 252c and 252d in the cell in which the sufficient electric charge particles are formed by the electric discharge for light emitting. The positive electric discharge particles 60 are gathered on the address A
10 electrode 29 side by supplying electric charge particle control pulse 244 to the common X electrode 22 before the electric discharges by the selection electric discharge pulses 252a, 252b, 252c, 252d,---, cease.

After that, the erasing electric discharge is
15 caused by the fine line erasing pulse 245 of the wave-form 220 supplied to the common X electrode 22 and the fine line erasing pulses 253a, 253b, 253c, 253d,---, of the wave-form 222 supplied to the independent Y electrode 23, and the electric charge particles on the
20 common X electrode 22 side and on the independent Y electrode 23 side are mainly erased. Thereby, the condition of the electric charge particles in all cells in which the electric discharges are caused is almost same as the condition of the electric charge particles
25 after the full writing erasing period 210a is finished.

On the other hand, the writing electric discharges or the address electric discharges are not



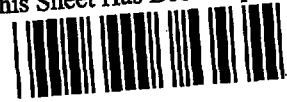
caused in the cells in which the electric discharges for light emitting are not caused and the condition of electric charge particles are the same condition after the full writing erasing period 210a is finished.

5 As explained above, the electric charge particles in all cells at a point of time after the final erasing pulses 245, 253a, 253b, 253c, 253d,---, are supplied in the first sub-field 202 can be made the same condition after the full writing erasing period
10 210a is finished. By this, in the succeeding sub-field, address electric discharges in all the cell can be caused without providing a full writing erasing period.

The same functions are repeated in the field blocks 211-213, and a screen of one field is constructed.

15 Fig. 29-Fig. 32 are sectional views of plasma display panel illustrating a condition of the electric charge particles in a cell in which a sustaining discharge is performed. Referring now to the drawing, wherein like numerals are utilized to designate like
20 parts throughout the several views, reference numeral 60 denotes a positive electric charge particles and reference numeral 61 denotes negative electric charge particles. The condition of the electric charge particles in the drawings is illustrated in a center
25 cell of three cells.

Fig. 29 is a sectional view of a plasma display panel in which a condition of electric charge particles



in a cell after supplying sustaining pulses is illustrated in accordance with a embodiment shown in Fig. 28(a)-28(e) of the present invention. The negative electric charge particles 61 are gathered on the dielectric layer 26 of the common X electrode 22 side and the positive electric charge particles 60 are gathered on the dielectric layer 26 of the independent Y electrode 23 side after a final pulse of the sustaining pulses 243 is supplied to the common X electrode 22.

Fig. 30 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell during discharging by a selection electric discharge pulse is illustrated in accordance with the embodiment shown in Fig. 28(a)-28(e) of the present invention. Electric discharges are caused by the voltage of the selection electric discharge pulses 252a, 252b, 252c, 252d,--- and the voltage of positive electric charge particles gathered on the dielectric layer at the independent Y electrode 23 and caused between the independent Y electrode 23 and the common X electrode 22 when selection electric discharge pulses 252a, 252b, 252c, 252d,---, are supplied to the independent Y electrode. Thereby many positive and negative electric charge particles are generated in the discharging space.

Fig. 31 is a sectional view of a plasma display panel in which a condition of electric charge particles



in a cell when electric charge particle control pulse is supplied is illustrated in accordance with the embodiment shown in Fig. 28(a)-28(e) of the present invention. The positive electric charge particles are
5 gathered on the address A electrode 29 when the electric charge particle control pulse 244 is supplied to the common X electrode 22 because the voltages of the common X electrode 22 and the independent Y electrode 23 are almost same and the voltages are higher than the voltage
10 of address A electrode 29. Erasing of electric charge particles by erase pulse are still needed because there still remains electric charge particles on the common X electrode 22 side, on the independent Y electrode 23 side and in the discharging space which are not
15 neutralized and not erased.

Fig. 32 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a fine line erasing pulse is illustrated in accordance with the embodiment shown in
20 Fig. 28(a)-28(e) of the present invention. The positive electric charge particles 60 are gathered on the address A electrode 29 side and the negative electric charge particles 61 are gathered on the common X electrode 22 side and the independent Y electrode 23 side. The
25 condition of electric charge particles is the same after the full writing erase period 210a is finished.

A condition of electric charge particles after



the full writing erasing period 210a is finished is maintained in the sustaining period 202b because the address electric discharges are not performed in the cells in which no sustaining electric discharge is performed. Also, any electric discharge is not performed by the selection electric discharge pulses 252a, 252b, 252c, 252d,---, and there is no change in the condition of electric charge particles even if electric charge particle control pulse 244 and erasing pulse are supplied. Therefore, the condition of electric charge particles in all cells is almost same as the condition after the full writing erasing period 210a and the address electric discharge or a writing electric discharge is caused in next sub-field 203, thereby increasing the contrast by double.

By increasing the voltage of the address pulses 249a and 249b in the sub-field 203, 205, 207, 209 in which the full writing erasing period is not arranged, comparing with the voltage of the address pulses 249a and 249b in the other sub-field 202, 204, 206 and 208, the address electric discharges are caused surely even in the cell in which sustaining electric discharges are not performed, because the positive electric charge particles 60 on the address A electrode 29 side are reduced gradually by neutralization.

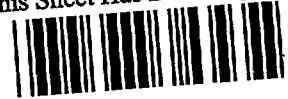
Fig. 33 is a time chart of sub-fields illustrating a driving system in accordance with a third



embodiment of the present invention. Referring to the drawing, a horizontal axis illustrates time, and a vertical axis illustrates lines of cells. Reference numeral 270 denotes one field period, 271-276 denote sub-fields, 271a-276a denote address periods, 271b-276b denote sustaining periods, 277 and 278 denote field blocks, 277a and 278a denote full writing erasing periods.

One field period 270 is divided into six sub-fields 271-276, and consecutive first three sub-fields 271-273 construct the field block 277 and succeeding consecutive three sub-fields 274-276 construct the other field block 278.

In the first period of these field blocks 277 and 278, the full writing erasing period 277a and 278a are arranged. In each sub-field 271-276, the address period 271a-276a and the sustaining period 271b-276b are arranged but the full writing erasing period 277a and 278a are not provided. That is, the full writing erasing period 277a and 278a are arranged at the first part of the first sub-fields 271 and 274 of the field blocks 277 and 278. The numbers of the light emitting are allotted for the sustaining period 271b-276b, and gradations of display are performed by the combining of the numbers of the light emitting. According to the fifteenth embodiment, the numbers of the light emitting are increased in order of the sub-fields 271, 272, 273.



The selection electric discharge pulse 252a-252d, the electric charge particle control pulse 244 and fine line erasing pulse 245, 253a-253b which are used in the fourteenth embodiment are provided in the first two sub-
5 fields 271, 272, 274, 275 of each field blocks 277 and 278, and these pulses are not provided in the other(last) sub-field. Further, these selection electric discharge pulses, electric charge particle control pulse and fine line erasing pulses are arranged
10 in the last part of the sustaining period 271b, 272b, 274b and 275b, thereby the condition of electric charge particles in all cells after sustaining period 271b, 272b, 274b and 275b are finished is maintained the same condition after the full writing erasing period 277a is
15 finished, so the full writing erasing period 210a is deleted in the sub-fields 272, 273, 275 and 276 other than the first sub-fields 271 and 274, and the address electric discharges are performed in the address period 272a, 273a, 275a and 276a without supplying the
20 selection electric discharge pulses 252a-252d and electric charge particle control pulse 244 in the last sub-field. Therefore, the contrast is multiplied by three.

Fig. 34 is a time chart of sub-fields
25 illustrating a driving system in accordance with a fifteenth embodiment of the present invention. Referring to the drawing, a horizontal axis illustrates



time, and a vertical axis illustrates lines of cells. Reference numeral 280 denotes one field period, 281-286 denote sub-fields, 281a-288a denote address periods, 281b-288b denote sustaining periods, 289 and 290 denote field blocks, 289a and 290a denote full writing erasing periods.

One field period 280 is divided into eight sub-fields 281-288, and consecutive first four sub-fields 281-284 construct the field block 289 and succeeding consecutive four sub-fields 285-288 construct the other field block 290.

The first period of these field blocks 289 and 290 include the full writing erasing period 289a and 290a, and the address period 281a-288a and the sustaining period 281b-288b are arranged in each sub-field 281-288. That is, the full writing erasing period 289a and 290a are arranged at the first part of the first sub-fields 281 and 285 of the field blocks 289 and 290. The numbers of the light emitting are allotted for the sustaining periods 281b-288b, and gradations of display are performed by the combining the numbers of the light emitting. According to the sixteenth embodiment, the numbers of the light emitting are increased in order of the sub-fields 281, 282, 283, ---.

The selection electric discharge pulse 252a-252d, the electric charge particle control pulse 244 and fin line erasing pulse 245, 253a-253b which are used in the



fourteenth embodiment are provided in the sustaining period 281b, 282b, 283b, 285b, 286b and 287b of the first three sub-fields 281, 282, 284, 285, 286 and 287 in each field blocks 287 and 290, and these pulses are
5 not provided in the other(last) sub-field.

The condition of electric charge particles in all cells after sustaining period 281b, 282b and 283b of the sub-fields 281, 282 and 283 in the field block 289 and sustaining periods 285b, 286b and 287b of the sub-
10 fields 285, 286 and 287 in the field block 290 are finished is maintained the same condition after the full writing erasing period 289a is finished, so the full writing erasing periods 210a are deleted in the three sub-fields 282, 283, 284, 286, 287 and 288 other than
15 the first sub-fields 281 and 285, and the address electric discharges are performed in the address period 282a, 273a, 284a, 286a, 287a and 288a without supplying the selection electric discharge pulses 252a-252d and electric charge particle control pulse 244 in the last
20 sub-field. Therefore, the contrast is multiplied by four.

Fig. 35 is a time chart of sub-fields illustrating a driving system in accordance with a seventeenth embodiment of the present invention.
25 Referring to the drawing, a horizontal axis illustrates time, and a vertical axis illustrates lines of cells. Reference numeral 300 denotes one field period, 301-308



denote sub-fields, 301a-308a denote address periods, 301b-308b denote sustaining periods, 309 denote field blocks, 309 denote a full writing erasing period.

One field period 300 is divided into eight sub-
5 fields 301-308, and the field block 309 is constructed by all sub-fields 301-308 in the one field. The first period of these field blocks 309 includes the full writing erasing period 309a. The address period 301a-308a and the following sustaining period 301b-308b are
10 arranged in each sub-field 301-308. That is, the full writing erasing period 309a are arranged at the first part of the first sub-fields 302. The numbers of the light emitting are allotted for the sustaining period 301b-308b and gradations of display are performed by the
15 combining the numbers of the light emitting.

The selection electric discharge pulses 252a-252d, the electric charge particle control pulses 244 and fin line erasing pulses 245, 253a-253b which are used in the fourteenth embodiment are provided in the
20 sustaining periods 301b-307b of the first seven sub-fields 301-307, and the full writing erasing period 309a is arranged only in the first sub-field 301. The address electric discharges in these address periods 302a-308a are possible, even if the full writing erasing
25 periods 309a in the sub-fields 302-308 which follow the first sub-field 301 is deleted. Thereby the contrast is multiplied by eight.



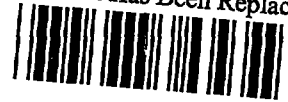
According to these embodiments, by deleting full writing erasing period in some sub-field, the contrast is improved. The practical contrast of cathode ray tube display is , for example, 150:1, and in the plasma
5 display according to the embodiments shown in Fig. 33 or Fig. 34, corresponding contrast is accomplished.

The numbers of sub-fields in one field and the numbers of the sub-fields in one field block are optional and not limited above mentioned embodiments,
10 and any combination will be applicable.

According to the present invention, full writing electric discharge and erasing electric discharge are deleted or reduced, thereby improving the contrast of the display.

15 According to the present invention, full writing erasing period can be arranged one time per several sub-fields, thereby improving the contrast.

While we have shown and described several embodiments in accordance with the present invention, it
20 is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to those skilled in the art, and we therefore do not wish to be limited to the details shown and described herein but intend to cover all such change and
25 modifications as are encompassed by the scope of the appended claims.



WHAT WE CLAIM IS:

1. A plasma display panel driving system for a display panel having a first electrode group arranged on a permeable substrate and being capable of driving in common, a second electrode group arranged in parallel
5 with said first electrode group on said permeable substrate and being capable of driving independently, a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of driving independently, said driving
10 system comprising the step of performing at least one electric discharge for equalizing of electric charge particle in a cell in which another electric charge particle is caused beforehand.

2. A plasma display panel driving apparatus comprising:

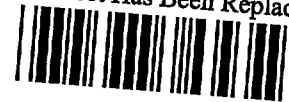
a first electrode group arranged on a permeable substrate and being capable of driving in common;

5 a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of driving independently;

a third electrode group arranged perpendicular to said first and second electrode groups on another
10 substrate and being capable of driving independently;

and means for performing at least one electric discharge for equalizing of electric charge particle in a cell in which another electric charge particles is





caused beforehand.

3. A plasma display comprising:

a first electrode group arranged on a permeable substrate and being capable of driving in common;

5 a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of driving independently;

a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of driving independently;

10 and means for performing at least one electric ischarge for equalizing of electric charge particles in a cell in which another electric charge particles is caused beforehand, whereby improving linearity of display gradation.

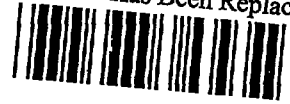
4. A plasma display panel driving system for

a display panel having a first electrode group arranged on a permeable substrate and being capable of driving in common, a second electrode group arranged in parallel

5 with said first electrode group on said permeable substrate and being capable of driving independently, a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of driving independently, a equalizing

10 means for equalizing electric charge particles in all cells by a discharge between said first and said second electrode group, an address electric discharge means for





determining a cell to be emitted by a discharge between
said second and said third electrode groups, and a
15 sustaining electric discharge means for performing light
emitting by a electric discharge between said first and
said second electrode groups, said driving system
comprising the step of performing discharge by a fine
line erasing pulse supplied after a sustaining electric
20 discharge is finished and erasing and polarizing of
electric charge particles in a cell in which sustaining
electric discharge is performed, the step of gathering
said electric charge particles in all cells by way of
said electric discharge caused by the fine line erasing
25 pulse, and canceling the voltage of a equalizing pulse
supplied to one of said first and said second electrode
groups by said electric charge particles resulting in no
discharge, the step of polarizing said electric charge
particles into a positive electric charge particles and
30 a negative electric charge particles, the step of
supplying a regulating pulse to the other electrode
groups of said first and said second electrode groups
after supplying said equalizing pulse to one of said
first and said second electrode groups for gathering the
35 same electric charge particles gathered on said one of
electrode groups supplied with said equalizing pulse,
and the step of gathering a electric charge particles
having the other polarity on said third electrode group

5. A plasma display panel driving system for





a display panel having a first electrode group arranged on a first substrate and being capable of driving in common, a second electrode group arranged in parallel with said first electrode group on said first substrate and being capable of driving independently, a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate and being capable of driving independently, said driving system comprising the step of performing a sustaining electric discharge by supplying a sustaining pulse to said first and said second electrode groups, the step of polarizing electric charge particles in a cell by supplying a fine line erasing pulse to one of said first and said second electrode groups, the step of gathering electric charge particles having one of the polarities in vicinity of said first and said second electrode groups and gathering said electric charge particles having the other polarity in the vicinity of said third electrode group by supplying a equalizing pulse to said one of electrode groups and supplying a regulating pulse rising later than said equalizing pulse to the other electrode group of said first and said second electrode groups without performing electric discharge.

6. A plasma panel display driving system according to the claim 4 or 5, further comprising the step of performing a electric discharge between said first electrode group and said second electrode group by





5 supplying said equalizing pulse to said one of the
electrode groups after supplying a power, and gathering
electric charge particles having one of the polarities
in the vicinity of said first and said second electrode
groups and gathering electric charge particles having
10 the other polarity in the vicinity of said third
electrode group by supplying said regulating pulse after
said equalizing pulse is supplied.

7. A plasma display panel driving system
according to claim 4 or 5, further comprising the step
of performing a address electric discharge between said
second electrode group and said third electric group
5 after gathering electric charge particles having one of
the polarities in the vicinity of the said first and
said second electrode groups and gathering electric
charge particles having the other polarity in the
vicinity of said third electrode group, and performing
10 sustaining electric discharge.

8. A plasma display panel driving system
according to claim 4 or 5, further comprising the step
of supplying said regulating pulse to said other
electrode group within 0.3 μ sec-2 μ sec after supplying
5 said equalizing pulse to said one of said electrode
groups.

9. A plasma display panel driving system
according to claim 4 or 5, further comprising the step
of arranging several fine line erasing pulses having a





first fine line erasing pulse whose pulse width is
5 within 0.5 μ sec-2 μ sec and having at least a second fine
line erasing pulse whose pulse width is equal to or less
than the pulse width of said first pulse width for
performing erasing and polarization of said electric
charge particle.

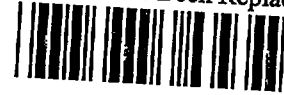
10. A plasma display panel driving system
according to claim 4 or 8 further, comprising the step
of supplying said equalizing pulse to said second
electrode group, and maintaining supply of said
5 regulating pulse to said first electrode group until
deciding cells to be emitted for gathering electric
charge particles predetermined electrode group.

11. A plasma display panel driving system
according to claim 4, 5 of 10, further comprising the
step of dividing said regulating pulse into a first
pulse for equalizing electric charge particles in all
5 cells and a second regulating pulse supplied during a
period for deciding cells to be emitted.

12. A plasma display panel driving system
according to claim 4 or 5, further comprising the step
of selecting the voltage of said regulating pulse
substantially equal to the voltage of said sustaining
5 pulse for performing display electric discharge.

13. A plasma display panel driving system
according to claim 13, further comprising the step of
falling the edge of said equalizing pulse after falling





the edge of said first regulating pulse, and falling
5 said edge of said equalizing pulse within 1 μ sec.

14. A plasma display panel driving system
according to claim 4 or 5, further comprising the step
of performing a discharge in all cells by supplying full
electric discharge pulse to one of said first and said
5 second electrode groups one or several times per one
field or several fields after performing sustaining
discharge, and then supplying said fine line erasing
pulse for performing a discharge in said all cells for
erasing electric charge particles so as to gather
10 positive electric charge particles in the vicinity of
said first and said second electrode groups.

15. A plasma display panel driving system
according to claim 4 or 5, further comprising the step
of supplying plurality of fine line erasing pulses to
said first and second electrode groups alternatively,
5 and shortening the pulse width of said fine line
erasing pulses which supplied afterward, and supplying
the last fine line erasing pulse to said one of
electrode group.

16. A plasma display panel driving system
according to claim 4, 5 or 8, further comprising the
step of supplying said equalizing pulse to one of
electrode group, and falling the edge of said equalizing
5 pulse in a time more than 1 μ sec.





17. A plasma display panel driving circuit comprising:

a first electrode group arranged on a first substrate and driven in common;

5 a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate provided faced on said first substrate and controlled independently;

a first driving circuit connected to said first electrode group for supplying a first driving pulse;

a second driving circuit connected to said second electrode group for supplying a second driving pulse;

a third driving circuit connected to said third electrode group for supplying an address driving pulse;

means for supplying a fine line erasing pulse to one of the electrode group of said first and second electrode groups from said driving circuit connected to said one of the electrode group after sustaining discharging;

means for supplying a equalizing pulse to said one of the electrode group from said driving circuit connected to said one of the electrode group;

means for supplying a regulating pulse delaying





a bit from rising edge of said equalizing pulse to the other electrode group of said first and said second
30 electrode groups from said driving circuit connected said other electrode group, and for gathering electric charge particles having one of the polarities in the vicinity of said first and said second electrode groups and for gathering electric charge particles having the
35 other polarity in the vicinity of said third electrode group.

18 A plasma display panel driving circuit according to claim 17, further comprising means for supplying said regulating pulse to said other electrode group within 0.3 μ sec-2 μ sec after supplying said
5 equalizing pulse to said one of said electrode groups.

19. A plasma display panel driving circuit according to claim 17 or 18, further comprising means for generating plurality of fine line erasing pulses from said first and said second driving circuits and
5 selecting pulse width of a first fine line erasing pulse within 0.5 μ sec-2 μ sec and selecting pulse width of a second fine line erasing pulse equal to or shorter than said first fine line erasing pulse.

20. A plasma display panel driving circuit according to claim 17, 18 or 19, further comprising means for supplying from said second driving circuit said equalizing pulse to said second electrode group and
5 for supplying said regulating pulse from said first





driving circuit to said first electrode group during addressing cells to be emitted.

21 A plasma display panel driving circuit according to claim 17, 18 or 19, further comprising means for generating a first and a second regulating pulses from said driving circuit connected to said one
5 of electrode group.

22. A plasma display panel driving circuit according to claim 17, further comprising means for selecting the voltage of said regulating pulse substantially identical with the voltage of said
5 sustaining pulse.

23. A plasma display panel driving circuit according to claim 17, 18 or 20, further comprising means for falling the edge of said equalizing pulse after lapse of time more than 1 μ sec by said driving
5 circuit connected to said one of electrode.

24. A plasma display panel driving circuit according to claim 17, further comprising means for supplying after performing sustaining discharge a full writing electric discharge pulse one time or several
5 times per one field or several fields generated from one of driving circuit of said first and said second driving circuit which is connected to said one of electrode group.



25. A plasma display panel driving circuit according to claim 21, further comprising means for falling the edge of said equalizing pulse after falling the edge of said first regulating pulse, and falling
5 said edge of said equalizing pulse within 1 μ sec.

26. A plasma display comprising :
a first electrode group arranged on a first substrate and driven in common;
a second electrode group arranged parallel to
5 said first electrode group on said first substrate and controlled independently;
a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate provided faced on said first substrate and
10 controlled independently;

cells constructed at the cross point of said first and said second and said third electrode group;
means for performing a electric discharge for erasing and polarizing electric charge particles in
15 cells performed a sustaining discharging during a period after sustaining discharging and just before the beginning of an address period;

means for equalizing of electric charge particle in all cells by said discharge for erasing and
20 polarizing.

27. A plasma display comprising:
a first electrode group arranged on a first





substrate and driven in common;

5 a second electrode group arranged parallel to
said first electrode group on said first substrate and
controlled independently;

a third electrode group arranged perpendicular
to said first and second electrode groups on a second
substrate provided faced on said first substrate and
10 controlled independently;

cells constructed at the cross point of said
first and said second and said third electrode group;

means for performing a discharge by a fine line
erasing pulse supplied to one of the electrode of said
15 first and said second electrode group after a sustaining
discharge and for erasing and polarizing electric charge
particles in cells generated by said sustaining
discharge;

means for gathering electric charge particles
20 having one of polarities in the vicinity of said first
and said second electrode groups and for gathering
electric charge particles having the other one of the
polarities in the vicinity of said third electrode group
by supplying a equalizing pulse to said one of
25 electrodes and by supplying a regulating pulse to the
other electrode of said first and said second electrode
groups so as to be able to discharge for addressing
which determines light emitting cells by said third
electrode group.





28. A plasma display according to claim 27, further comprising means for supplying said regulating pulse to said other electrode within $0.3 \mu\text{sec}$ - $2 \mu\text{sec}$ after supplying said equalizing pulse to said one of
5 said electrode groups for collecting electric charge particles having one of polarities in the vicinity of said first and said second electrode group and electric charge particles having the other one of polarities in the vicinity of said third electrode group.

29. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, means for
5 generating plurality of said fine line erasing pulses including a first fine line erasing pulse having pulse width within $0.5 \mu\text{sec}$ - $2 \mu\text{sec}$ and a second fine line erasing pulse having pulse width equal to or less than said second fine line erasing pulse, and means for
10 erasing and polarizing electric charge particles by supplying last pulse of said fine line erasing pulses to said one of said first and second electrode groups.

30. A plasma display according to claim 27, further comprising means for supplying from said second driving circuit said equalizing pulse to said second electrode group and for maintaining supply of said
5 regulating pulse supplied from said first driving circuit to said first electrode group during addressing





cells to be emitted.

31. A plasma display according to claim 27, further comprising means for generating from one of said first driving circuit connected said first electrode group and said second driving circuit connected to said
5 second electrode group a first and a second regulating pulses.

32. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, and means for
5 selecting the voltage of said regulating pulse substantially identical with the voltage of said sustaining pulse by means of one of driving circuit of said first and said second driving circuits.

33. A plasma display according to claim 27, further comprising a driving circuit connected one of said first and said second electrode groups, and means for falling the edge of said equalizing pulse after
5 lapse of time more than 1 μ sec by said driving circuit connected to said one of electrode group.

34. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, and means for
5 generating a full writing pulse one time or several times per one field or several fields from one of





driving circuit of said first and said second driving circuit and for performing a discharge in all cells after sustaining discharge is finished.

35. A plasma display panel driving system comprising the step of dividing one field into several sub-fields and providing an address period for setting cells to be emitted and a sustaining period for light
5 emitting, and the step of constructing field block by plurality of sub-fields and arranging full writing electric discharge and full erasing electric discharge in a first sub-field of said field block.

36. A plasma display panel driving system according to claim 35, further comprising the step of performing discharge in selected cells in which light
5 emitting is performed by said sustaining electric discharge in said sub-fields of said sub-field block except the last sub-field of said sub-field thereby keeping the condition of electric charge particles almost same condition after performing full writing electric discharge and full erasing electric discharge.

37. A plasma display panel driving system according to claim 35 or 36, wherein said plasma display
pane having a first electrode group covered with a dielectric layer and arranged on a first glass substrate
5 and driven in common, a second electrode group covered with a dielectric layer arranged parallel to said first electrode group on said first glass substrate and





controlled independently, a third electrode group covered with a dielectric layer and arranged perpendicular to said first and said second electrode groups on a second glass substrate provided faced on said first substrate and controlled independently, and said driving system comprising the step of performing discharge in selected cells in which light emitting is performed by said sustaining electric discharge in said sub-fields of said sub-field block except the last sub-field of said sub-field, thereby gathering positive electric charge particles on said dielectric layer covering said third electrode group and gathering negative electric charge particles on said dielectric layer covering said first and said second electrode group for leaving condition of electric charge particle unchanged without selection electric discharge.

38. A plasma display panel driving system according to claim 37, further comprising the step of performing said address electric discharge for determining cells to be emitted by discharging between said first and said second electrode groups and performing said sustaining discharge between said first and second electrode groups, and the step of supplying after supplying said last sustaining pulse to said first and said second electrode groups in all sub-fields of each sub-field block except each last sub-field a first pulse having almost the same voltage as the voltage of



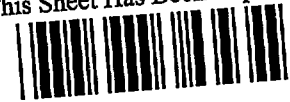


said sustaining pulse to one of electrode group of said first and second electrode groups to which the last sustaining pulse is not supplied and performing electric discharge in said cell in which said sustaining electric discharge has performed, and the step of arranging a second pulse rising after 0.3 μ sec-1.5 μ sec from the rising edge of said first pulse and supplying said second pulse to the other electrode group of said first and said second electrode groups to which said first pulse is not supplied, and providing plurality of fine line erasing pulses after supplying said first and said second pulses for erasing electric charge particles in the vicinity of said first and second electrode groups.

39. A plasma display panel driving system according to claim 38, wherein the voltage of said first and said second pulses and said fine line erasing pulse supplied after the supply of said sustaining pulse having a voltage the same as the sustaining voltage selected so as to cause sustaining electric discharge in cells performed said address electric discharge and to cause no sustaining electric discharge in cells in which no electric discharge is not performed.

40. A plasma display panel driving system according to claim 38 or 39, wherein further comprising a first address pulse supplied to cells in which no full writing electric discharge and no full erasing electric discharge are not performed, and said first address





pulse having a voltage higher than a voltage of a second address voltage supplied to the other cells in which said full writing electric discharge and said full erasing electric discharge are performed.

41. A plasma display comprising:

a first electrode group arranged on a first substrate and driven in common;

5 a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate provided faced on said first substrate and
10 controlled independently;

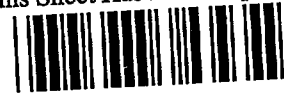
a field block constructed from plurality of sub-fields;

means for performing a full writing electric discharge between said first and said second electrode
15 groups in a first field of said field block;

means for performing a electric discharge by supplying a selection electric discharge pulse to one of the electrode group of said first and said second electrode groups in said sub-fields of each field block
20 except each last sub-field in cells in which light emitting is performed by a sustaining discharge;

means for gathering electric charge particles having one of polarities in the vicinity of said first





and second electrode groups and gathering electric
25 charge particles having the other polarity in the
vicinity of said third electrode groups by supplying
said selection electric discharge pulse to said one of
electrode group and by supplying a electric charge
particle control pulse to the other one of said first
30 and second electrode groups;

means for performing no selection electric
discharge in cells in which light emitting is not
performed by said sustaining electric discharge.

42. A plasma display according to claim 41,
further comprising means for supplying a sustaining
pulse to said first and said second electrode groups and
means for supplying the last sustaining pulse to said
5 other electrode group.

43. A plasma display according to claim 41,
wherein the rising edge of said electric charge particle
control pulse having time lag of $0.3 \mu\text{sec}$ - $1.5 \mu\text{sec}$ from
rising edge of said selection electric discharge pulse.

44. A plasma display according to claim 41,
further comprising means for supplying said fine line
erasing pulse to said first and said second electrode
group after selection electric discharge pulse is
5 supplied.





ABSTRACT OF THE DISCLOSURE

A plasma display panel driving system having a
5 common X electrode 22 arranged on a front glass
substrate 21 driven in common, a independent Y electrode
23 arranged parallel to the common X electrode 22 on the
front glass substrate 21 driven independently, an
address A electrode arranged perpendicular to the common
10 X electrode and the independent Y electrode on the back
glass substrate driven independently, and means for
performing at least one electric discharge for
equalizing of electric charge particle in a cell in
which another electric charge particle is caused
15 beforehand, thereby improving contrast.

Erasing and polarization of electric charge
particles are performed by the fine line erasing pulse
46a after sustaining period 2c, and a equalizing pulse
having a high voltage is supplied to the independent Y
20 electrode to which the last fine line erasing pulse 46a
or 86a is supplied, and a regulating pulse 40 is
supplied to the common X electrode after supplying of
the equalizing pulse.

Further, a field bloc having plurality of sub-
25 fields are provided, and a full writing electric
discharge and a fine line erasing electric discharge are
performed in the first sub-field of each field block for
reducing the number of electric discharging.

FIG. 1

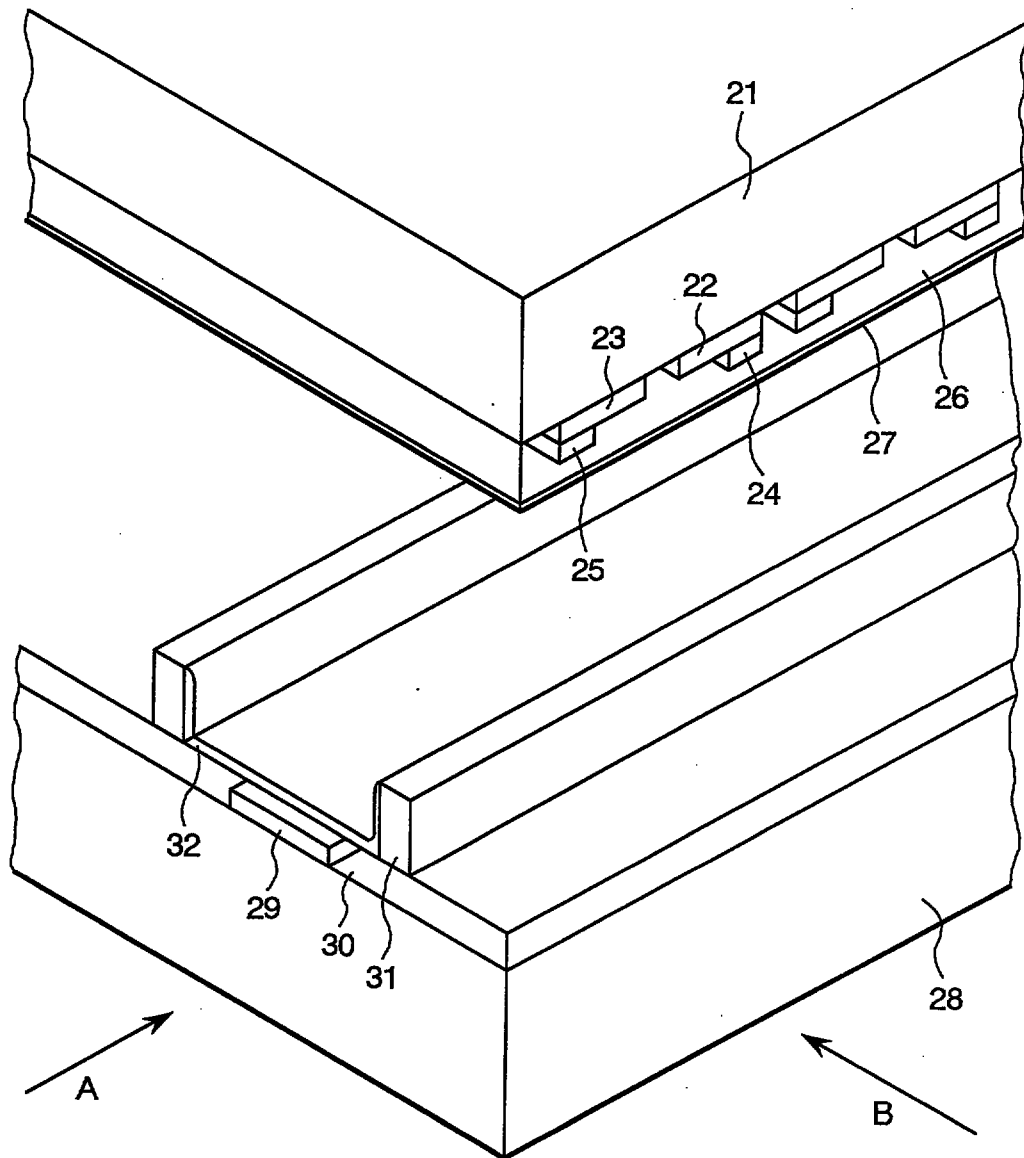


FIG. 1

FIG. 2

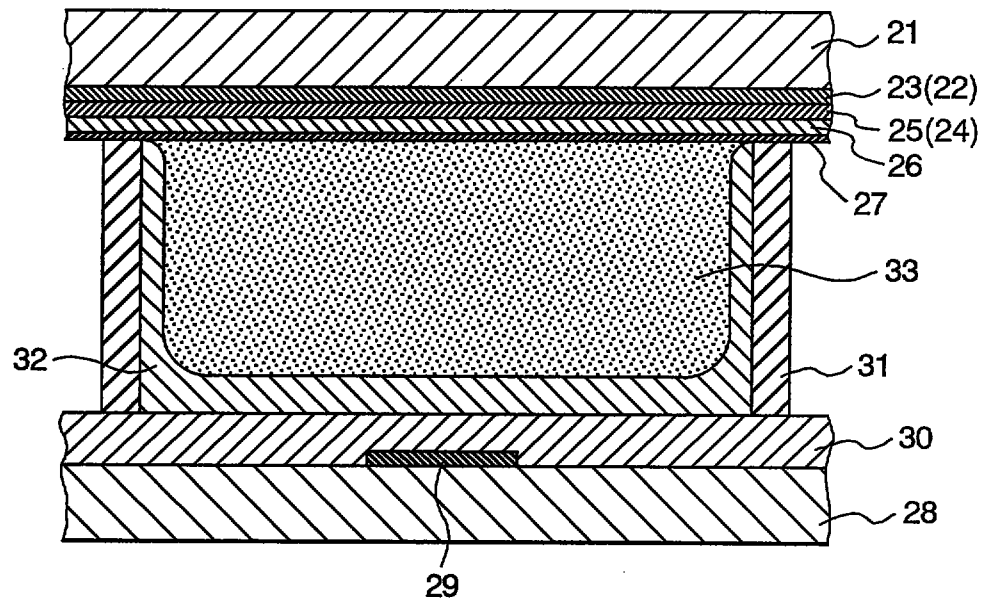


FIG. 3

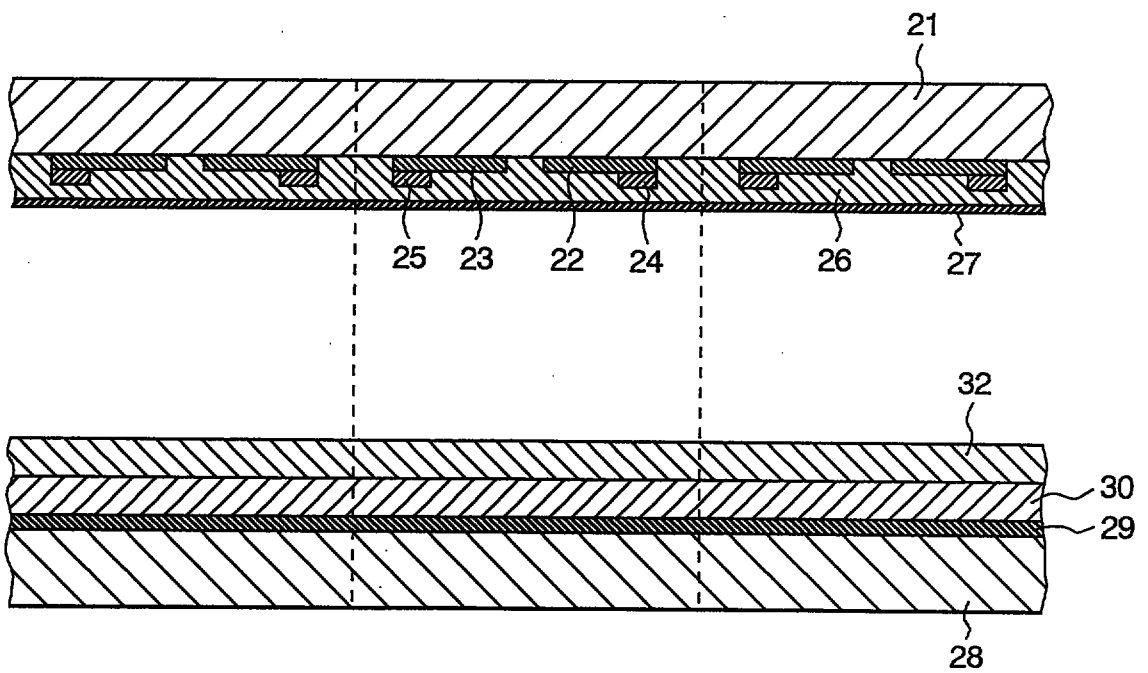


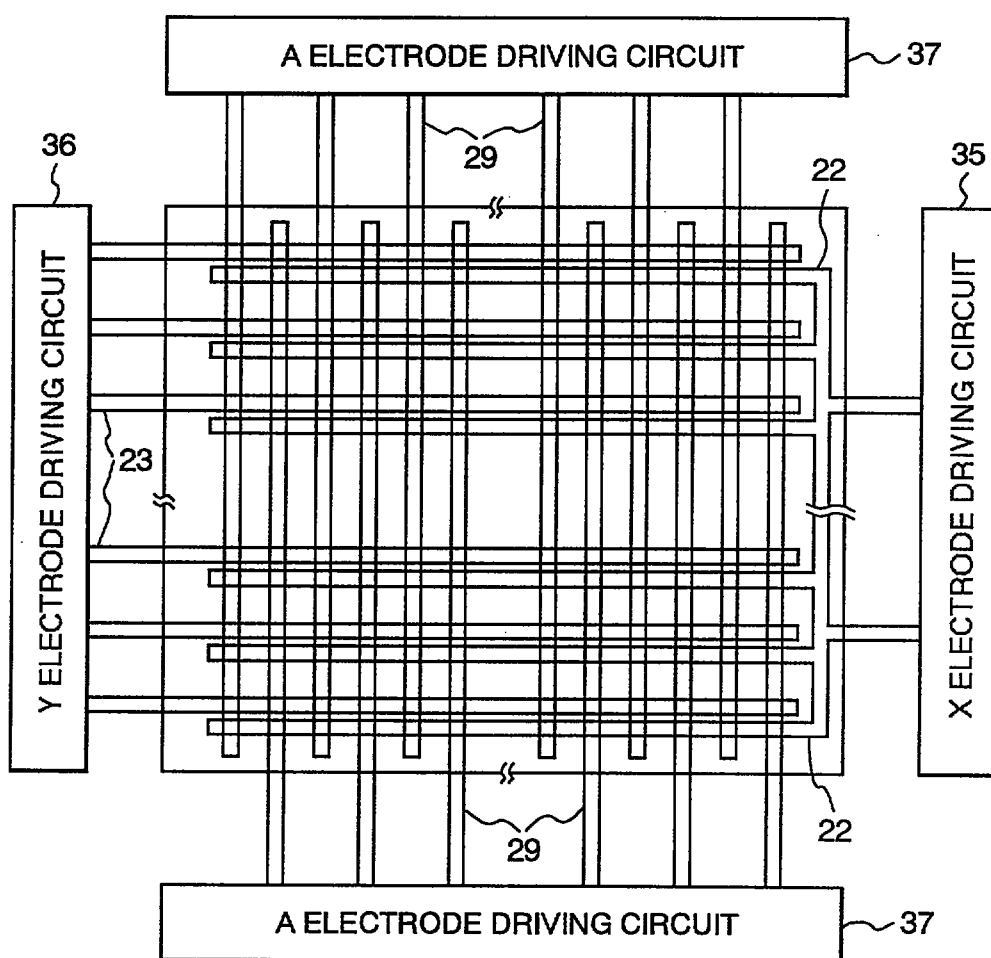
FIG. 4

FIG. 5(a)

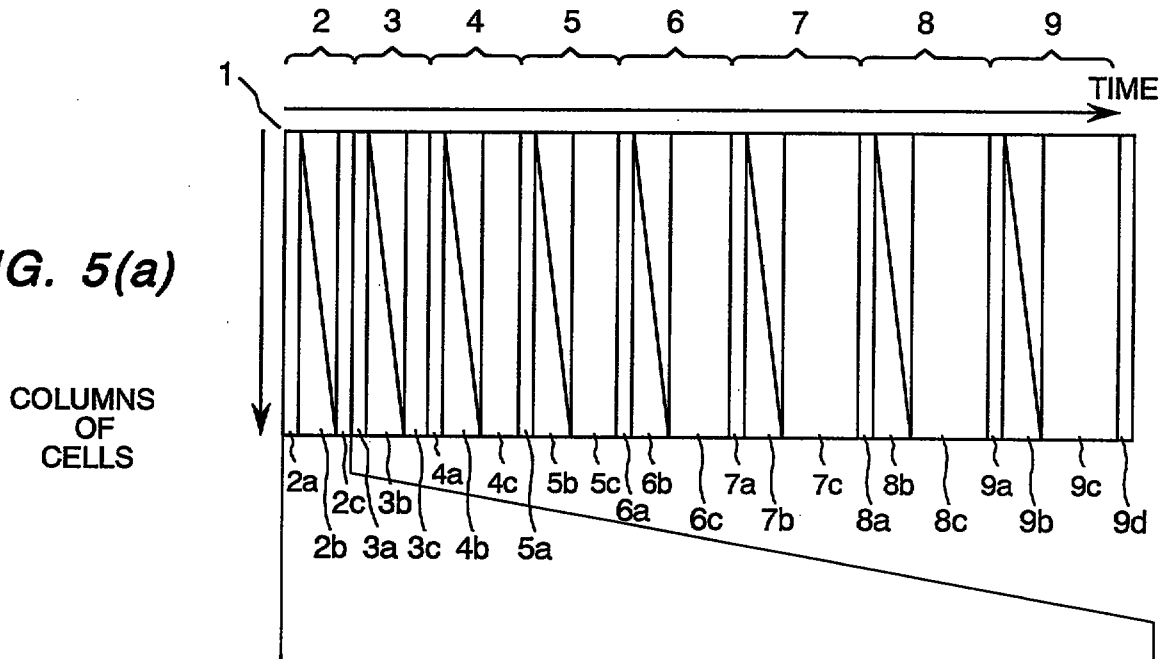


FIG. 5(b)

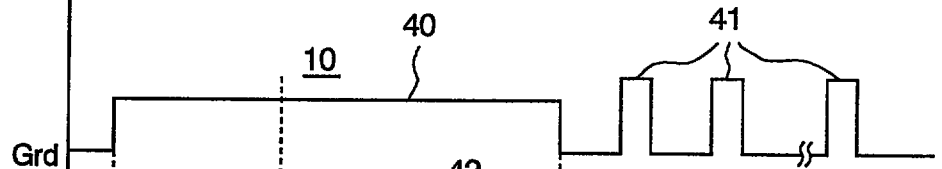


FIG. 5(c)



FIG. 5(d)



FIG. 5(e)

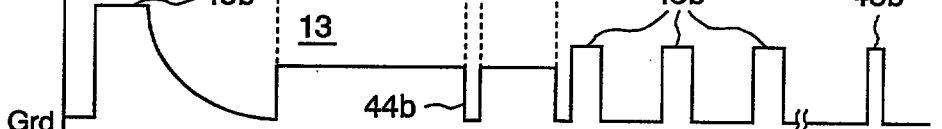
EQUALIZING
PERIODADDRESS
PERIODSUSTAIN
PERIOD

FIG. 6

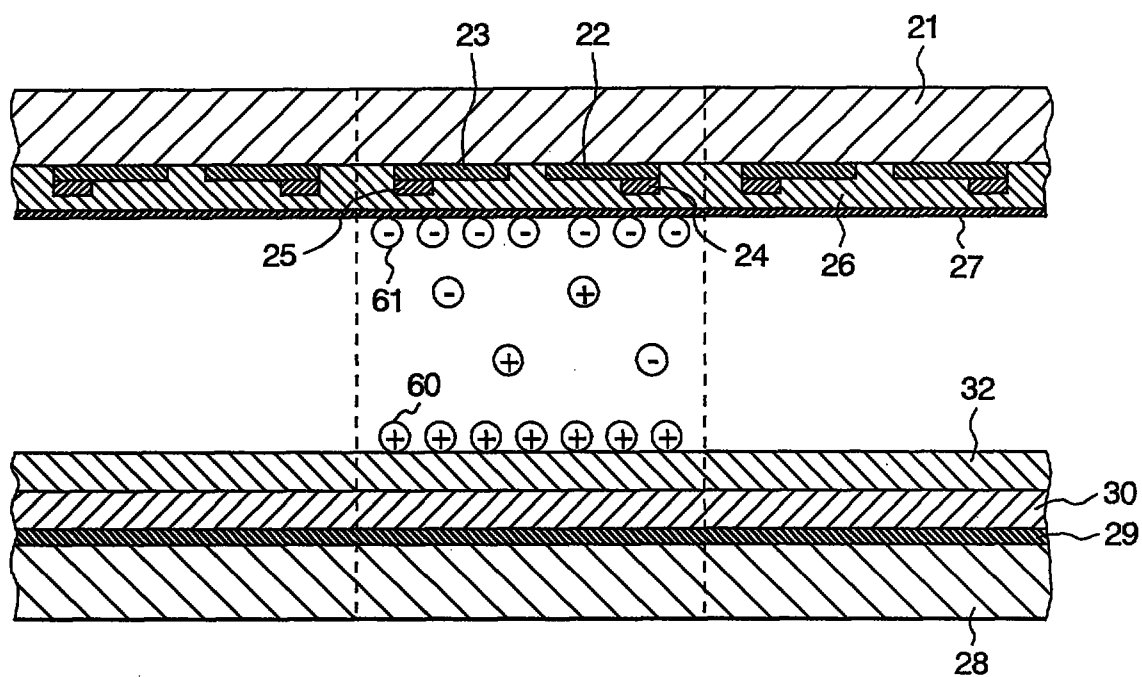


FIG. 7

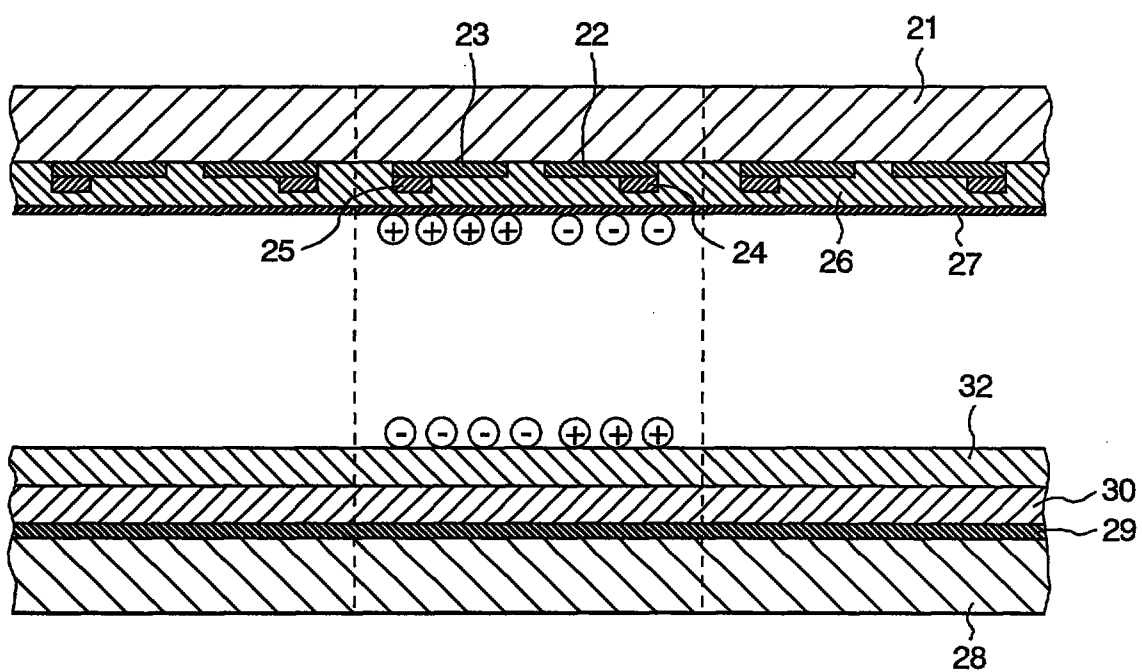


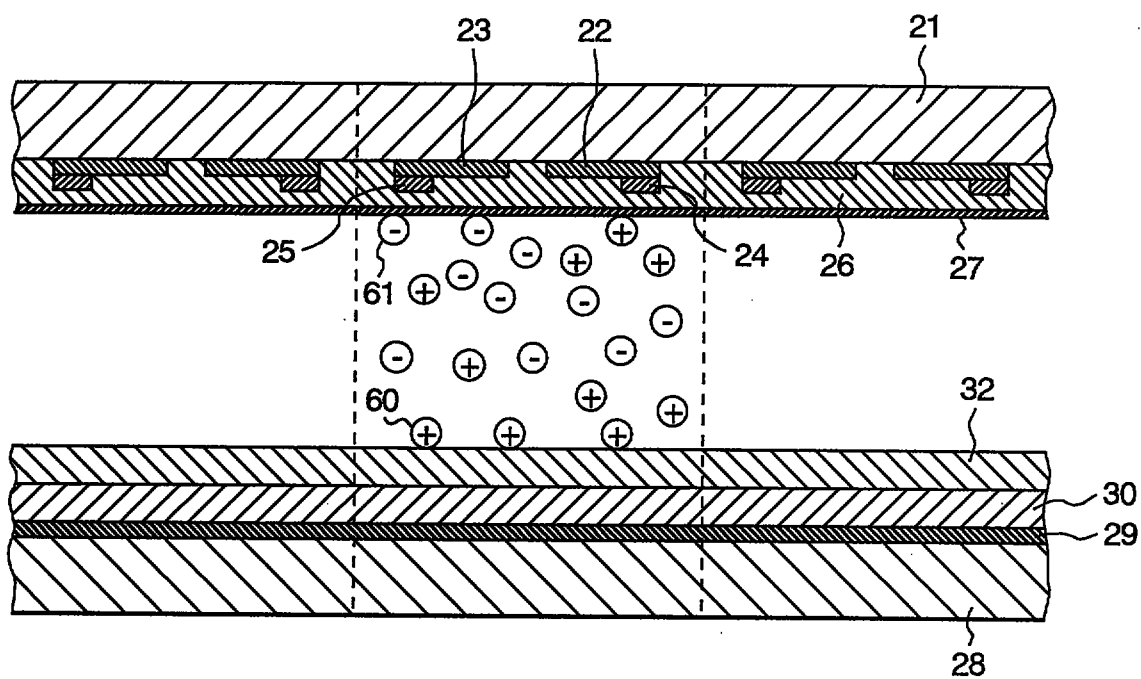
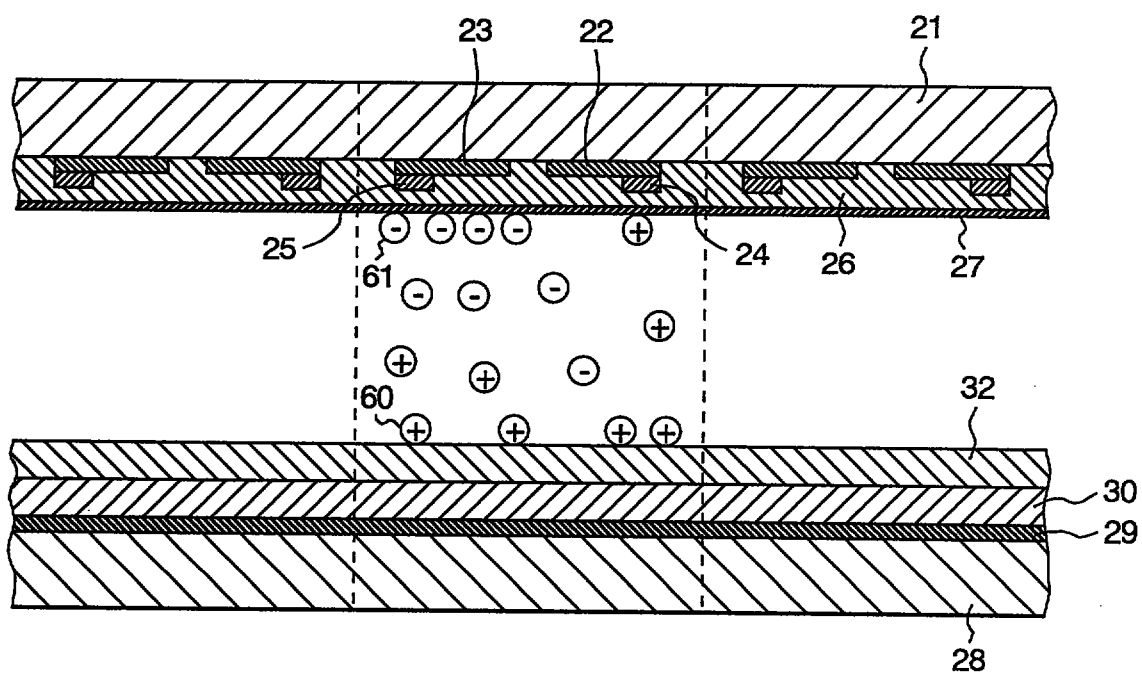
FIG. 8**FIG. 9**

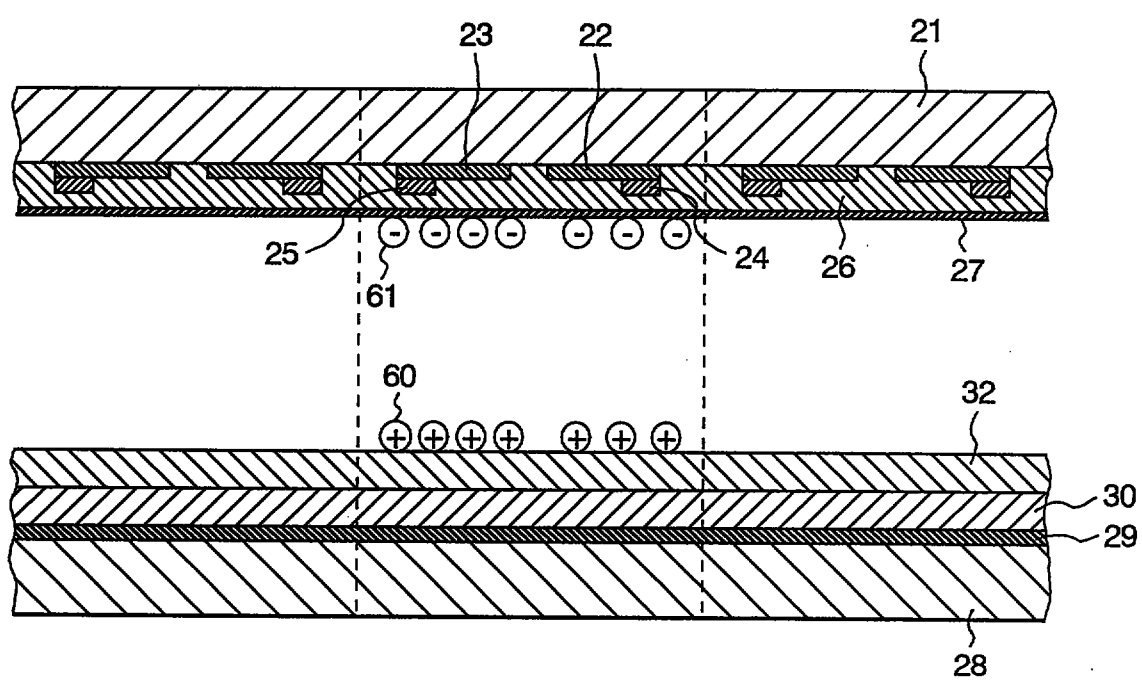
FIG. 10

FIG. 11(a)

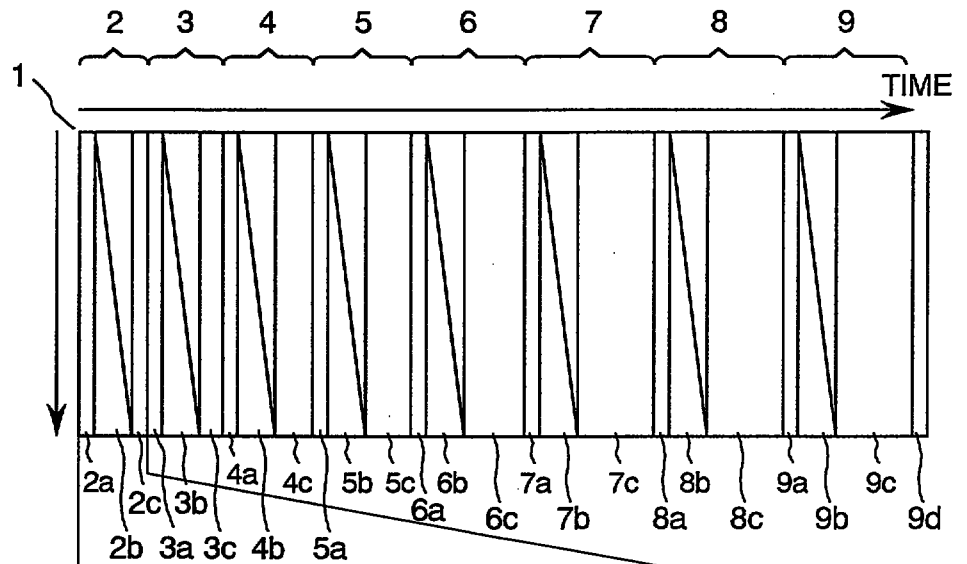
COLUMNS
OF
CELLS

FIG. 11(b)

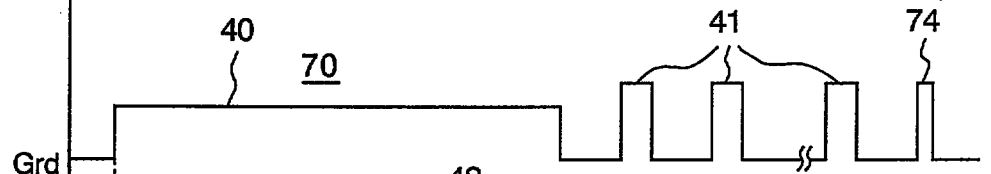


FIG. 11(c)



FIG. 11(d)

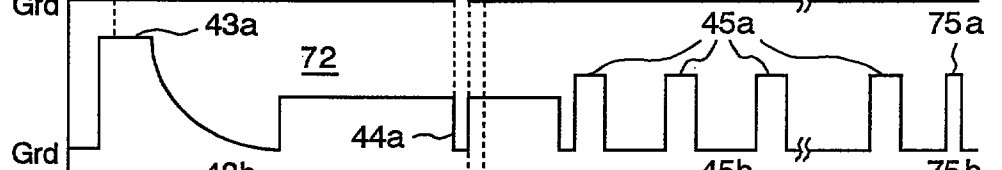


FIG. 11(e)

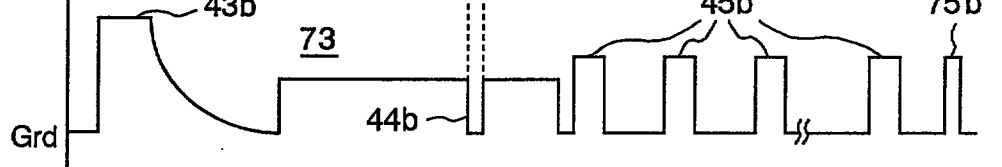


FIG. 12(a)

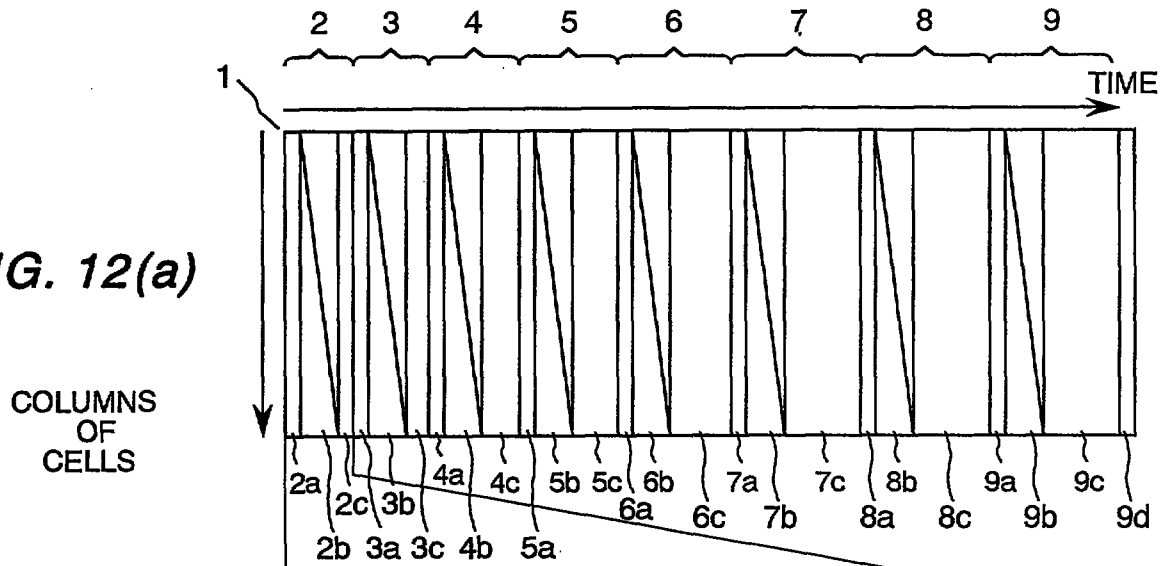


FIG. 12(b)

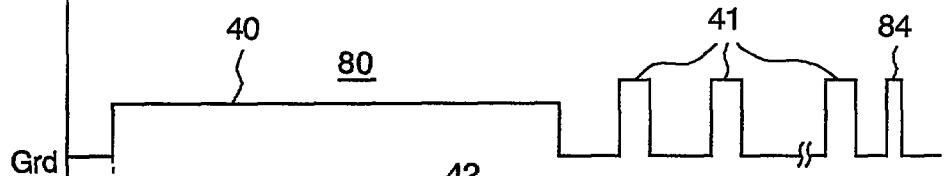


FIG. 12(c)



FIG. 12(d)



FIG. 12(e)

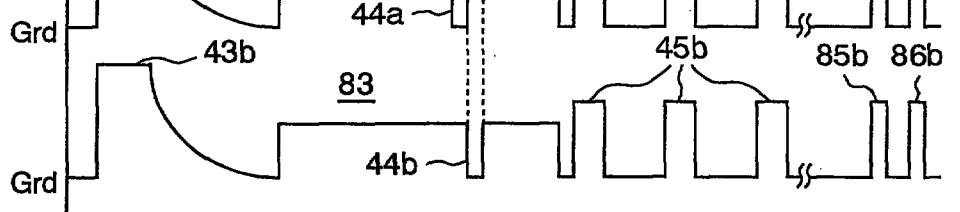


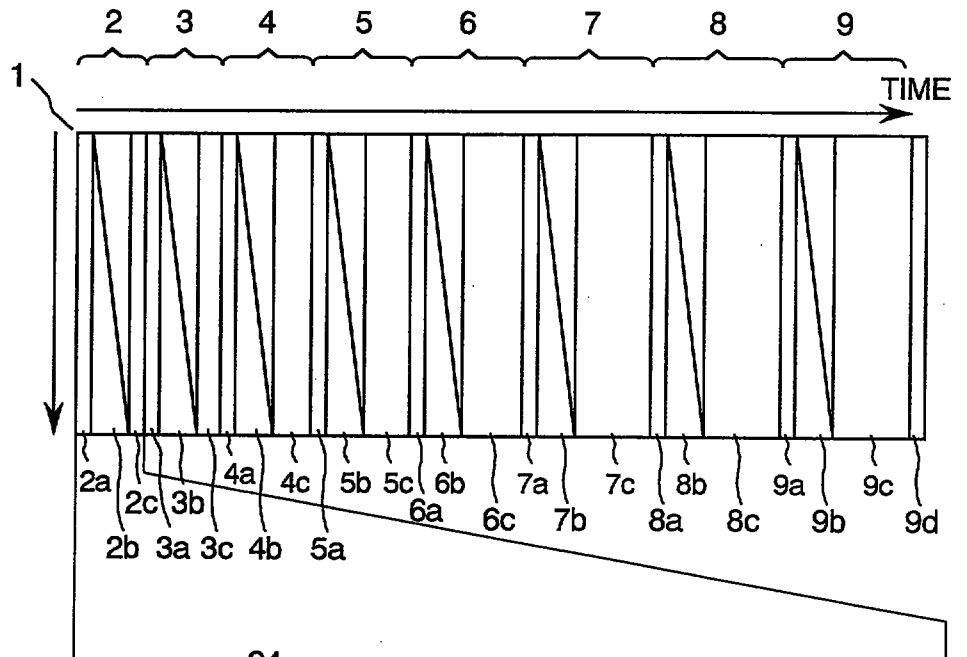
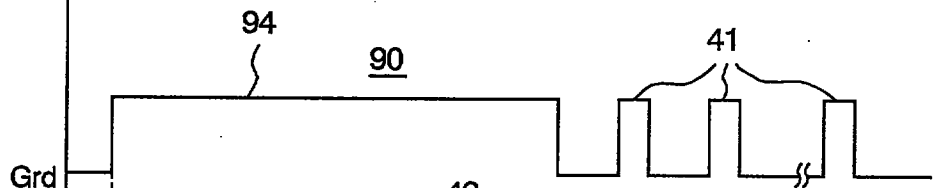
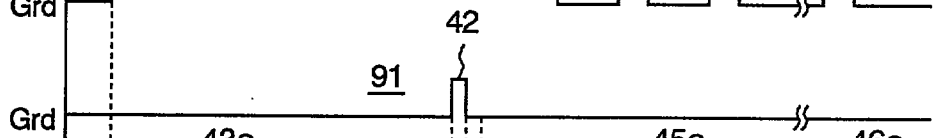
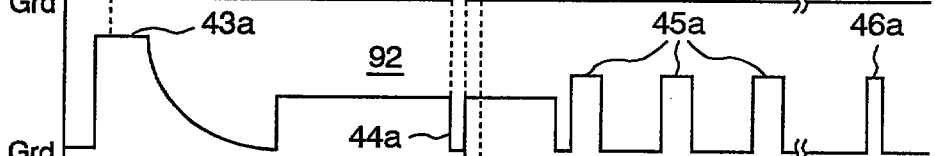
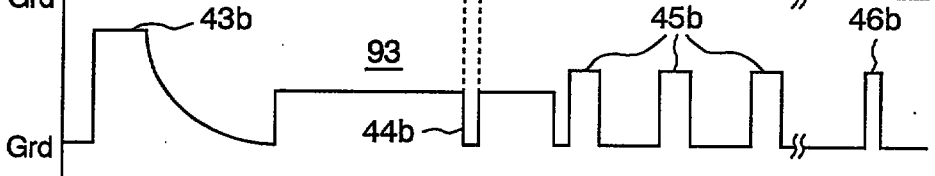
FIG. 13(a)COLUMNS
OF
CELLS**FIG. 13(b)****FIG. 13(c)****FIG. 13(d)****FIG. 13(e)**

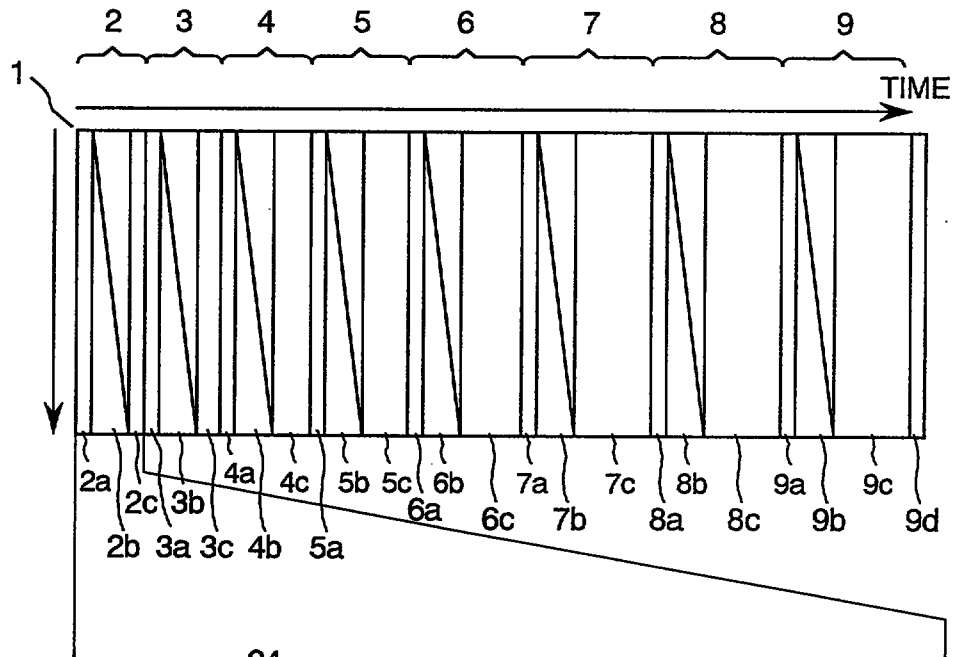
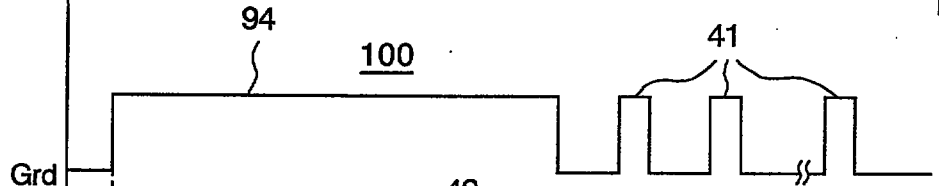
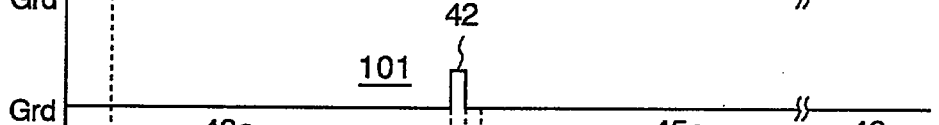
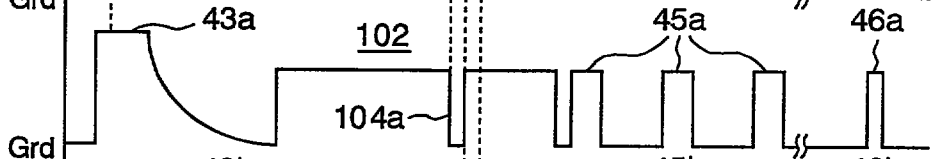
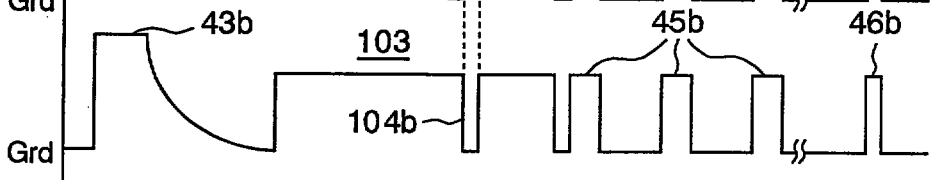
FIG. 14(a)COLUMNS
OF
CELLS**FIG. 14(b)****FIG. 14(c)****FIG. 14(d)****FIG. 14(e)**

FIG. 15(a)

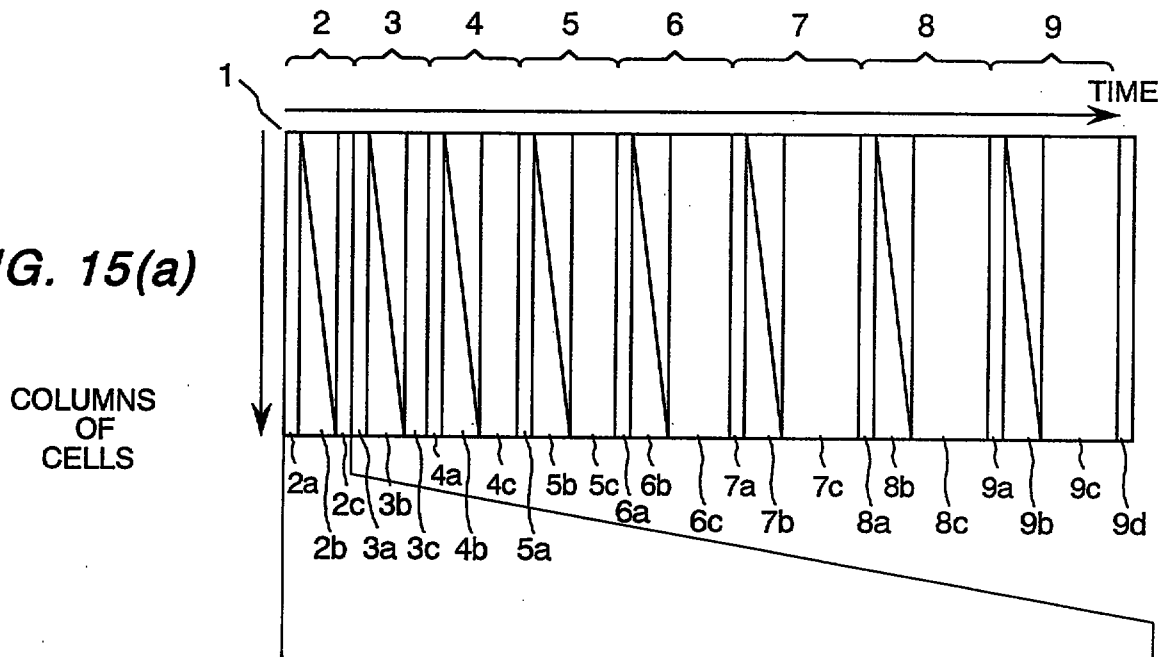


FIG. 15(b)

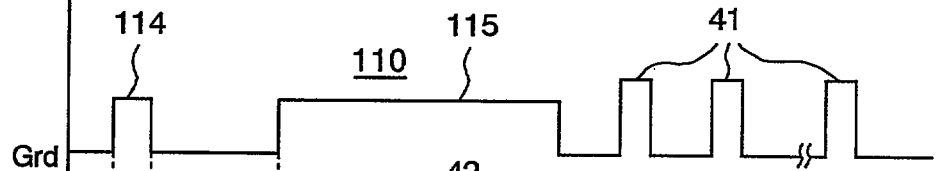


FIG. 15(c)

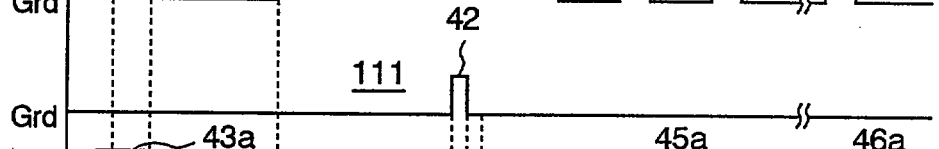


FIG. 15(d)

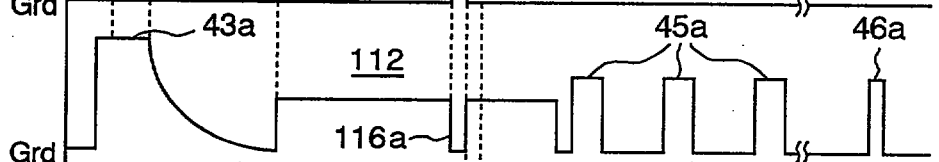


FIG. 15(e)

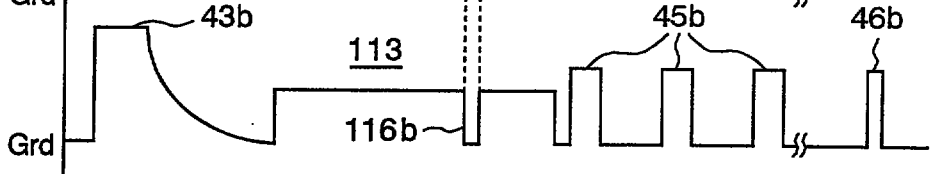


FIG. 16(a)

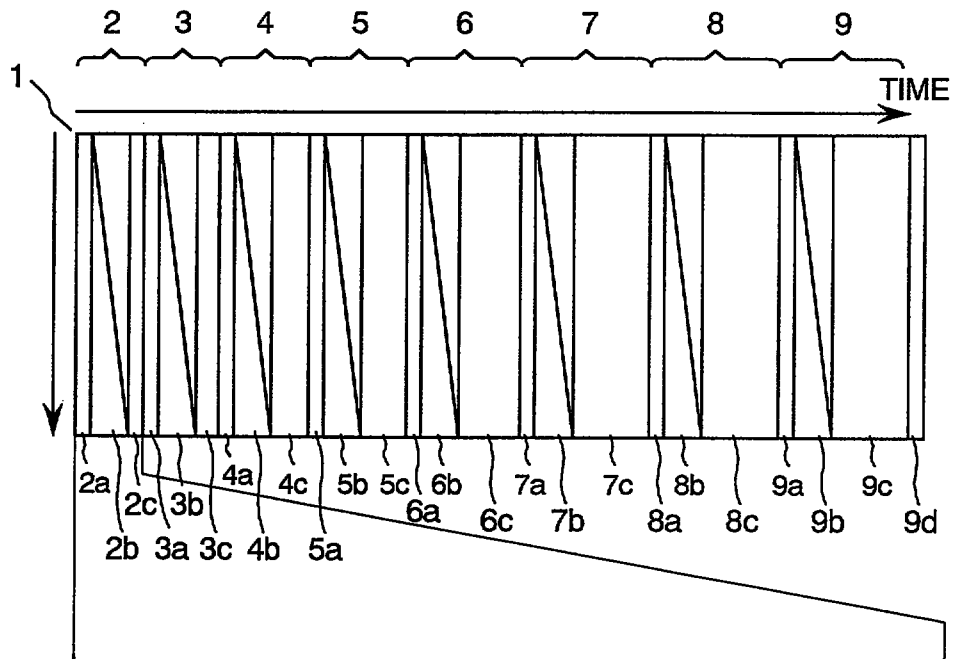
COLUMNS
OF
CELLS

FIG. 16(b)

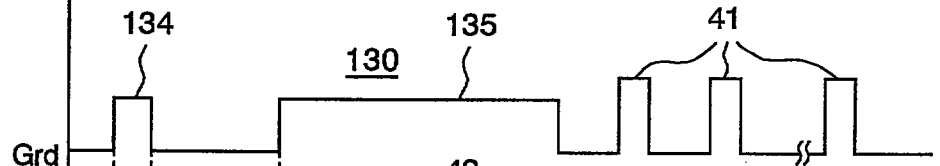


FIG. 16(c)

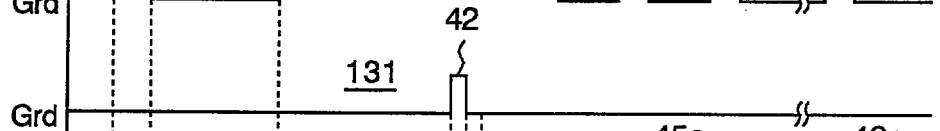


FIG. 16(d)



FIG. 16(e)

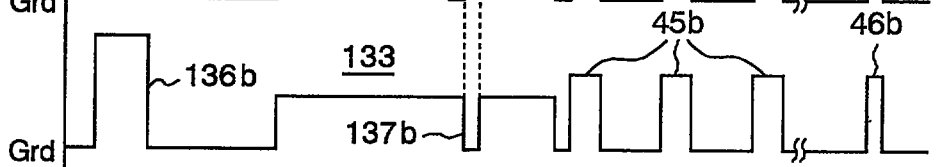


FIG. 17(a)

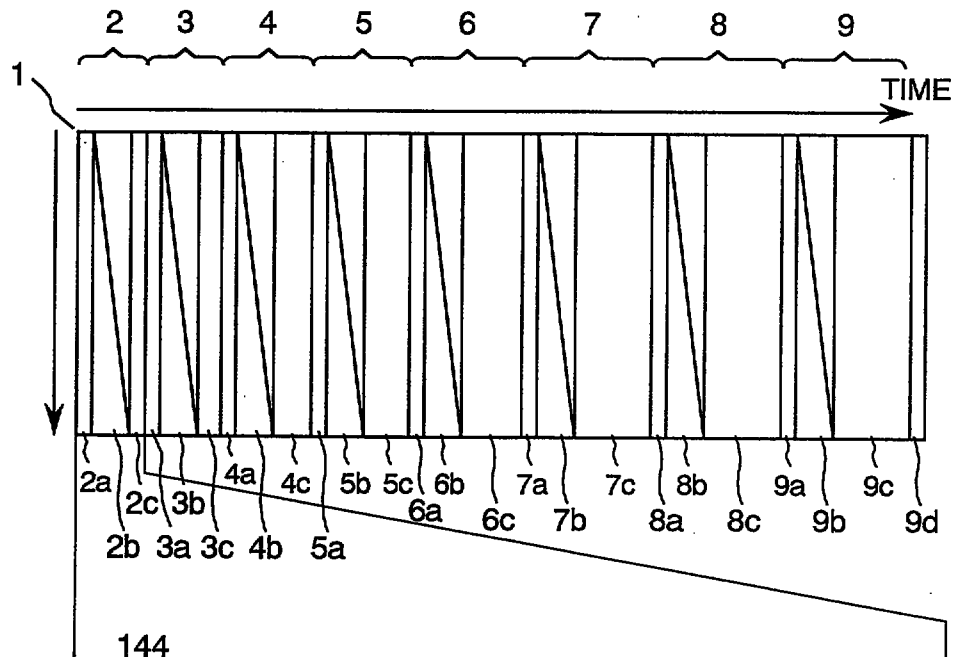
COLUMNS
OF
CELLS

FIG. 17(b)

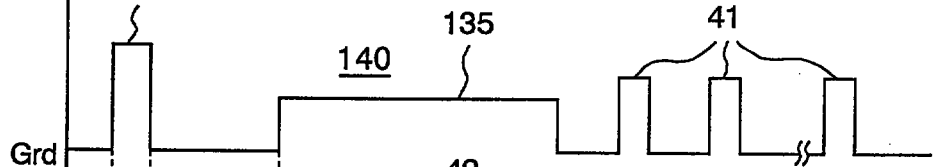


FIG. 17(c)

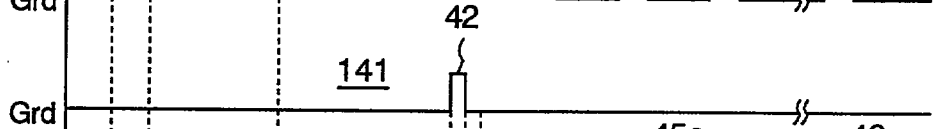


FIG. 17(d)



FIG. 17(e)

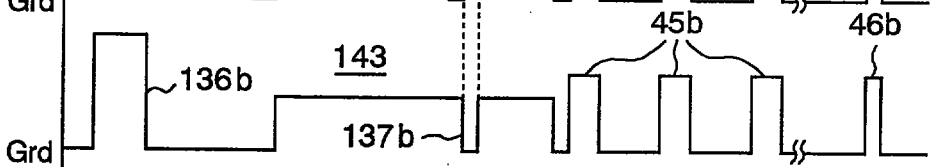


FIG. 18(a)

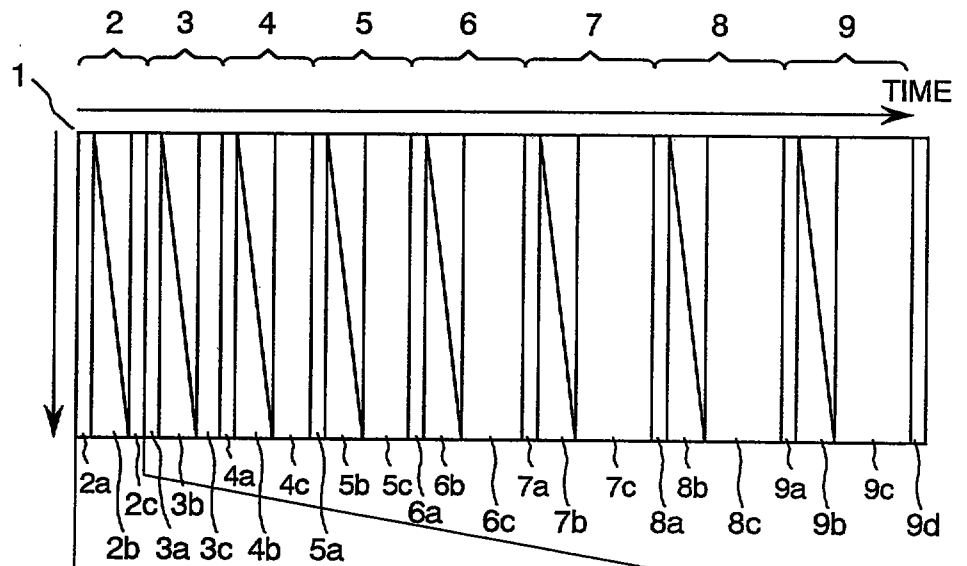
COLUMNS
OF
CELLS

FIG. 18(b)

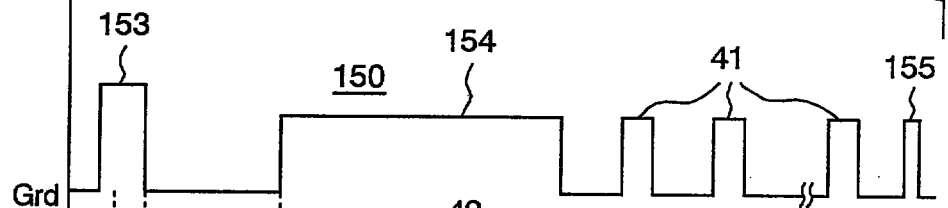


FIG. 18(c)

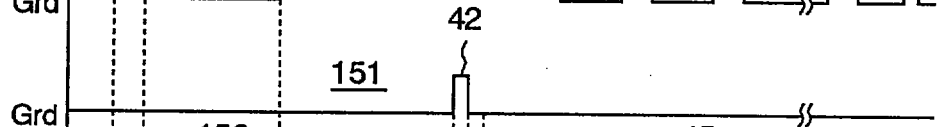


FIG. 18(d)

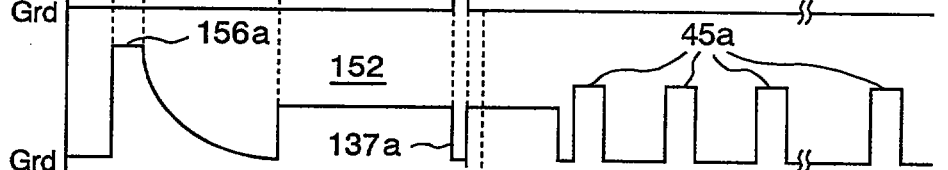
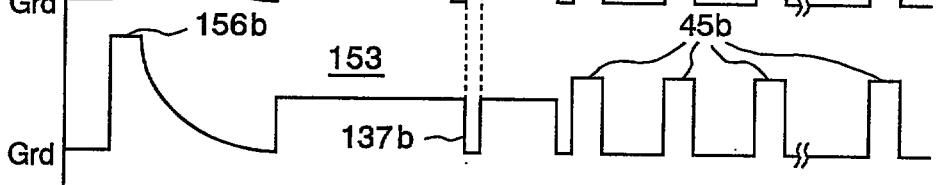


FIG. 18(e)



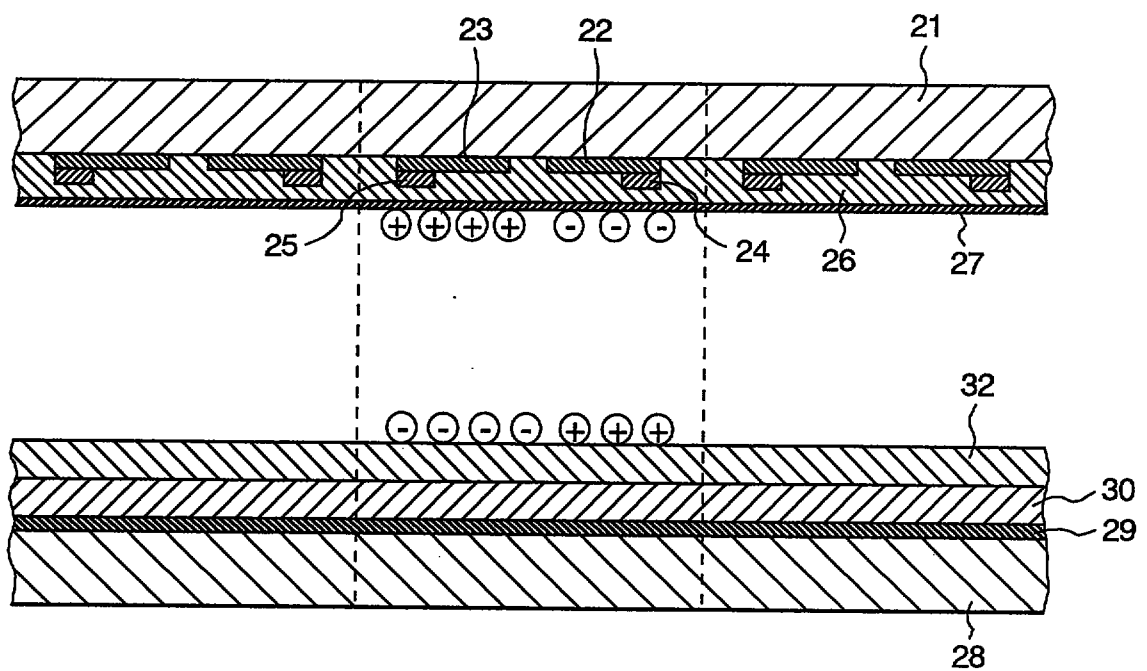


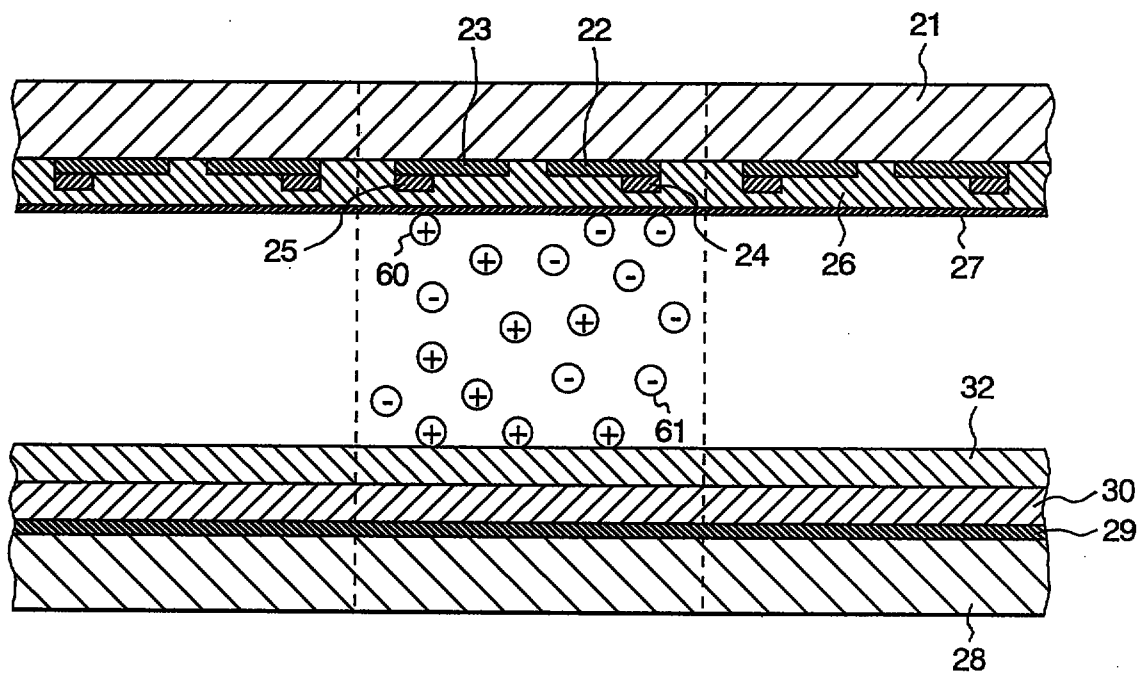
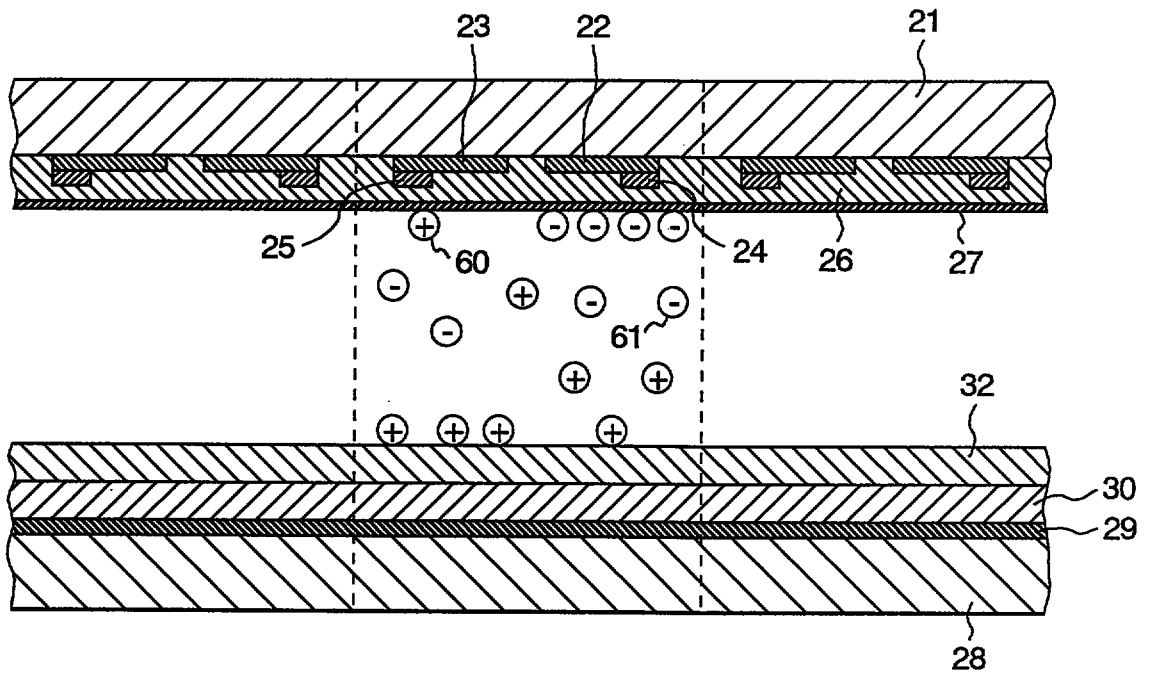
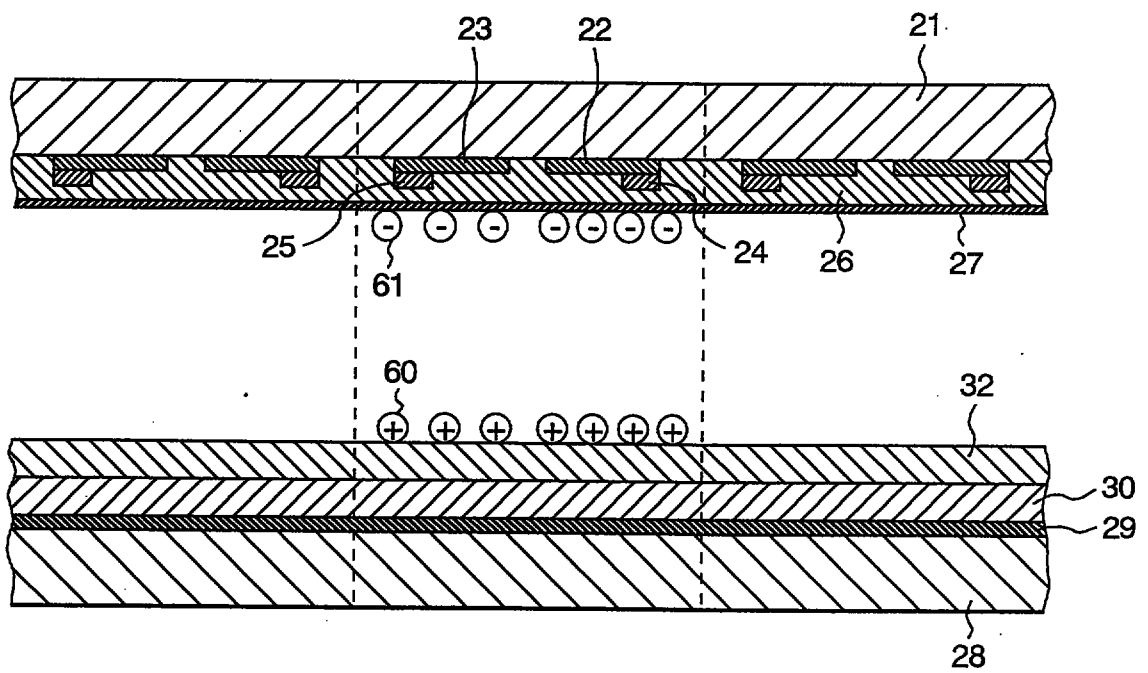
FIG. 21

FIG. 22**FIG. 23**

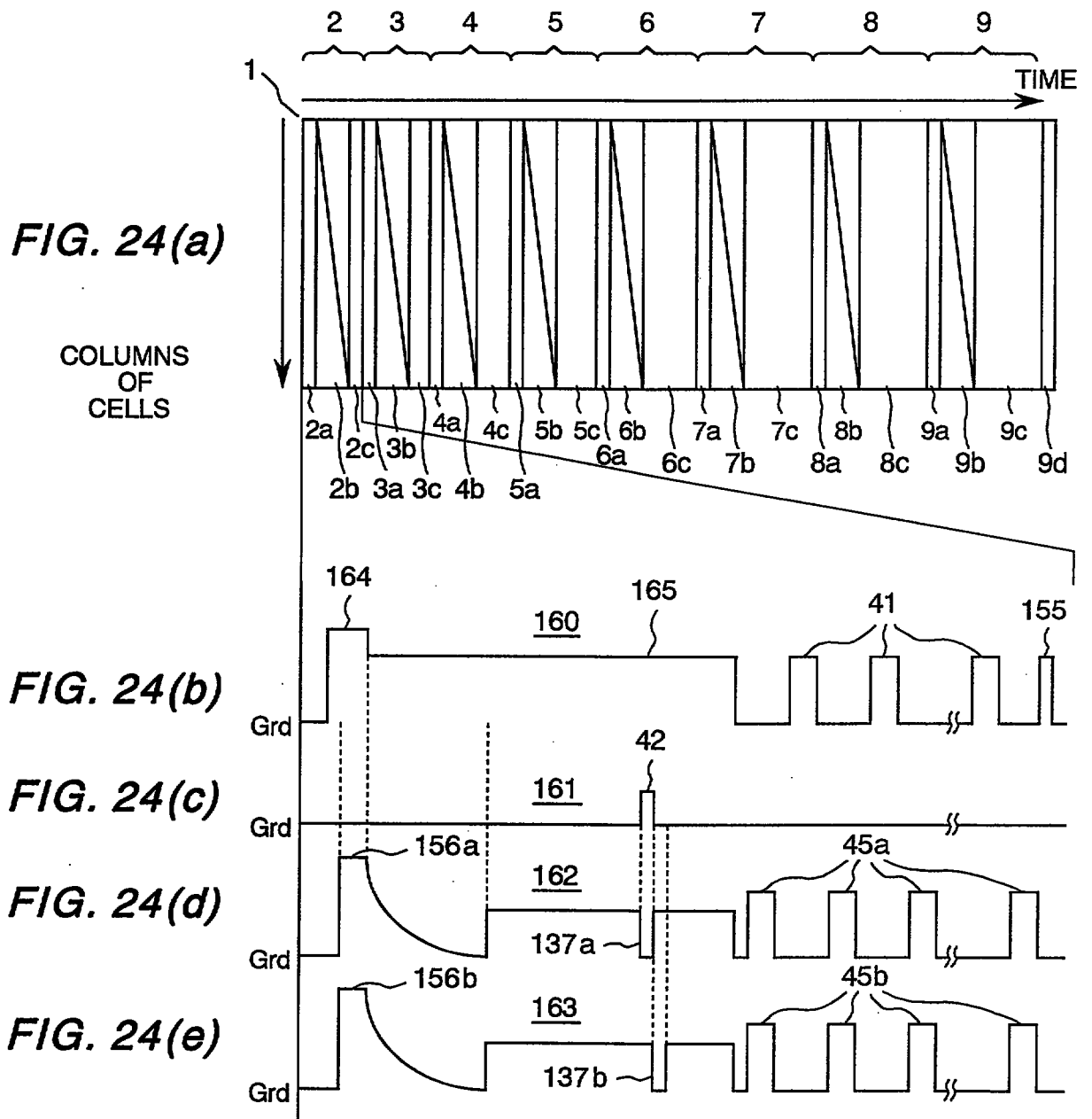
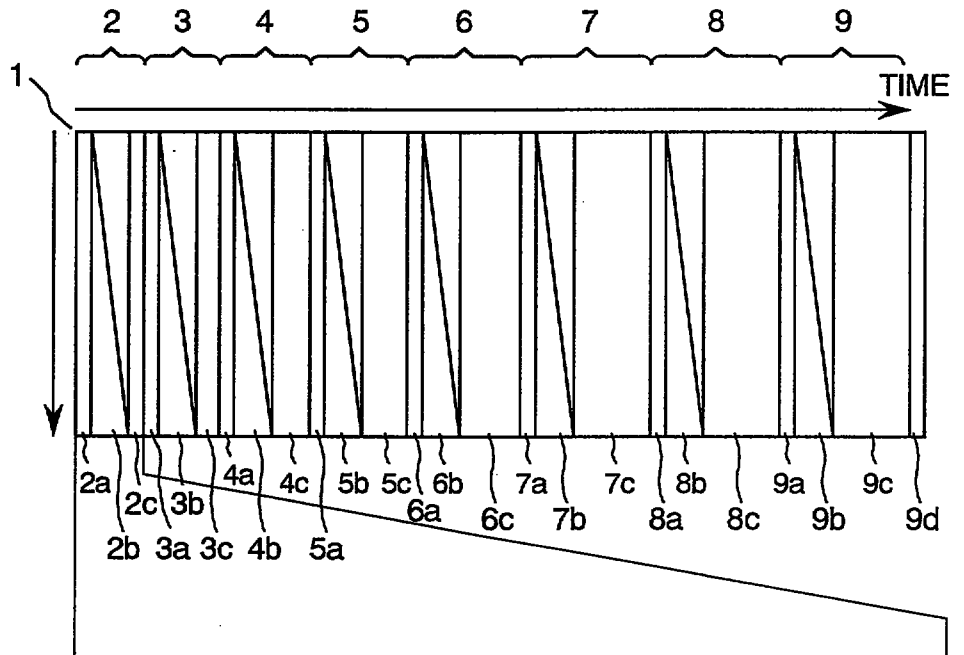
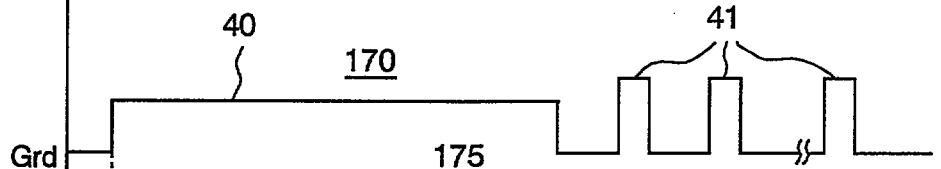
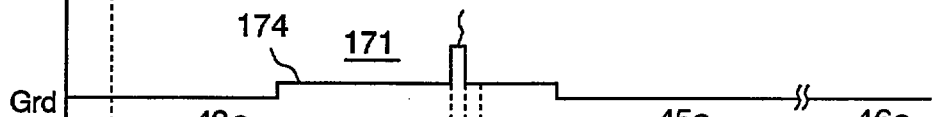
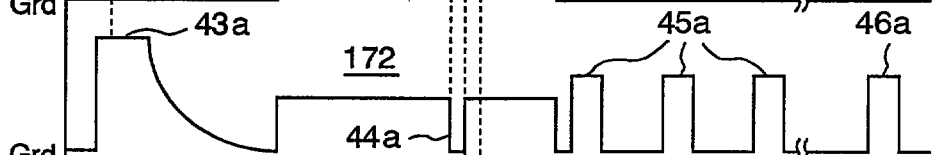
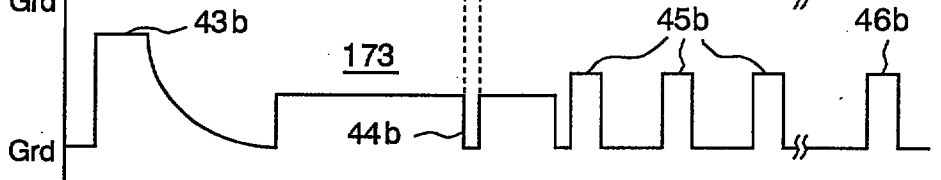


FIG. 25(a)COLUMNS
OF
CELLS**FIG. 25(b)****FIG. 25(c)****FIG. 25(d)****FIG. 25(e)**

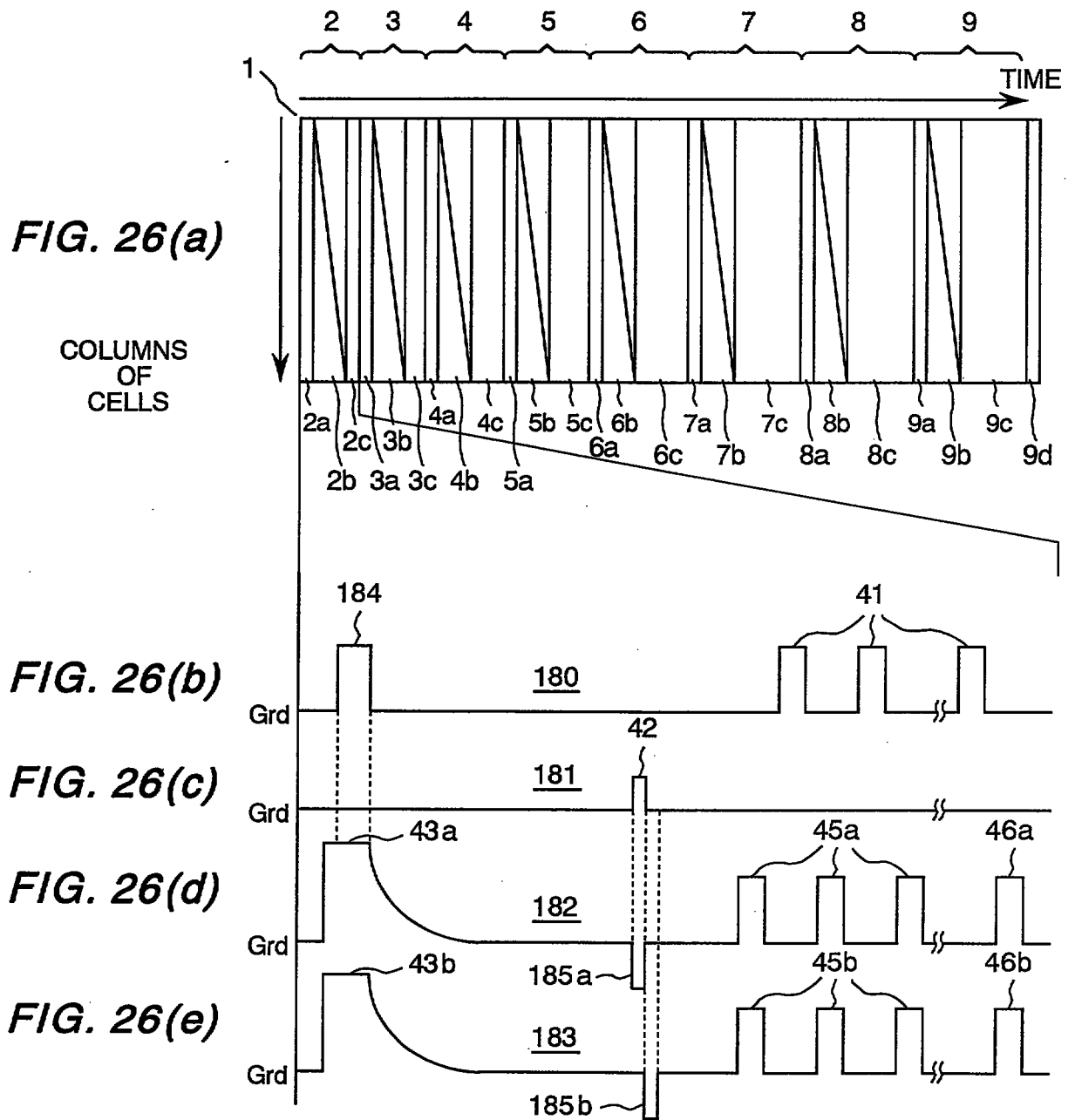


FIG. 27(a)

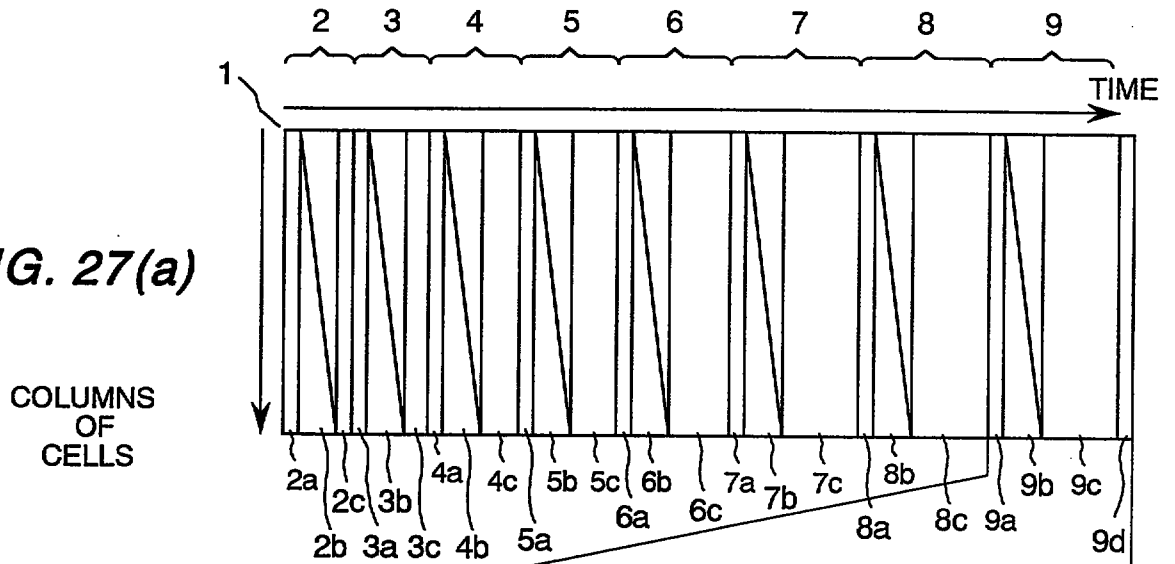


FIG. 27(b)

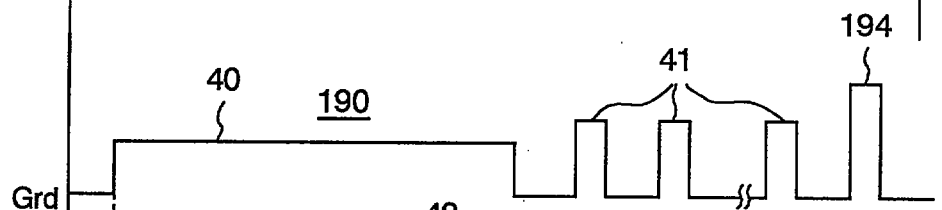


FIG. 27(c)

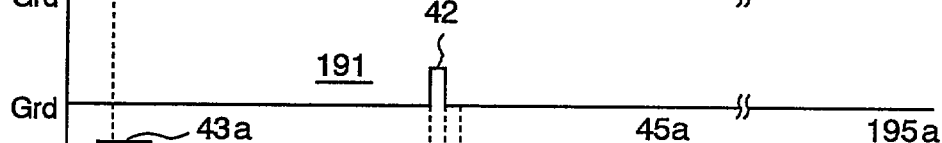


FIG. 27(d)

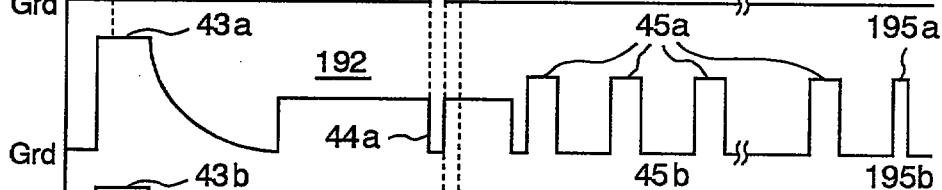
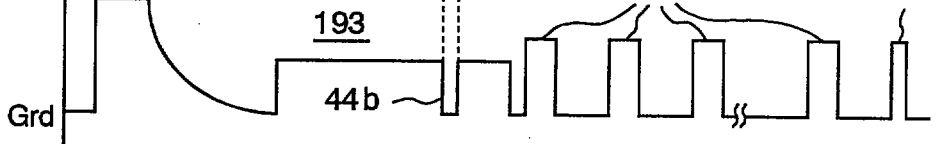


FIG. 27(e)



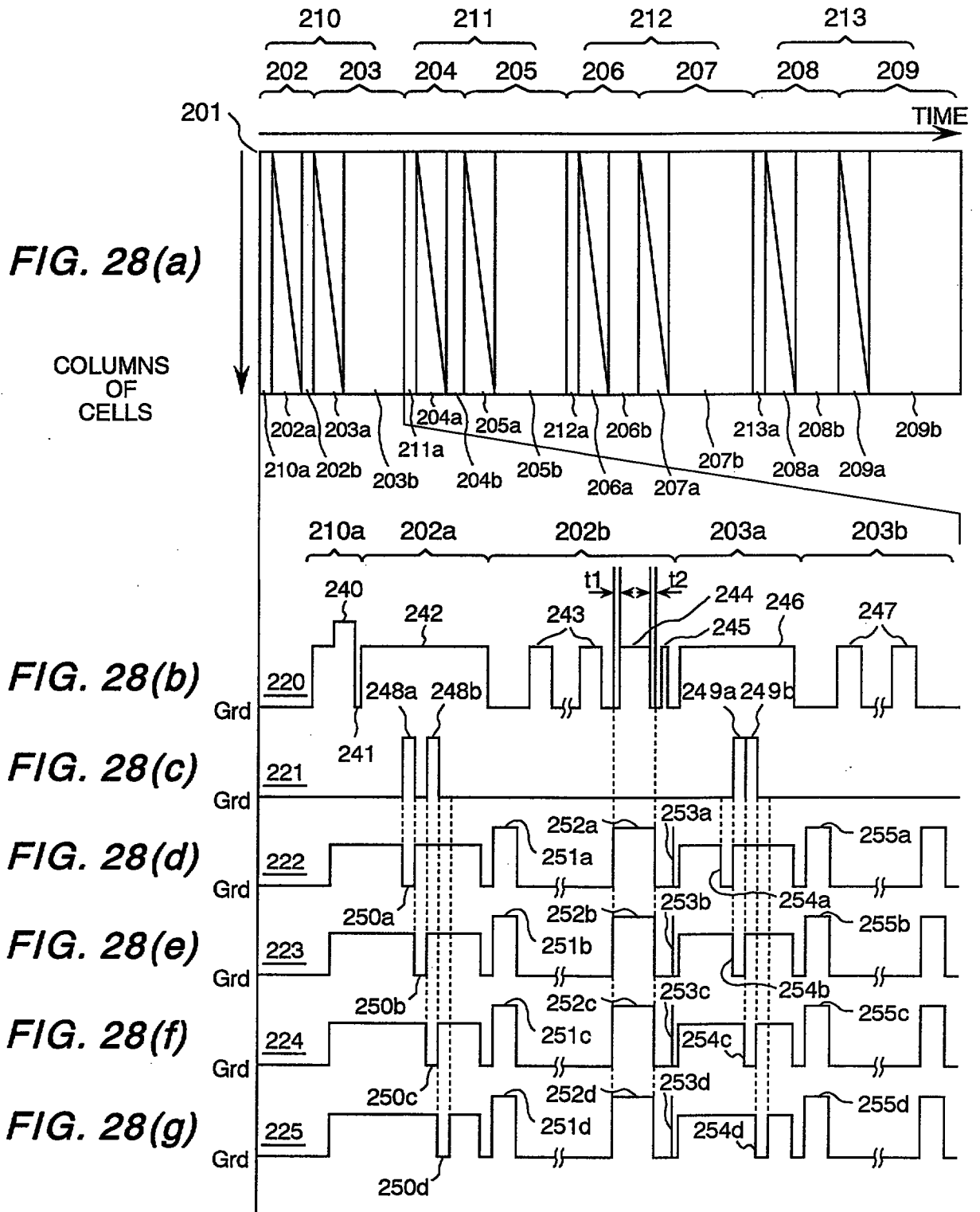


FIG. 29

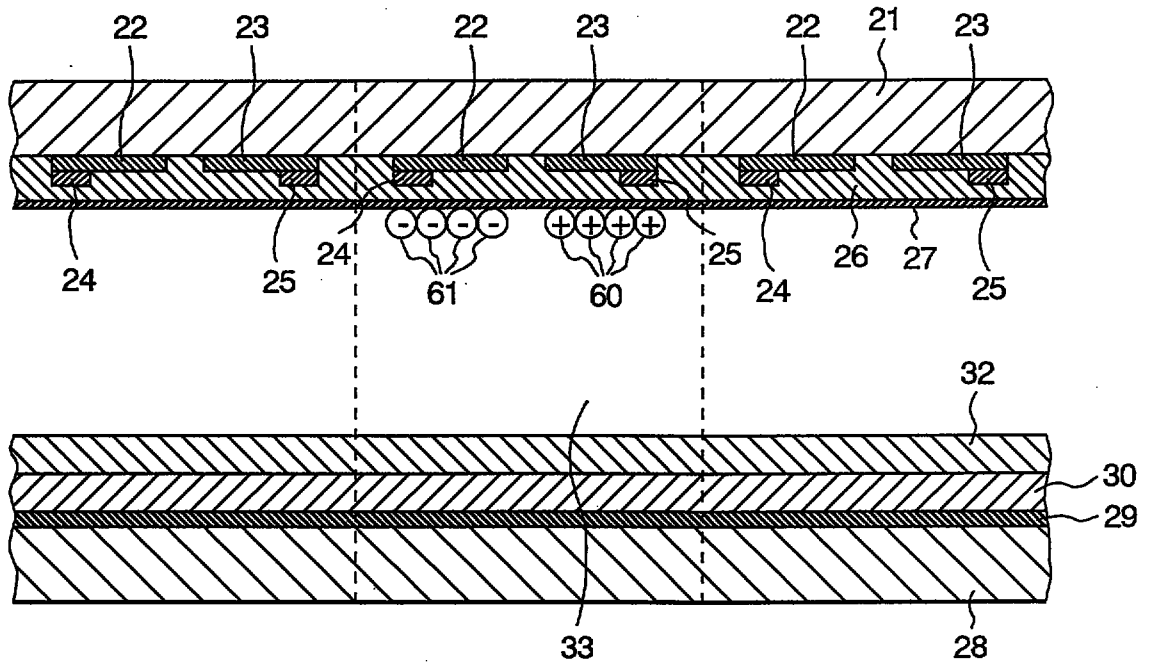


FIG. 30

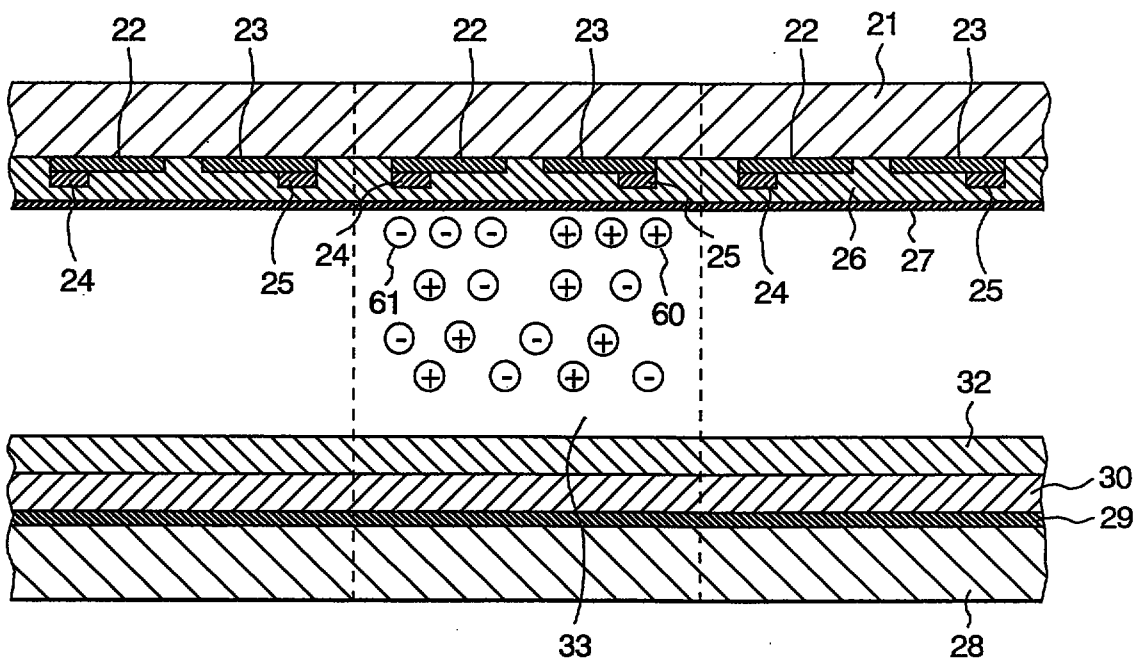


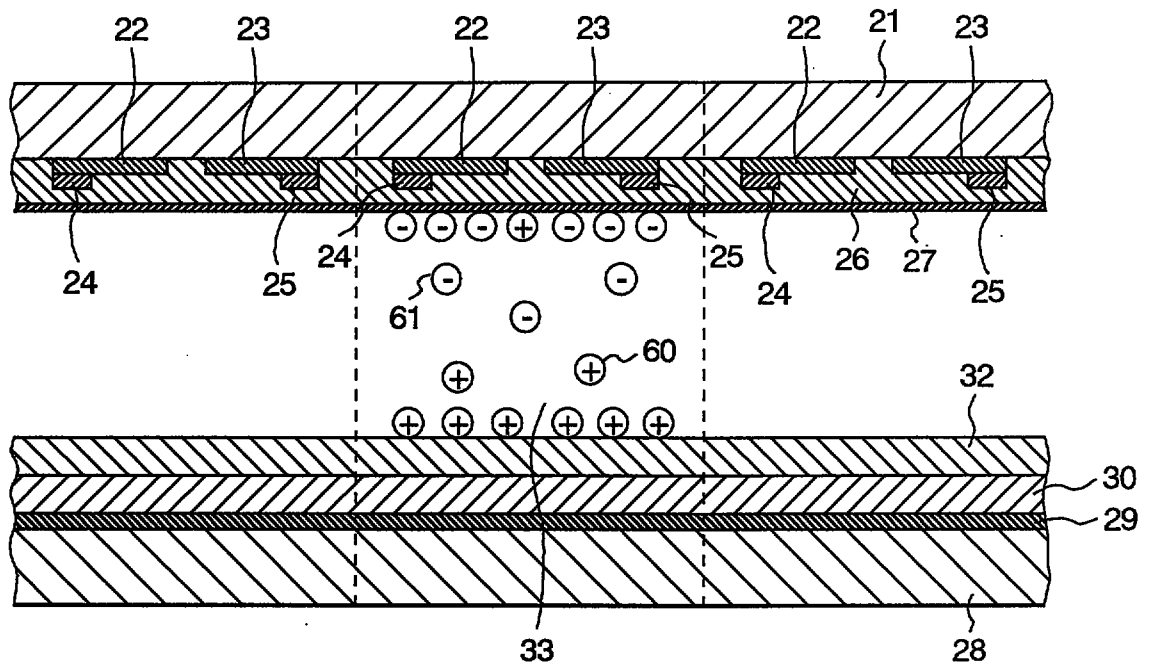
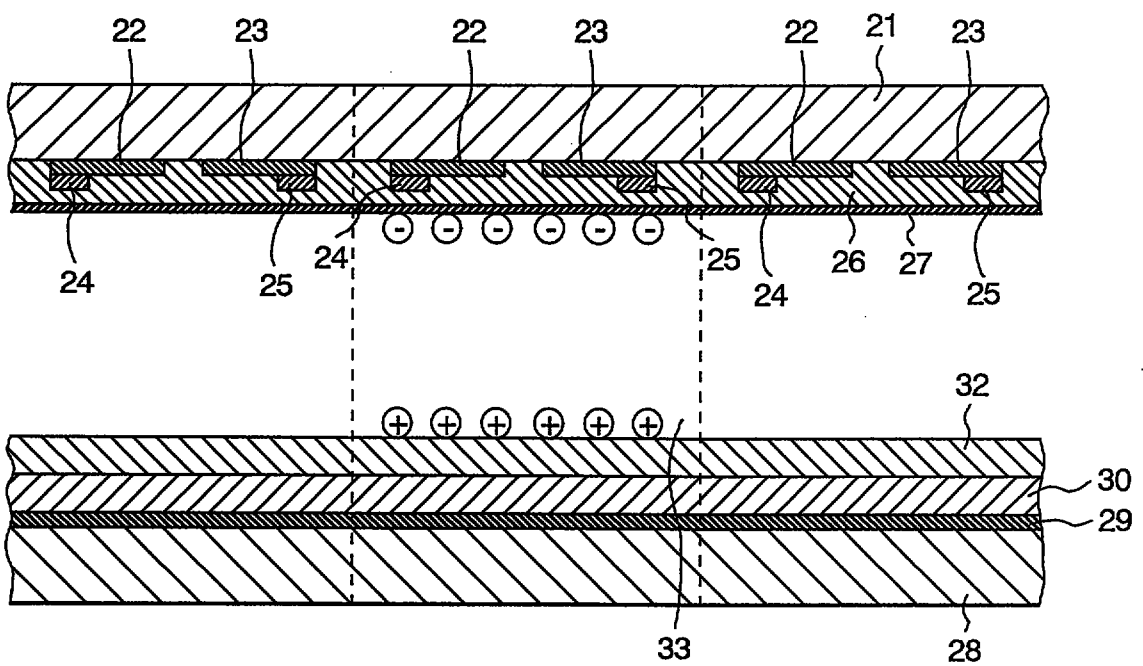
FIG. 31**FIG. 32**

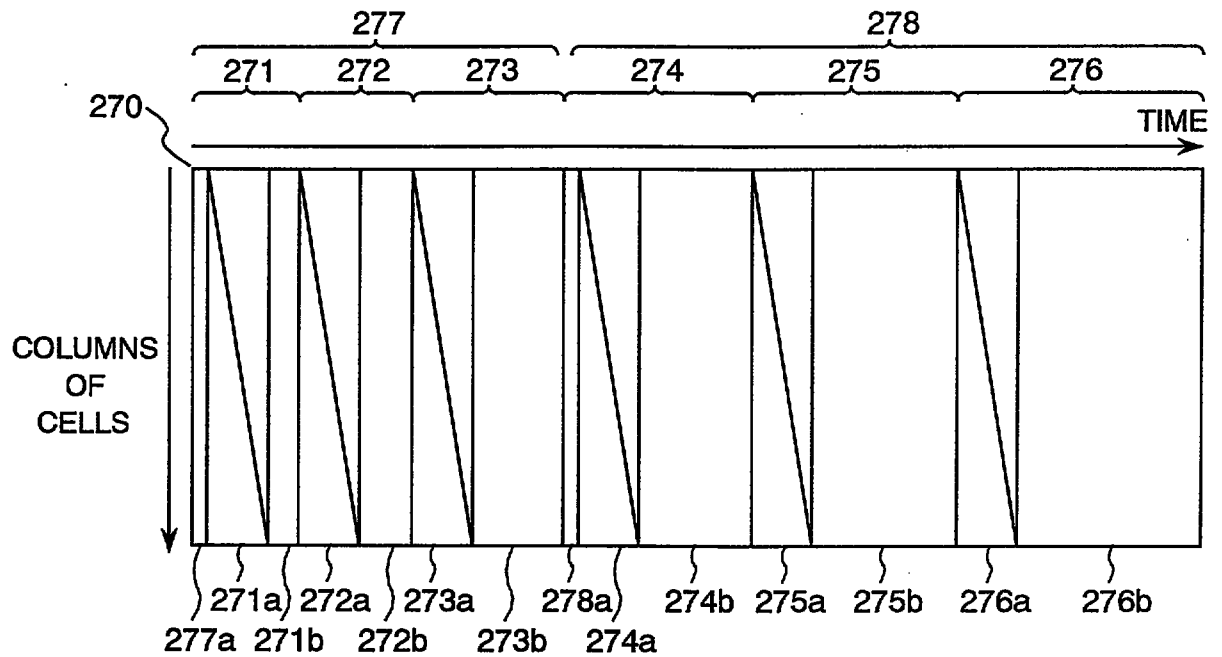
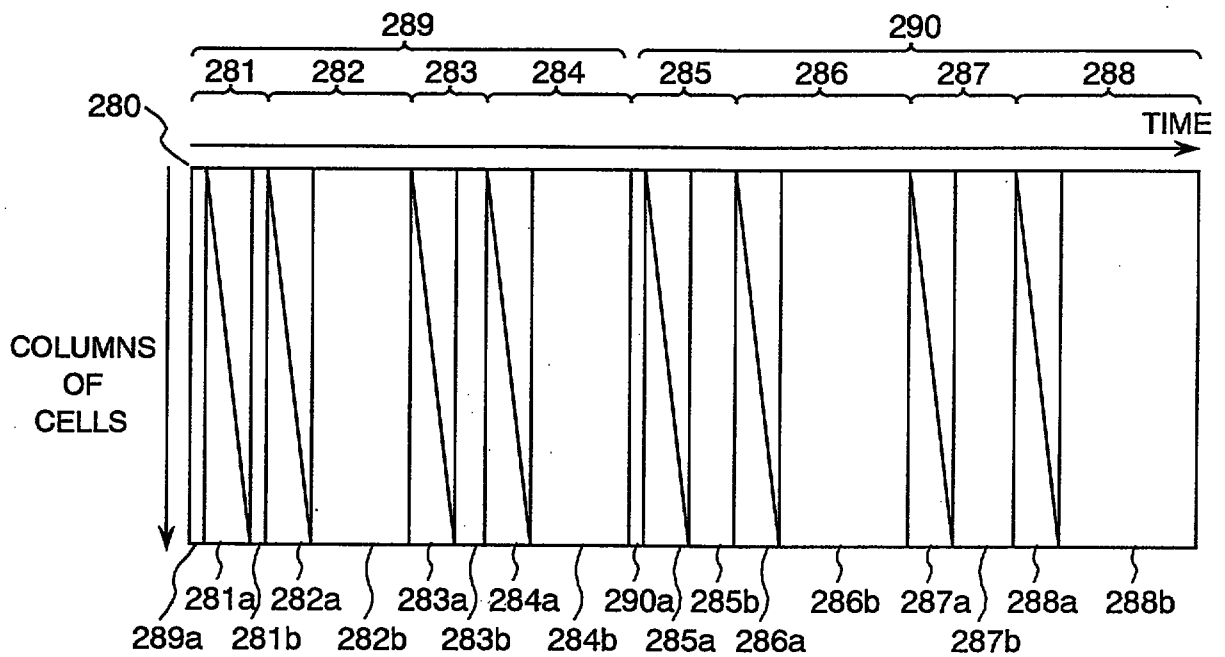
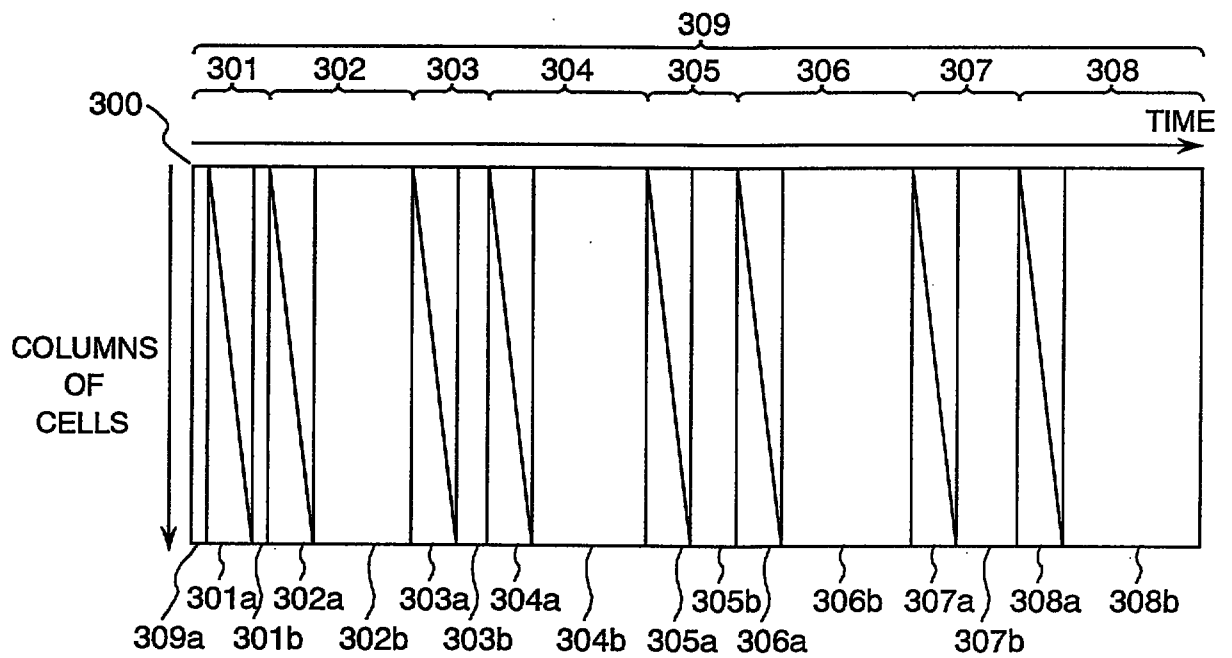
FIG. 33**FIG. 34**

FIG. 35



1 6 DEC 1997

1

TITLE OF THE INVENTION

PLASMA DISPLAY, DRIVING APPARATUS OF PLASMA
DISPLAY PANEL AND DRIVING SYSTEM THEREOF

BACKGROUND OF THE INVENTION

The invention relates to plasma display, driving apparatus of plasma display panel and driving system thereof for , for example, display apparatus of personal computer or workstation, a flat type wall hanging television receiver and a display apparatus for advertising and information. This invention is preferably applicable to AC type plasma display.

In plasma display, one field is divided into several sub-fields, and each pixel (cell) is given forth light by exciting a phosphor by ultraviolet rays that are generated by a electric discharge carried out in the cell. The cell that emits light is practiced by an address electric discharge between two set of electrodes which are provided perpendicular to each other on a front side glass substrate and a back side glass substrate respectively and are capable of driving independently.

A first prior art relating to a plasma display is disclosed ,for example, Japanese Patent Application Laid-Open No.1994/186927. In the prior art , the condition of the electric charge particles in all cells is equalized for surely prohibiting lighting for some



16 DEC 1997

cells which are not intended to emit light, and two sets of light emitting discharges, that is, a full writing electric discharge and a full erasing electric discharge in each sub-field are carried out so as to be able to use low voltage for an address electric discharge. Therefore, the contrast is deteriorated because light emitting occurs on full panel when black is displayed.

A second prior art is disclosed, for example, Japanese Patent Application Laid-Open No. 1995/49663. In the prior art, the plurality of the sub-fields having the same brightness gradations are arranged to construct a sub-field block, and several blocks are provided. In sub-field blocks, a preliminary discharge including a full writing electric discharge and a fine line erasing electric discharge is performed in one sub-field, and a writing electric discharge and a erasing electric discharge to a pixel is carried out one time. Therefore, deterioration of a panel is reduced and contrast of a display is improved. The second prior art discloses one of the solution to improve the contrast, but no prior art is shown to improve the contrast in which plural sub-fields having different brightness gradations for constructing one sub-field block.

About 3 μ sec to 4 μ sec is needed to write one line of plasma panel, and an ordinal television display has 480 lines. A writing period of a screen is 1.44 msec if a writing period of one line is 3 μ sec, so that



16 DEC 1997

$1.44 \text{ msec} \times 9 \div 13 \text{ msec}$ is needed for one field. The period of one field is 16.7 msec. A sustaining period is 16.7 msec minus a writing period and preliminary discharge period, and this period is not so long enough. Further, if a display has 760 lines per a screen like a high definition display, or if a display has 8 sub-fields for constructing 256 gradations, period for writing is not sufficient.

SUMMARY OF THE INVENTION

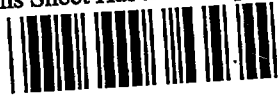
It is an object of the present invention to improve contrast.

It is another object of the present invention to improve contrast by reducing a full erasing electric discharge and full writing electric discharge.

It is still another object of the invention to improve contrast by reducing preliminary discharge without changing the number of sub-fields.

According to a feature of the present invention, to achieve the above object, a plasma display and a plasma display driving system include a first electrode group arranged on a permeable substrate and being capable of driving in common, a second electrode group arranged in parallel with the first electrode group on the permeable substrate and being capable of driving independently, a third electrode group arranged perpendicular to the first and second electrode groups

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REPLACEMENT SHEET

1 6 DEC 1997

4

on the other substrate and being capable of driving independently, and the plasma panel and the driving system comprising means for performing at least one electric discharge for equalizing electric charge particles in a cell in which another electric charge particle is caused beforehand.

According to another feature of the present invention, to achieve the above object, a plasma display, and a plasma display panel driving system and circuit include a first electrode group driven in common, a second electrode group driven independently, a third electrode group for an address electric discharge, means for erasing and polarizing electric charge particles by a fine line erasing pulse after sustaining period and for supplying an equalizing pulse to one of the electrode group of the first and second electrode group to which the last fine line erasing pulse is supplied and for supplying a regulating pulse to the other electrode of the first and the second electrode groups after supply of the equalizing pulse, thereby controlling the electric charge particles without full erasing electric discharge and full writing electric discharge and improving contrast without light emitting discharge in case of displaying of black color.

According to still another feature of the present invention, to achieve the above object, a plasma display and a plasma display panel driving system and

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REPLACEMENT SHEET

1 6 DEC 1997

5

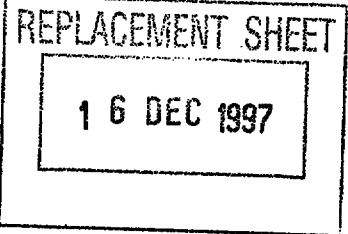
circuit include means for constructing a field block from plurality of sub-fields and for performing a full writing electric discharge and a fine line erasing electric discharge in first sub-field of the field block for decreasing number of electric discharge, means for gathering positive electric charge particles in the vicinity of an address electrode by the full writing electric discharge and fine line erasing electric discharge thereby decreasing a voltage of an address pulse, and means for reproducing the condition of electric charge particles the same as the condition after performing full writing electric discharge and fine line erasing electric discharge are performed by utilizing a sustaining electric discharge in a cell in which the address electric discharge occurred, thereby reducing the voltage of a address electric discharge in the next field without the full writing electric discharge and the fine line electric discharge.

In a cell having no address electric discharge, the condition of electric charge particles after the full writing electric discharge and fine line erasing electric discharge are performed is maintained during one field, so that it is sufficient to perform one time of the full writing electric discharge and fine line electric discharge.

These and other objects, features and advantages of the present invention will become more apparent form

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the following description when taken in conjunction with the accompanying drawings

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a exploded perspective view illustrating a plasma display panel of the present invention.

Fig. 2 is a sectional view of a plasma display panel which is illustrated from a direction in accordance with an arrow A of Fig. 1.

Fig. 3 is a sectional view of a plasma display panel which is illustrated from a direction in accordance with an arrow of Fig. 1.

Fig. 4 illustrates electrodes and circuits connected to the electrodes of the plasma display panel of Fig. 1.

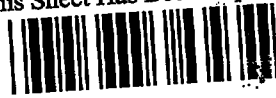
Fig. 5(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the first embodiment of the present invention.

Fig. 5(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the first embodiment of the present invention.

Fig. 5(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the first embodiment of the present invention.

Fig. 5(d) illustrates a driving wave-form supplied to a first independent Y electrode in

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accordance with the first embodiment of the present invention.

Fig. 5(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the first embodiment of the present invention.

Fig. 6 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell is illustrated immediately after a power is supplied and then a equalizing pulse and a protecting pulse are supplied.

Fig. 7 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after performing an address electric discharge is illustrated.

Fig. 8 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a fine line erasing pulse is illustrated.

Fig. 9 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a equalizing pulse in a second field is illustrated.

Fig. 10 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a regulating pulse in a second field is illustrated

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8

REPLACEMENT SHEET

1 6 DEC 1997

Fig. 11(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 11(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the second embodiment of the present invention.

Fig. 11(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the second embodiment of the present invention.

Fig. 11(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the second embodiment of the present invention.

Fig. 11(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the second embodiment of the present invention.

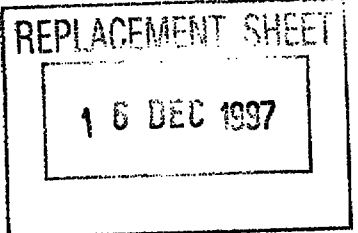
Fig. 12(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 12(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the third embodiment of the present invention.

Fig. 12(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the third embodiment of the present invention.

Fig. 12(d) illustrates a driving wave-form

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supplied to a first independent Y electrode in accordance with the third embodiment of the present invention.

Fig. 12(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the third embodiment of the present invention.

Fig. 13(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the invention.

Fig. 13(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the fourth embodiment of the present invention.

Fig. 13(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the fourth embodiment of the present invention.

Fig. 13(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the fourth embodiment of the present invention.

Fig. 13(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the fourth embodiment of the present invention.

Fig. 14(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the invention.



Fig. 14(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the fifth embodiment of the present invention.

Fig. 14(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the fifth embodiment of the present invention.

Fig. 14(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the fifth embodiment of the present invention.

Fig. 14(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the fifth embodiment of the present invention.

Fig. 15(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 15(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the sixth embodiment of the present invention.

Fig. 15(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the sixth embodiment of the present invention.

Fig. 15(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the sixth embodiment of the present invention.

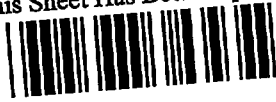


Fig. 15(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the sixth embodiment of the present invention.

Fig. 16(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the invention.

Fig. 16(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the seventh embodiment of the present invention.

Fig. 16(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the seventh embodiment of the present invention.

Fig. 16(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the seventh embodiment of the present invention.

Fig. 16(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the seventh embodiment of the present invention.

Fig. 17(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 17(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the eighth embodiment of the present invention.

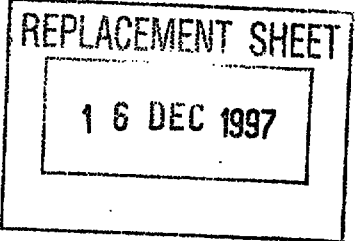


Fig. 17(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the eighth embodiment of the present invention.

Fig. 17(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the eighth embodiment of the present invention.

Fig. 17(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the eighth embodiment of the present invention.

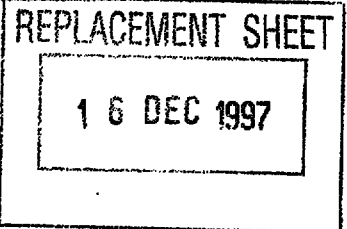
Fig. 18(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 18(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the ninth embodiment of the present invention.

Fig. 18(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the ninth embodiment of the present invention.

Fig. 18(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the ninth embodiment of the present invention.

Fig. 18(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the ninth embodiment of the present invention.



invention.

Fig. 19 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell is illustrated immediately after a power is supplied and then a equalizing pulse and a regulating pulse are supplied in accordance with the ninth embodiment.

Fig. 20 is a sectional view of a plasma display panel in which a condition ¹³ of electric charge particles in a cell after performing a address electric discharge is illustrated in accordance with ninth embodiment of the present invention.

Fig. 21 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a fine line erasing pulse is illustrated in accordance with the ninth embodiment of the present invention.

Fig. 22 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a equalizing pulse in a second field is illustrated in accordance with the ninth embodiment of the present invention.

Fig. 23 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a regulating pulse in a second field is illustrated in accordance with the ninth embodiment of the present invention.



16 DEC 1987

Fig. 24(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 24(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the tenth embodiment of the present invention.

Fig. 24(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the tenth embodiment of the present invention.

Fig. 24(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the tenth embodiment of the present invention.

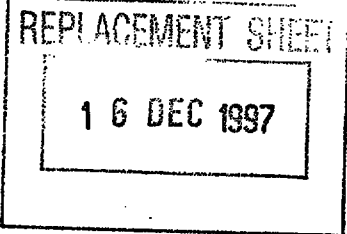
Fig. 24(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the tenth embodiment of the present invention.

Fig. 25(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 25(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the eleventh embodiment of the present invention.

Fig. 25(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the eleventh embodiment of the present invention.

Fig. 25(d) illustrates a driving wave-form



supplied to a first independent Y electrode in accordance with the eleventh embodiment of the present invention.

Fig. 25(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the eleventh embodiment of the present invention.

Fig. 26(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 26(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the twelfth embodiment of the present invention.

Fig. 26(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the twelfth embodiment of the present invention.

Fig. 26(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the twelfth embodiment of the present invention.

Fig. 26(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the twelfth embodiment of the present invention.

Fig. 27(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

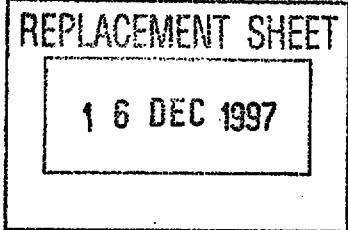


Fig. 27(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the thirteenth embodiment of the present invention.

Fig. 27(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the thirteenth embodiment of the present invention.

Fig. 27(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the thirteenth embodiment of the present invention.

Fig. 27(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the thirteenth embodiment of the present invention.

Fig. 28(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with a second embodiment of the present invention.

Fig. 28(b) illustrates a driving wave-form supplied to a common X electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 28(c) illustrates a driving wave-form supplied to an address A electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 28(d) illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the fourteenth embodiment of the present invention.

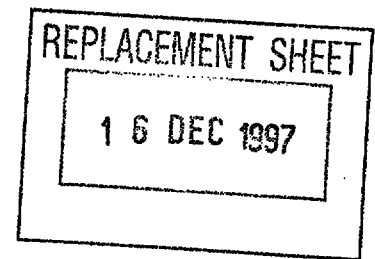


Fig. 28(e) illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 28(f) illustrates a driving wave-form supplied to a third independent Y electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 28(g) illustrates a driving wave-form supplied to a fourth independent Y electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 29 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying sustaining pulses is illustrated in accordance with an embodiment shown in Fig. 28(a)-28(g) of the present invention.

Fig. 30 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell during discharging by a selection electric discharge pulse is illustrated in accordance with the embodiment shown in Fig. 28(a)-28(g) of the present invention.

Fig. 31 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell during supplying electric charge particles control pulse is illustrated in accordance with the



1 6 DEC 1997

embodiment shown in Fig. 28(a)-28(g) of the present invention.

Fig. 32 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a fine line erasing pulse is illustrated in accordance with the embodiment shown in fig. 28(a)-Fig. 28(g) of the present invention.

Fig. 33 is a time chart of sub-fields illustrating a driving system in accordance with a third embodiment of the present invention.

Fig. 34 is a time chart of sub-fields illustrating a driving system in accordance with a fourth embodiment of the present invention.

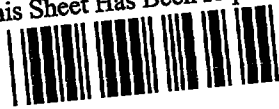
Fig. 35 is a time chart of sub-fields illustrating a driving system in accordance with a fifth embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the present invention will be described with using drawings hereinafter.

Fig. 1 illustrates a exploded perspective view of a plasma display panel relating to the first embodiment of the present invention.

A transparent common X electrode 22 and a transparent independent Y electrode 23 are provided under a front glass substrate 21, and a X bus electrode 24 and a Y bus electrode 25 are laminated on respective

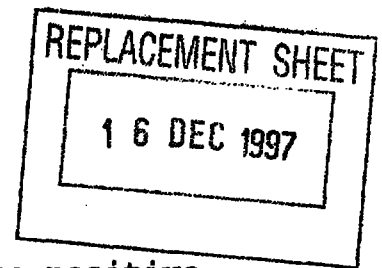


16 DEC 1997

electrode 21 and 22. A dielectric layer 26 and a protecting layer 27 such as a acid magnesium (MgO) are provided on these electrodes 22,23,24 and 25. An address A electrode 29 provided on a back glass substrate 28 is arranged perpendicular to the common X electrode 22 and the independent Y electrode 23 on the front glass substrate 21. The address A electrode 29 is covered by a dielectric layer 30 and a partition wall 31 arranged parallel to the address A electrode 29 is provided on the electrode 29. A phosphor 32 is coated on the partition wall 31 and the address A electrode 29.

Fig. 2 is a sectional view of a plasma display panel which is illustrated from a direction in accordance with an arrow A of Fig. 1. The address A electrode 29 is arranged in the middle of the two partition walls. A discharge gas such as a neon gas or a xenon gas is filled in a space 33 that is provided between the front glass substrate 21 and the back glass substrate 38.

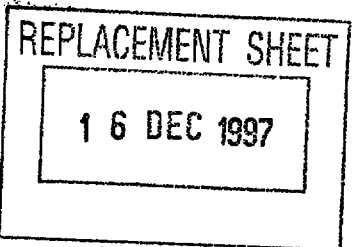
Fig. 3 is a sectional view of a plasma display panel which is illustrated from a direction in accordance with an arrow of Fig. 1. A border of each cell is shown by a dotted line, and the common X electrode 22 and the independent Y electrode 23 are arranged alternatively. In AC type plasma display panel, the electric charge particles on the dielectric layer in the vicinity of the common X electrode 22 and the



independent Y electrode 23 are divided into positive electric charge particles and negative electric charge particles for forming an electric field, so that a discharge is performed by using the electric field.

Fig. 4 illustrates electrodes and circuits connected to the electrodes of the plasma display panel of Fig. 1. The common X electrode 22 is connected to an output terminal or several terminals of a X electrode driving circuit 35 that generates a driving pulse for supplying to the common X electrode 22. Each independent Y electrode 23 is connected respective output terminals of a Y electrode driving circuit 36. Each address A electrode 29 is connected respective output terminals of a A electrode driving circuit 37.

Fig. 5 illustrates a first driving system in accordance with a first embodiment of the present invention. Fig.(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the invention. In the figure, reference numeral 1 denotes one field, a horizontal axis illustrates time and a vertical axis illustrates a line of the cell. The one field is divided into eight sub-fields, that is, a first sub-field 2 to a eighth sub-field 9. A electric charge particle equalizing period 2a-9a, an address period 2b-9b and a sustaining period 2c-9c are arranged in order in each sub-field. Numbers of electric discharges are allotted for each sub-field and display



gradations are determined by the total numbers of the discharges. The order for arranging the sub-fields having predetermined numbers of discharges is free, but in the embodiment, the sub-fields are arranged in order from a sub-field having a fewer numbers of electric discharge.

Fig. 5(a)-Fig. 5(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively. In the figure, a pulse wave-form 10 illustrates a part of driving wave-form supplied to the common X electrode 22 in one field. A pulse wave-form 11 illustrates a part of driving wave-form supplied to the one of the address A electric rode 29. Pulse wave-forms 12 and 13 illustrate a parts of driving wave-form supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 10 which is supplied to the common X electrode 22 during first sub-field includes a regulating pulse 40 lasting from the electric charge particle equalizing period 2a to the address period 2b and the sustaining pulses 41 in the sustaining period 2c. In this embodiment, the voltage of the regulating pulse 40 is lower than the voltage of the sustaining pulses 41. The pulse wave-form 11 which is supplied to one of the address A electrodes 29 illustrates the address pulse 42 in the address period 2b and the address pulse 42



1 6 DEC 1997

corresponds to the cell to be emitted light . The address pulse 42 is not supplied when there is no cell to be emitted. That is, the address pulses 42 are supplied to the cells to be emitted, and the address pulse 42 is not supplied to the other cells not to be emitted. The pulse wave-forms 12 and 13 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a electric charge particle equalizing pulses 43a, 43b,--- in the electric charge particle equalizing period 2a of the first sub-field, scan pulses 44a, 44b,---in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. In the embodiment, the voltage of the scan pulses 44a, 44b, --- is lower than the voltage of the sustaining pulses 45a, 45b,---. The fine line erasing pulses 46a, 46b,--and the equalizing pulses 43a, 43b,--- are supplied to the same electrodes. Further, it is preferable to select the pulse width of the fine line erasing pulses 46a, 46b,--- between 0.5 μ sec-2 μ sec.

The movements of the panel is explained hereinafter. In Fig. 5, electric discharges in all cells are performed between the independent Y electrodes 23 and the common X electrodes 22 by supplying the equalizing pulses 43a, 43b,--- to the independent Y electrodes 23, and negative electric charge particles

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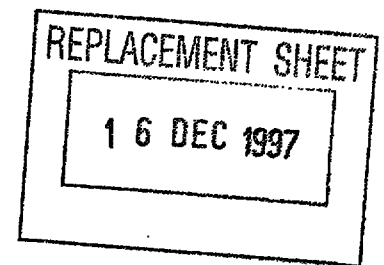
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1 6 DEC 1997

are formed on the dielectric layer 26 in the vicinity of the independent Y electrode 23 during electric charge particle equalizing period 2a occurring immediately after the power is supplied to the display. The electric discharge by the equalizing pulses 43a, 43b,--- occurs only first one time, and the discharge is not occurred after this. That is, the discharge occurs only one time other than the space 33 of the cell becomes abnormal condition. The regulating pulse 40 is supplied to the common X electrode 22 within the time between 0.3 μ sec-2 μ sec from the rising edge of the equalizing pulses 43a, 43b,---. The negative electric charge particles are formed in the vicinity of the common X electrode 22, and the positive electric charge particles are formed in the vicinity of the address A electrode 29.

The reason the time between the rising edge of the equalizing pulses 43a, 43b,---and the rising edge of the regulating pulse 40 is determined as described the above is that : too many negative electric charge particles are gathered in the vicinity of the independent Y electrode 23 and the negative electric charge particles gather in the common X electrode 22 when the time between edges of both pulses 43a, 43b,-- and 40 is selected too long. When the time is too short, the negative electric charge particles are not gathered on the independent Y electrode 23 and also the positive electric charge particles are not gathered on the

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address A electrode 22.

The main purpose for supplying the regulating pulse 40 is to attract the negative electric charge particles toward the common X electrode 22 and to form the positive electric charge particles on the address A electrode 29. Another purpose is to assist electric discharges between the common X electrode 22 and the independent Y electrode 23 when the address electric discharge is performed between the address A electrode 29 and the independent Y electrode 23.

The address electric discharges is performed in the cell which is formed at the cross point of the first line of the independent Y electrode 23 and one of the address A electrode 22 when the scan pulses 44a is supplied to the first line of the independent Y electrode 23 and the address pulse 42 is supplied to one of the address A electrode 29 at the same time, as a result, the positive electric charge particles are gathered on the independent Y electrode 23. On the other hand, no discharge is occurred when the address pulse 42 which corresponds to the scan pulses 44b is not supplied to the second line of the independent Y electrode 23, therefore, no electric charge particle is gathered on the independent Y electrode 23. The address pulses 42 are supplied to the address A electrodes 29 which correspond to the cell to be emitted and are selected all the cells at the cross points of all



1 6 DEC 1997

address A electrodes 29 and the scan pulses 44a or 44b is supplied to the independent Y electrodes 23, so that the electric discharges are performed between the address A electrode 29 and the independent Y electrodes 23.

Next, in the sustaining period 2c, the electric discharges for light emitting are performed by the sustaining pulses 41, 45a, 45b,---between the common X electrode 22 and the independent Y electrodes 23 in the cell in which the positive electric charge particles are gathered on the independent Y electrodes 23 side by the electric discharges performed during address period 2b. After that, electric discharges occur between the independent Y electrodes 23 and the common X electrode 22 by supplying the fine line erasing pulses 46a, 46b,-- - to the independent Y electrodes 23 and the electric charge particles in the cells are erased, so that the all electric charge particles generated for light emitting in the cell are erased. The pulse width of the fine line erasing pulses 46a, 46b,---is a little longer than the electric discharge continuation time, therefore, the negative electric charge particles are gathered on the dielectric layer in the vicinity of the independent Y electrodes 23. In the cells in which no electric discharge is occurred, the erasing discharges are not performed because no electric charge particle is in the cell. Therefore, the negative electric charge particles

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26

REPLACEMENT SHEET

1 6 DEC 1997

formed in the vicinity of the independent Y electrodes 23 are kept unchanged.

In this situation, no electric discharge occurs by supplying the equalizing pulses 43a, 43b, --- to the independent Y electrodes 23 because the negative electric charge particles in the cell negate the voltage of the equalizing pulses 43a, 43b, ---and sufficient electric fields needed for electric discharge are not formed. After that, no electric discharge is performed through all sub-fields even if the equalizing pulses are supplied. Therefore, the electric discharges are not performed except the first sub-field immediately after the power on, therefore no light emitting occurs in black display.

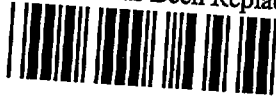
Further, for the linearity of display gradations determined by the numbers of sustaining pulses, one electric discharge have less influence more than two electric discharges. According to the present invention, the equalization of electric charge particles is effected by one electric discharge in the cell in which the sustaining electric discharge is performed, therefore, the influence to the linearity for display gradations is very small.

The same driving system is performed during the second sub-field 3 to the eighth sub-field 9 and a screen of one field is formed.

Fig. 6-Fig. 10 are sectional views of the plasma

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27

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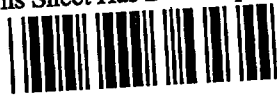
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display panel in which the condition of electric charge particles in the cell performed sustaining electric discharge are illustrated from the first sub-field after the power is supplied to the second sub-field until the equalizing pulses and the regulating pulse are supplied. In these figure, reference numeral 60 denotes a positive electric charge particles, reference numeral 61 denotes a negative electric charge particles. Further the condition of electric charge particles is illustrated in a cell at center position of Fig. 6-Fig. 7.

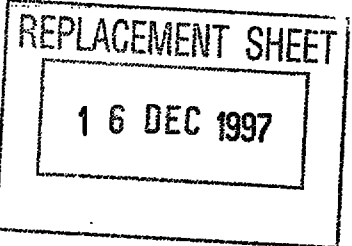
Fig. 6 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell is illustrated immediately after a power is supplied and then a equalizing pulse and a regulating pulse are supplied. The figure illustrate the condition of electric charge particles in the first sub-field after power is supplied at first and then the equalizing pulses 43a, 43b are supplied to the independent Y electrodes 23 and finally the regulating pulse 40 is supplied. The electric discharges in all cells occur between the common X electrode 22 and the independent Y electrodes 23 by supplying the equalizing pulses 43a, 43b,---to the independent Y electrodes 23, and the negative electric charge particles 61 are gathered on the dielectric layer in the vicinity of the independent Y electrodes 23a and the common X electrode 22 and the positive electric charge particles 60 are gathered on

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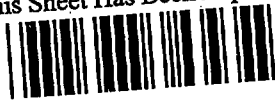
28



the address A electrodes 29 side.

Fig. 7 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after performing an address electric discharge is illustrated. In Fig. 7, the condition of electric discharges is illustrated after the address pulses 42 is supplied to the address A electrodes 29 and address electric discharges occur between the address A electrode 29 and the independent Y electrode 23. The positive electric charge particles 60 are gathered on the dielectric layer in the vicinity of the independent Y electrode 23 because the voltage of the independent Y electrode 23 is lower than the voltages of the address A electrode 29 and the common X electrode 22. The condition of the electric charge particles are shown in Fig. 7. The electric discharge occurs between the independent Y electrode 23 and the common X electrode 22 by the positive electric charge particles 60 and the first pulse of the sustaining pulses 45a, 45b,--- supplied to the independent Y electrode 23. This is a sustain discharge. This time, the negative electric charge particles 61 are gathered around the independent Y electrode 23 and the positive charges 62 are gathered around the common X electrode 22 by the electric discharge generated by the sustaining pulses 45a, 45b. As a result, the sustaining electric discharges occur between the independent Y electrode 23 and the common X

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16 DEC 1997

electrode 22 by the first pulse of sustaining pulses 41. This electric discharges are repeated during sustaining period 2c.

Fig. 8 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a fine erase pulse is illustrated. In Fig. 8, the condition of electric discharge after the last sustaining pulses 41 is supplied to the common X electrode 22 and then the fine line erasing pulses 46a, 46b,---are supplied is illustrated.

The condition of the electric charge particles after the discharges are occurred by the final sustaining pulses 41 is the same with the condition shown in Fig. 7.

The pulse width of the fine line erasing pulses 46a, 46b,---is longer than the discharge continuation time, so that negative electric charge particles 61 which move so quickly are gathered on the dielectric layer in the vicinity of the independent Y electrode 23. As a result, separation of the electric charge particles is performed. The positive electric charge particles that move slowly in space float in the cell. The negative charges float discharge space for a while.

Fig. 9 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a equalizing pulse in a second



16 DEC 1997

field is illustrated. In Fig. 9, a condition of electric discharge after the equalizing pulses 43a, 43b,---in the second sub-field are supplied is illustrated. The voltage of the equalizing pulses 43a, 43b, ---are canceled by the negative charges and is not reached to the discharge voltage, so that any discharges is not performed. The voltage of the independent Y electrode 23 is higher than the voltage of the other electrodes, so the negative charges are attracted toward the independent Y electrode 23.

Fig. 10 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a regulating pulse in a second field is illustrated.

Referring to the drawing, the condition of electric charge particles after the regulating pulse 40 is supplied to the common X electrode 22 is illustrated. The negative electric charge particles are gathered on the dielectric layer in the vicinity of the common X electrode 22 and the positive charges are gathered at the address A electrode 29. By this, the same driving as the first sub-field is performed without electric discharge by the equalizing pulses 43a, 43b,---. In this case, the voltage of the equalizing pulses 43a, 43b,--- is reduced by the negative electric charge particles at the independent Y electrode 23, so that the electric discharge between the independent Y electrode



16 DEC 1997

23 and the common X electrode 22 is not performed.

The driving of the panel is capable of performing without using the full writing electric discharge and fine line erasing electric discharge for each sub-field. As a result, unnecessary light emitting is erased for displaying black brightness so that the contrast is improved.

The second embodiment of the present invention is described hereinafter. Fig. 11 illustrates a second driving system in accordance with a second embodiment of the present invention. Fig.(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis shows time and a vertical axis shows lines of cells.

Fig. 11(b)-Fig. 11(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 70 illustrates a part of driving wave-form supplied to the common X electrode 22 in one field. A pulse wave-form 71 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 72 and 73 illustrate parts of driving wave-form supplied, for example, to a first and a second independent Y electrodes 23.

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32

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1 6 DEC 1997

The pulse wave-form 70 which is supplied to the common X electrode 22 during first sub-field includes a regulating pulse 40 lasting from the electric charge particle equalizing period 2a to the address period 2b and the sustaining pulses 41 and a fine line erasing pulse 74 in the sustaining period 2c. The pulse wave-form 71 which is supplied to one of the address A electrodes 29 illustrates the address pulse 42 in the address period 2b which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 71 and 72 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a electric charge particle equalizing pulse 43a 43b,--- in the electric charge particle equalizing period 2a of the first sub-field, scan pulse 44a, 44b,---in the address period 2b, sustaining pulses 45a, 45b,--- and a first fine line erasing pulses 75a, 75b,--- in the sustaining period 2c.

Under these circumstances, the pulse width of the first fine line erasing pulses 75a, 75b,---is the same with or shorter than a pulse width of a second fine line erasing pulse 74. The number of the fine line erasing pulses is an even number as shown in Fig. 11, that is, the first and the second fine line erasing pulses 75a, 75b and 74, the first fine line erasing

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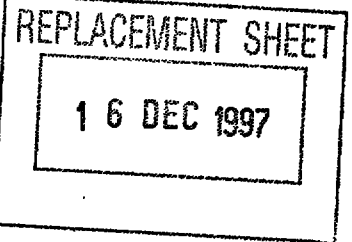


16 DEC 1997

pulses 75a, 75b,---which are the last erasing pulses and the equalizing pulses 43a, 43b,---are supplied to the same electrodes, that is, the independent Y electrode 23 of Fig. 11. The second fine line erasing pulse 74 is supplied to the other electrode, that is, the common X electrode 22.

In the embodiment, the last sustaining pulse is supplied to the independent Y electrode 23. A condition of electric charge particles after supplying the first fine line erasing pulses 75a, 75b,---is almost same as the condition shown in Fig. 8. in accordance with the first embodiment. The condition of electric discharges in the other sub-fields 3-9 are the same condition. Further, the erasing and polarizing of electric charge particles are performed by these fine line erasing pulses, so these erasing pulses are called polarization pulse group. In this embodiment, by using the first and the second fine line erasing pulses 75a, 75b and 74, the erasing and polarization are effectively performed, and electric discharging time during address discharging time is maintained constant.

The third embodiment of the present invention is described hereinafter. Fig. 12 illustrates a third driving system in accordance with a third embodiment of the present invention. Fig. 12(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure

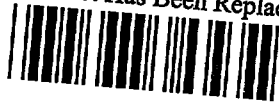


illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells.

Fig. 12(b)-Fig. 12(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 80 illustrates a part of driving wave-form supplied to the common X electrode 22 in first sub-field. A pulse wave-form 81 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 82 and 83 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 80 which is supplied to the common X electrode 22 during the first sub-field includes a regulating pulse 40 lasting from the electric charge particle equalizing period 2a to the address period 2b and the sustaining pulses 41 in the sustaining period 2c and second fine line erasing pulse 84. The pulse wave-form 81 which is supplied to one of the address A electrodes 29 illustrates the address pulse 42 in the address period 2b which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-



16 DEC 1937

forms 82 and 83 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes electric charge particles equalizing pulse 43a 43b,--- in the electric charge particles equalizing period 2a of the first sub-field, scan pulses 44a, 44b,---in the address period 2b, sustaining pulses 45a, 45b,--- and a third fine line erasing pulses 85a, 85b,--- and a first fine line erasing pulses 86a, 86b,--- in the sustaining period 2c.

Under these circumstances, the pulse width of the second fine line erasing pulses 84 is the same as or shorter than a pulse width of a third fine line erasing pulses 85a, 85b,---.

And a pulse width of the first fine line erasing pulses 86a, 86b,---is the same as or shorter than a pulse width of the second fine line erasing pulse 84

If the numbers of the fine line erasing pulses are an odd number as shown in Fig. 12, that is, the first to the third fine line erasing pulses, the first fine line erasing pulses 86a, 86b,---which are the last supplied erasing pulses and the equalizing pulses 43a, 43b,---are supplied to the same electrodes, that is, the independent Y electrode 23 of Fig. 12. The third fine line erasing pulse 85 which is first supplied fine line erasing pulse is supplied to the same electrode to which first supplied fine line erasing pulses 86a and 86b are



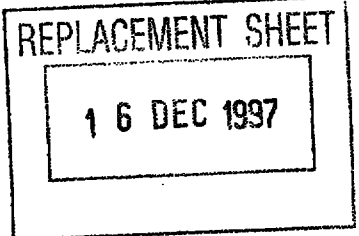
16 DEC 1997

supplied, that is, the independent Y electrode 23.

Therefore, the last sustaining pulse is supplied to the common X electrode 22. A condition of electric charge particles after supplying the first fine line erasing pulses 86a, 86b,---is almost same condition as shown in Fig. 8 in accordance with the first embodiment. The condition of electric discharges in the other sub-fields 3-9 is the same condition. In the embodiment, by using the first, the second and the third fine line erasing pulses 86a, 86b, 84, 85a and 85b, the erasing and polarization are more effectively performed, and electric discharging time during address discharging time is maintained constant. According to an experiment by present inventors, it is effective for erasing up to three fine line erasing pulses and using more than four fine line erasing pulses is not so effective.

The fourth embodiment of the present invention is described hereinafter. Fig. 13 illustrates a fourth driving system in accordance with a fourth embodiment of the present invention. Fig. 13(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells.

Fig. 13(b)-Fig. 13(e) illustrate wave-forms of



pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 90 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub- field. A pulse wave-form 91 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 92 and 93 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 90 which is supplied to the common X electrode 22 during the first sub-field includes a regulating pulse 94 lasting from the electric charge particles equalizing period 2a to the address period 2b and the sustaining pulses 41 in the sustaining period 2c.

The voltage of the regulating pulse 94 and the voltage of the sustaining pulses 41 are the same, thereby a driving circuit is simplified because the same power is used.

The pulse wave-form 91 which is supplied to one of the address A electrodes 29 illustrates the address pulses 42 in the address period 2b which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 92 and 93 which are supplied to the first



16 DEC 1997

wave-forms 92 and 93 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a electric charge particle equalizing pulse 43a 43b,--- in the electric charge particle equalizing period 2a of the first sub-field, scan pulse 44a, 44b,---in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same condition. In the embodiment, the voltage of the regulating pulse 94 supplied to the common X electrode 22 and the voltage of the sustaining pulses are the same, therefore simplifying the driving circuit construction.

The fifth embodiment of the present invention is described hereinafter. Fig. 14 illustrates a fifth driving system in accordance with a fifth embodiment of the present invention. Fig. 14(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis



1 6 DEC 1997

illustrates time and a vertical axis illustrates line of cells. Fig. 14(b)-Fig. 14(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 100 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 101 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 102 and 103 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 100 which is supplied to the common X electrode 22 during the first sub-field includes a regulating pulse 94 lasting from the electric charge particle equalizing period 2a to the address period 2b and the sustaining pulses 41 in the sustaining period 2c. The voltage of the regulating pulse 94 and the voltage of the sustaining pulses 41 are the same as the fourth embodiment shown in Fig. 13, thereby a driving circuit is simplified because the same power is used. The pulse wave-form 101 which is supplied to one of the address A electrodes 29 illustrates the address pulses 42 in the address period 2b which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse



1 6 DEC 1997

wave-forms 102 and 103 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes electric charge particles equalizing pulse 43a 43b,--- in the electric charge particle equalizing period 2a of the first sub-field, scan pulses 104a, 104b,---in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. The voltage of the independent Y electrode 23 during the address period 2c and the voltage of the sustaining pulses 45a, 45b,--- are the same, thereby a driving circuit is simplified because the same power is used. A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric charge particles in the other sub-fields 3-9 is the same the condition.

The sixth embodiment of the present invention is described hereinafter. Fig. 15 illustrates a sixth driving system in accordance with a fifth embodiment of the present invention. Fig. 15(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-



16 DEC 1997

fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 15(b)-Fig. 15(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 110 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 111 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 112 and 113 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 111 which is supplied to the common X electrode 22 during the first sub-field includes a first regulating pulse 114 in the electric charge particle equalizing period 2a, a second regulating pulse 115 in the address period 2b and the sustaining pulses 41 in the sustaining period 2c. In the embodiment, the regulating pulse supplied to the common X electrode 22 is divided into the first regulating pulse 114 in the electric charge particle equalizing period 2a and the second regulation pulse 115 in the address period 2b. The pulse wave-form 111 which is supplied to one of the address A electrodes 29 includes the address pulses 42 in the address period 2b



16 DEC 1997

which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 112 and 113 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a electric charge particle equalizing pulses 43a 43b,--- in the electric charge particle equalizing period 2a of the first sub-field, a scan pulse 114a, 114b,---in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same condition. In Fig. 15, the falling edge of the first regulating pulse is slightly earlier than that of the equalizing pulse 43a, thereby preventing electric discharging by mistake between the common X electrode 22 and the independent Y electrode. Further, a rising edge of the second regulating pulse and a rising edge of the scan pulses 115 is effected at the same time, thereby preventing electric discharge by mistake between the common X electrode 22 and the independent Y electrode 23.

The first regulating pulse 114 supplied to the



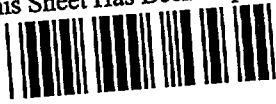
1 6 DEC 1997

common X electrode 22 and the sustaining pulses 41 may use the same voltage.

The seventh embodiment of the present invention is described hereinafter. Fig. 16 illustrates a seventh driving system in accordance with a seventh embodiment of the present invention. Fig. 16(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 16(b)-Fig. 16(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 130 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 131 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 132 and 133 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

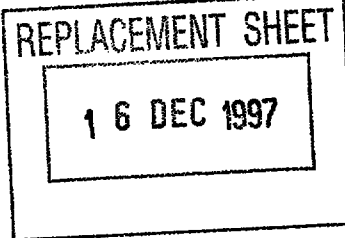
The pulse wave-form 131 which is supplied to the common X electrode 22 during the first sub-field includes a first regulating pulse 134 in the electric charge particle equalizing period $2a$, a second



1 6 DEC 1997

regulating pulse 135 in the address period 2b and the sustaining pulses 41 in the sustaining period 2c. The pulse wave-form 131 which is supplied to one of the address A electrodes 29 includes the address pulses 42 in the address period 2b of the first sub-field which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 132 and 133 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a electric charge particle equalizing pulse 136a 136b,--- in the electric charge particle equalizing period 2a of the first sub-field, a scan pulse 137a, 137b,---in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c.

A falling edge of the equalizing pulse 136a, 136b,---becomes zero voltage within the time less than 1 μ s in accordance with the present embodiment which is different from above mentioned embodiment. As the voltage of the second regulating pulse 135 and the scan pulses 137a, 137b, the same voltage of the sustaining pulses 41, 45a, 45b,---is able to apply. A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first

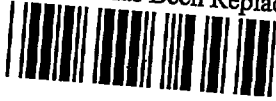


embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same condition.

In the embodiment, the edge of the first regulating pulse 139 falls before the edge of the equalizing pulse falls as shown in Fig. 16, thereby preventing electric discharge by mistake between the common X electrode 22 and the independent Y electrode.

The eighth embodiment of the present invention is described hereinafter. Fig. 17 illustrates a eighth driving system in accordance with a eighth embodiment of the present invention. Fig. 17(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 17(b)-Fig. 17(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 140 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 141 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 142 and 143 illustrate part of driving wave-form supplied, for example, to a first and a second independent Y



16 DEC 1997

electrodes 23.

The pulse wave-form 141 which is supplied to the common X electrode 22 during the first sub-field includes a first regulating pulse 144 in the electric charge particle equalizing period 2a, a second regulating pulse 145 in the address period 2b and the sustaining pulses 41 in the sustaining period 2c.

According to the present embodiment, the voltage of the first regulating pulse 144 is set higher than the voltage of the sustaining pulses 41. The pulse wave-form 141 which is supplied to one of the address A electrodes 29 includes the address pulses 42 in the address period 2b of the first sub-field which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 142 and 143 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a electric charge particle equalizing pulse 136a 136b,--- in the electric charge particle equalizing period 2a of the first sub-field, a scan pulse 137a, 137b,---in the address period 2b, a sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c.

The voltage of the second regulating pulse 144 and the scan pulses 137a, 137b,---can be set the same voltage of the sustaining pulses 41, 45a, 45b,---. A



1 6 DEC 1997

condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same with the condition.

According to the present embodiment, the voltage of the first regulating pulse 144 is higher than that of the sustaining pulses 41. By using higher voltage of the first regulating pulse 144, a lot of negative electric charge particles can be collected, and as a result, a lot of positive electric charge particles are collected on the address electrode 29 side, thereby address discharging is performed so easily.

The ninth embodiment of the present invention is described hereinafter. Fig. 18 illustrates a ninth driving system in accordance with a ninth embodiment of the present invention. Fig. 18(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 18(b)-Fig. 18(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y



1 6 DEC 1997

electrode respectively.

A pulse wave-form 150 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 151 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 152 and 153 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 151 which is supplied to the common X electrode 22 during the first sub-field includes a equalizing pulse 153 in the electric charge particle equalizing period 2a, a second regulating pulse 154 in the address period 2b and the sustaining pulses 41 and a fine line erasing pulse 155 in the sustaining period 2c.

According to the present embodiment, the only one fine line erasing pulse 155 is provided. The equalizing pulse 153 is supplied to the electrode to which the fine line erasing pulse 155 is supplied such as the case of the fifth embodiment. In case the numbers of the fine line erasing pulses are two or three as shown in the second and the third embodiment (see Fig. 11 and Fig. 12), the equalizing pulses are supplied to the electrode to which the last fine line erasing pulse is supplied.

The pulse wave-form 151 which is supplied to one



16 DEC 1997

of the address A electrodes 29 includes the address pulses 42 in the address period 2b of the first sub-field which corresponds to the light emitting cell. The address pulses 42 are not supplied when there is no cell to be emitted. The pulse wave-forms 152 and 153 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 include a first regulating pulse 156a, 156b,--- in the electric charge particle equalizing period 2a of the first sub-field, a scan pulse 137a, 137b,---in the address period 2b, sustaining pulses 45a, 45b,--- in the sustaining period 2c.

In the embodiment, the first regulating pulses 156a, 156b,---are supplied within the lapse of time 0.3 μ sec to 2 μ sec from the rising edge of the equalizing pulse 153.

The voltage of the second regulating pulse 144 and the scan pulses 137a, 137b,---can be set the same voltage of the sustaining pulses 41, 45a, 45b,---as shown in the fifth embodiment (see Fig. 14) A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same with the condition.

According to the present embodiment, the first

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1 6 DEC 1997

regulating pulse 43a, 43b,---are similar to the equalizing pulse 43a, 43b,---as shown in Fig. 15, but a equalizing pulse according to the present invention is a pulse that rises first during electric charge particle equalizing period. The reason for providing 0.3 μ sec to 2 μ sec period between the rising edge of the equalizing pulse 153 and the rising edge of the first regulating pulse 156a, 156b,---has already explained.

From Fig. 19 to Fig. 23 are sectional views of the plasma display panel in accordance with the ninth embodiment in which the condition of electric charge particles in the cell performed electric discharge for light emitting are illustrated from the first sub-field after the power is supplied to the second sub-field until the equalizing pulses and the regulating pulse are supplied. In these drawings, reference numeral 60 denotes a positive electric charge particle, reference numeral 61 denotes a negative electric charge particle. Further the condition of electric charge particles is illustrated in a cell at center position of Fig. 19 through Fig. 23.

Fig. 19 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell is illustrated immediately after a power is supplied and then a equalizing pulse and a protecting pulse are supplied. The figure illustrate the condition of electric charge particles in first sub-field after

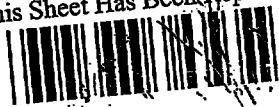


1 6 DEC 1997

power is supplied at first and then the equalizing pulses 153 are supplied to the common X electrode 22 and finally the first regulating pulses 156a, 156b,--- are supplied. The electric discharge occurs between the common X electrode 22 and the independent Y electrodes 23 by supplying the equalizing pulses 153 to the independent Y electrodes 23 in all cells, and the negative electric charge particles 61 are gathered on the dielectric layer in the vicinity of the independent Y electrodes 23a and the common X electrode 22 and the positive electric charge particles 60 are gathered on the address A electrodes 29 side.

Fig. 20 is a sectional view of a plasma display panel in accordance with the ninth embodiment in which a condition of electric charge particles in a cell after performing an address electric discharge is illustrated. In Fig. 20, the condition of electric discharges is illustrated after the address pulses 42 is supplied to the address A electrodes 29 and address electric discharges are performed between the address A electrode 29 and the independent Y electrode 23. The positive electric charge particles 60 are gathered on the dielectric layer in the vicinity of the independent Y electrode 23 because the voltage of the independent Y electrode 23 is lower than the voltages of the address A electrode 29 and the common X electrode 22. The negative electric charge particles 61 are gathered on

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52

REPLACEMENT SHEET

16 DEC 1997

the other electrode side.

The condition of the electric charge particles is shown in Fig. 20. The sustaining electric discharge occurs between the independent Y electrode 23 and the common X electrode 22 by the positive electric charges particles 60 and the first pulse of the sustaining pulses 45a, 45b,---supplied to the independent Y electrode 23. This is a sustain discharge.

Fig. 21 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a fine line erasing pulse is illustrated. In Fig. 21, the condition of electric discharge after the last sustaining pulses 45a, 45b,--- are supplied to the independent Y electrode and then the fine line erasing pulses 155 are supplied to the common X electrode 22 is illustrated.

The pulse width of the fine line erasing pulse 155 is longer than the discharge continuation time, so that negative electric charges particles 61 which move so quickly are gathered on the dielectric layer in the vicinity of the common X electrode 22. The positive electric charge particles that move slowly in space float in the cell. The negative charges float discharge space for a while.

Fig. 22 is a sectional view of a plasma display panel in accordance with the ninth embodiment in which a condition of electric charge particles in a cell after

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1 6 DEC 1997

supplying a equalizing pulses in a second field is illustrated.

In Fig. 22, a condition of electric discharge after the equalizing pulse 153 in the second sub-field is supplied is illustrated. The voltage of the equalizing pulse 153 is canceled by the negative charge particles 61 and is not reached to the discharge voltage, so that any electric discharge is not occurred.

Fig. 23 is a sectional view of a plasma display panel in which a condition of electric charges in a cell after supplying a regulating pulse in a second field is illustrated.

In the figure, the condition of electric charge particles after the first regulating pulses 156a, 156b, -- are supplied to the independent Y electrode 23 is illustrated. The negative electric charge particles 61 are gathered on the dielectric layer in the vicinity of the common X electrode 22 and the independent Y electrode 23, and the positive electric charge particles 60 are gathered on the address A electrode 29. By this, the same driving as the first sub-field is performed without electric discharge by the equalizing pulses 153.

The tenth embodiment of the present invention is described hereinafter. Fig. 24 illustrates a tenth driving system in accordance with a tenth embodiment of the present invention. Fig. 24(a) is a time chart illustrating an arrangement of sub-fields in one field



16 DEC 1997

in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 18. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 24(b)-Fig. 24(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 160 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 161 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 162 and 163 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 160 which is supplied to the common X electrode 22 during the first sub-field includes a equalizing pulse 163 in the electric charge particle equalizing period 2a, a second regulating pulse 165 which continues from equalizing pulse 164 in the electric charge particle equalizing period 2a and the address period 2b and the sustaining pulses 41 and a fine line erasing pulse 155 in the sustaining period 2c.

According to the present embodiment, the only one fine line erasing pulse is provided. The equalizing pulse 164 is supplied to the electrode to which the fine



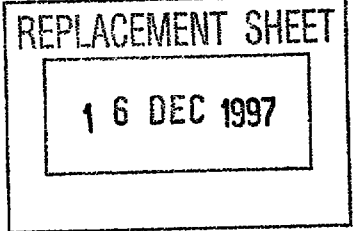
16 DEC 1997

line erasing pulse 155 is supplied such as the case of the first embodiment. In case the numbers of the fine line erasing pulses are two or three as shown in the second and the third embodiment (see Fig. 11 and Fig. 12), the equalizing pulse is supplied to the electrode to which the last fine line erasing pulse is supplied. The pulse wave-form 161 which is supplied to one of the address A electrodes 29 includes the address pulses 42 in the address period 2b of the first sub-field which correspond to the light emitting cell. The address pulses 42 are not supplied when there is no cell to be emitted. The pulse wave-forms 162 and 163 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes a first regulating pulse 156a, 156b,--- in the electric charge particle equalizing period 2a of the first sub-field, scan pulses 137a, 137b,---in the address period 2b, sustaining pulses 45a, 45b,--- in the sustaining period 2c. In the embodiment, the first regulating pulses 156a, 156b,--- are supplied within the lapse of time 0.3 μ sec to 2 μ sec from the rising edge of the equalizing pulse 153. The voltage of the second regulating pulse 165 and the scan pulses 137a, 137b,---can be set the same voltage of the sustaining pulses 41, 45a, 45b,---as shown in the ninth embodiment (see Fig. 18). The other sub-fields 3-9 are constructed the same as the first sub-field.

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56



A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---are almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same condition.

According to the present embodiment, the reason for setting the voltage of the equalizing pulse 164 a higher voltage is to collect the negative electric charge particles on the common X electrode side, and to collect lots of positive electric charge particles on the address A electrode 29. Further, the reason for setting the voltage of the second regulating pulse 165 in the address period 2b is to protect electric discharging by mistake between the common X electrode 22 and the independent Y electrode 23.

The eleventh embodiment of the present invention is described hereinafter. Fig. 25 illustrates a eleventh driving system in accordance with a eleventh embodiment of the present invention. Fig. 25(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 25(b)-Fig. 25(e) illustrate wave-

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1 6 DEC 1997

forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 170 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 171 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 172 and 173 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 170 which is supplied to the common X electrode 22 during the first sub-field includes a regulating pulse 40 in the period continuing from the electric charge particles equalizing period 2a to the address period 2b and the sustaining pulses 41 in the sustaining period 2c. The pulse wave-form 171 which is supplied to one of the address A electrodes 29 includes a voltage holding pulse 174 whose voltage is determined not to occur a discharge by the scan pulses 44a, 44b,--- and the address pulses 42 in the address period 2b of the first address period 2b which corresponds to the light emitting cell and between the address electrode 29 and the independent Y electrode 23. The address pulses 42 is not supplied when there is no cell to be emitted. According to the present embodiment, the voltage needed for the address electric discharging



16 DEC 1997

is the sum of the voltage of the voltage holding pulse 174 and the voltage of address pulses 175, thereby reducing the voltage of the address pulses 175. The address pulses 175 is not supplied when there is no cell to be emitted. The pulse wave-forms 172 and 173 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 include equalizing pulses 43a, 43b,--- in the electric charge particle equalizing period 2a of the first sub-field, a scan pulse 44a, 44b,---in the address period 2b, sustaining pulses 45a, 45b,--- in the sustaining period 2c. The voltage of the regulating pulse 40 and the scan pulses 44a, 44b,---can be determined to the same voltage of sustaining pulses 41, 45a, 45b,---.

A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost the same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same condition.

The twelfth embodiment of the present invention is described hereinafter. Fig. 26 illustrates a twelfth driving system in accordance with a twelfth embodiment of the present invention. Fig. 26(a) is a time chart illustrating an arrangement of sub-fields in one field



1 6 DEC 1997

in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 5. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 26(b)-Fig. 26(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 180 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 181 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. pulse wave-forms 182 and 183 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The pulse wave-form 180 which is supplied to the common X electrode 22 during the first sub-field includes a regulating pulse 184 in the electric charge particles particle equalizing period 2a, the sustaining pulses 41 in the sustaining period 2c.

The pulse wave-form 181 which is supplied to one of the address A electrodes 29 includes the address pulses 42 in the address period 2b of the first address period which corresponds to the light emitting cell. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 182 and 183



16 DEC 1997

which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 include a equalizing pulse 43a, 43b,--- in the electric charging equalizing period 2a of the first sub-field, scan pulses 137a, 137b,---in the address period 2b, sustaining pulses 185a, 185b,---in the address period 2b and sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. The voltage of the regulating pulse 184 can be determined the same the voltage of the sustaining pulses 41.

A condition of electric charge particles after supplying the fine line erasing pulses 46a, 46b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same condition. According to the present embodiment, the voltage of the scan pulses 185a, 185b,---is minus voltage and the voltage of the address pulses 42 is plus voltage, therefore the voltage differences becomes so large that the electric discharge is performed surely.

The thirteenth embodiment of the present invention is described hereinafter. Fig. 27 illustrates a thirteenth driving system in accordance with a thirteenth embodiment of the present invention. Fig. 27(a) is a time chart illustrating an arrangement of



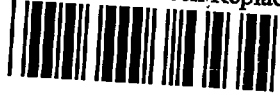
16 DEC 1997

sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields such as the case of Fig. 18. A horizontal axis illustrates time and a vertical axis illustrates line of cells. Fig. 27(b)-Fig. 27(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrode respectively.

A pulse wave-form 190 illustrates a part of driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 191 illustrates a part of driving wave-form supplied to the one of the address A electrode 29. Pulse wave-forms 192 and 193 illustrate parts of driving wave-forms supplied, for example, to a first and a second independent Y electrodes 23.

The wave-form 190 which is supplied to the common X electrode 22 during the eighth sub-field and the field blank period 9d thereafter includes a regulating pulse 40 in the electric charge particle equalizing period 2a and the address period 2b lasting from the equalizing period 2a, sustaining pulses 41 and a full writing pulse 194 in the sustaining period 2c. In the embodiment, the voltage of the full writing pulse 194 is higher enough to be discharged regardless the sustaining discharge is performed or not. As a result, the electric charge particles in all cells are equalized.

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62

REPLACEMENT SHEET

1 6 DEC 1997

The field blank period 9d can be provided between the sub-fields. And also, the field blank period 9d is able to arrange several times in one field. The pulse waveform 191 which is supplied to one of the address A electrodes 29 includes the address pulses 42 in the address period 2b. The address pulses 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 192 and 193 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 include the equalizing pulses 43a, 43b,--- in the electric charging equalizing period 2a, the scan pulses 44a, 44b,---in the address period 2b, the sustaining pulses 45a, 45b,--- in the sustaining period 2c and fine line erasing pulses 195a, 195b,---in the field blank period 9d. The voltage of the regulating pulse 40 and the scan pulses 44a, 44b, --- can be determined the same as the voltage of the sustaining pulses 41. A condition of electric charge particles after supplying the fine line erasing pulses 195a, 195b,---is almost same condition as shown in Fig. 8 which illustrates the condition of electric charge particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same as the condition.

According to the present embodiment , any electric charge particle in the cells is not remained

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1 6 DEC 1997

when black portion continues across several sub-fields, and the address electric discharges are not performed well in the coming address period. To prevent this situation, a discharges are forced by the field full writing pulse 194 between the common X electrode 22 and the independent Y electrode 23.

As explained the above, the plasma display driving system in accordance with the first through the twelfth embodiments can drive the panel without using the full writing electric discharge and erasing discharge for all the cells for equalizing the electric charge particles .

Still another embodiments of the present invention will be explained hereinafter.

Fig. 28 illustrates driving system of a plasma display panel in accordance with a fourteenth embodiment of the present invention. Fig. 28(a) is a time chart illustrating an arrangement of sub-fields in the first sub-field. A horizontal axis illustrates time, and a vertical axis illustrates lines of cells. Fig. 28(b)-Fig. 28(g) are wave-forms illustrating pulse wave-forms supplied to a common X electrode, address A electrode and four independent Y electrode respectively. In the figure, reference numeral 201 denotes a field, reference numerals 202-203 denote sub-fields, reference numeral 202a-209a denote address periods, reference numeral 202b-209b denote sustaining periods, reference numeral

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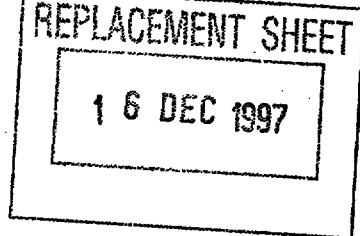
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210-213 denote field blocks, reference numeral 210a-213a denote full writing periods. A wave-form 220 is a driving wave-form supplied to the common X electrode, A wave-form 221 is a driving wave-form supplied to the address A electrode 29, wave-forms 222-225 are driving wave-forms supplied to a first, a second, a third and a fourth electrodes of the independent Y electrodes 23.

In Fig. 28(a), one field period 201 is divided into eight sub-fields 202-209, one field block is arranged by two successive sub-fields, therefore one field period 201 is constructed by four field blocks.

In each field block, the full writing periods 210a, 211a, 212a and 213a which are arranged first period of sub-fields are provided in each first sub-field 202, 204, 206 and 208 of the field blocks 210-213, and following the writing period 210a-213a, the address period 202a, 204a, 206a and 208a and sustaining period 202b, 204b, 206b and 208b are provided. In the second sub-fields 203, 205, 207 and 209 which follow the first sub-fields 202-208, the address period 203a, 205a, 207a and 209a are provided first, and then the sustaining period 203b, 205b, 207b and 209b are provided.

The numbers of light emitting are allotted for each sustaining period 202b-209b, and display graduations are effected by the combinations of the numbers of the light emitting. The numbers of light emitting and the order of the sub-fields are optional.



In the embodiment, the numbers of light emitting of the sustaining periods 202b, 204b, 206b, 208b, 203b, 205b, 207b and 209b are arranged in this order from few numbers. The sustaining period 202b, 204b, 206b and 208b just before the sub-fields 203, 205, 207 and 209 in which the full writing erase period are not provided have fewer numbers of light emitting.

Fig. 28(b) illustrates the field block 210, and the other field blocks are constructed similarly. The driving wave-form 220 supplied to the common X electrode 22 includes in the first sub-field 202 a full writing pulse 240 and a polarizing pulse 241 in the first full writing erasing period 210a, a high pulse 242 in the succeeding address period 202a and sustaining pulses 243 and a electric charge particle control pulse 244 and a fine line erasing pulse 245 in the succeeding sustaining period 202b, and further include in the succeeding sub-field a high pulse 246 and sustaining pulses 247.

The voltage of the electric charge particle control pulse 244 and the fine line erasing pulse 245 is the same as or less than the voltage of the sustaining pulses 243. Next to the sustaining pulses 247 is the field block 211. The voltage of the full writing pulse 240 is stepped up a level. The voltage is usually determined about 300 volts, and the reason for stepping up a level is to construct the circuit simply, therefore the stepping up the voltage of full writing pulse 240 is



16 DEC 1997

not always necessarily.

The driving wave-form 221 supplied to the address A electrode 29 shown in Fig. 28(a) includes, in the first sub-field, plurality of the address pulses 248a, 248b,--- which relates to the cells to be emitted in the address period 202a, and include, in the succeeding sub-field 203, plurality of address pulses 249a, 249b,--- in the address period 203a.

Fig. 28(d)-28(g) are wave-forms 222,223,224 and 225 supplied to four independent Y electrodes 23 whose electrodes 23 are arranged side by side include, in the first sub-field 202, scan pulses 250a, 250b, 250c, 250d,--- in the address period 202a, sustaining pulses 251a, 251b, 251c, 251d,--- selection electric discharge pulses 252a, 252b, 252c, 252d---, fine line erasing pulses 253a, 253b, 253c, 253d,--- in the sustaining period 222b and include, in the succeeding sub-field 203, scan pulses 254a, 254b, 254c, 254d,---, in the address period 203a, sustaining pulses 255a, 255b, 255c, 255d,-- - in the sustaining period 203b.

The voltage of selection electric discharge pulses 252a, 252b, 252c, 252d,--- is almost the same as the voltage of the electric charge particle control pulse 244, and the electric charge particle control pulse 244 rises with time lag from the rising edge of the selection electric discharge pulses 252a, 252b, 252c, 252d,---, and the delay time t_1 is 0.1 μ sec-1.5 μ sec.



1 6 DEC 1997

The electric charge particle control pulse 244 falls earlier than the selection electric discharge pulses 252a, 252b, 245c, 252d,---. The time t_2 is about 0.1 μ sec-1.0 sec. The reason for setting the time lag from the rising edge of the election electric discharge pulses 252a-252d to the rising edge of the electric charge particle control pulse 244 as above mentioned is that, if the time sets longer than that, a lot of negative electric charge particles gathers on the independent Y electrode 23, and a few negative electric charge particles gathers on the common X electrode 22. Further, the reason for rising the selection electric discharge pulses 252a-252d a little earlier than the electric charge particles control pulse 244 is to cause the electric discharge by the selection electric discharging between the common X electrode 22 and independent Y electrode 23. The reason for falling the electric charge particles 244 is to defends the electric charge between the common X electrode 22 and the independent Y electrode 23 when the selection electric discharge pulses 252a-252d falls.

The selection electric discharge pulses 252a, 252b, 252c, 252d,---, the fine line erasing pulses 253a, 253b, 253c, 253d,--- and the electric discharge particle control pulse 244 are not provided in the succeeded sub-field 203 of the field block 210 of Fig. 28(a).

The sustaining pulses of the sub-field 203



16 DEC 1997

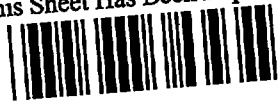
terminate with the sustaining pulses 255a, 255b, 255c, 255d,--- supplied to the independent Y electrodes 23.

The same driving wave-forms are used in the other field blocks 211-213, but the numbers of the sustaining pulses are different. The selection electric discharge pulses, the electric charge particle control pulse and the fine line erasing pulses are provided in the first sub-field 204, 206, 208 of the field blocks 210-213.

The function of the embodiment is explained with Fig. 29-Fig. 32.

The electric discharges occur in all the cells by the full writing pulse 240 supplied to the common X electrode 22 in the field block 210 of Fig. 28(a)-Fig. 28(b) and the electric charge particles are formed. Under these circumstances, the negative electric charge particles 61 are gathered on the address A electrode 29 side. The electric discharge for polarization occurs by the polarization pulse 241, and electric discharge particles on the common X electrode 22 side and the independent Y electrode 23 side are polarized.

The scan pulses 250a of the wave-form 222 are supplied to the first line of the independent Y electrode 23 and at the same time, the address pulses 248a are supplied to the predetermined address A electrode 29 in the succeeded address period 202a, thereby generating full writing electric discharge and



forming the electric charge particles in the cell positioned at the cross point of first line of the independent Y electrode 23 and the address A electrode 29, and the positive electric charge particles are gathered on the independent Y electrode 23 side in the cell.

In a similar way, when the scan pulses 250c of the driving wave-form 224 are supplied to the third independent Y electrode 23 and the address pulse 248b is supplied to predetermine address A electrode 29, thereby generating full writing electric discharge and forming the electric charge particles in the cell positioned at the cross point of the third line of the independent Y electrode 23 and the address A electrode 29, and the positive electric charge particles 60 are gathered on the independent Y electrode 23 side in the cell.

The address pulses which correspond to the scan pulses 250b, 250d of the driving wave-form 223, 225 supplied to the second and the fourth independent Y electrode 23 are not supplied when the predetermined cells are not emitted, therefore, writing electric discharges do not occur and electric charge particle is not formed on the independent Y electrode 23 side.

The sustaining discharge or light emitting discharge in the sustaining period 202b occurs by the sustaining pulses 234 of the driving wave-form 220 and the sustaining pulses 251a, 251b, 251c, 251d,---, of the



16 DEC 1997

driving wave-forms 222, 223, 224, 225 in the cell in which the positive electric charge particles are gathered on the independent Y electrode 23 side.

The optional or selecting electric discharges occur by the selection electric discharge pulses 252a, 252b, 252c and 252d in the cell in which the sufficient electric charge particles are formed by the electric discharge for light emitting. The positive electric discharge particles 60 are gathered on the address A electrode 29 side by supplying electric charge particle control pulse 244 to the common X electrode 22 before the electric discharges by the selection electric discharge pulses 252a, 252b, 252c, 252d,---, cease.

After that, the erasing electric discharge is caused by the fine line erasing pulse 245 of the wave-form 220 supplied to the common X electrode 22 and the fine line erasing pulses 253a, 253b, 253c, 253d,---, of the wave-form 222 supplied to the independent Y electrode 23, and the electric charge particles on the common X electrode 22 side and on the independent Y electrode 23 side are mainly erased. Thereby, the condition of the electric charge particles in all cells in which the electric discharges are caused is almost same as the condition of the electric charge particles after the full writing erasing period 210a is finished.

On the other hand, the writing electric discharges or the address electric discharges are not



16 DEC 1997

caused in the cells in which the electric discharges for light emitting are not caused and the condition of electric charge particles are the same condition after the full writing erasing period 210a is finished.

As explained above, the electric charge particles in all cells at a point of time after the final erasing pulses 245, 253a, 253b, 253c, 253d,---, are supplied in the first sub-field 202 can be made the same condition after the full writing erasing period 210a is finished. By this, in the succeeding sub-field, address electric discharges in all the cell can be caused without providing a full writing erasing period.

The same functions are repeated in the field blocks 211-213, and a screen of one field is constructed.

Fig. 29-Fig. 32 are sectional views of plasma display panel illustrating a condition of the electric charge particles in a cell in which a sustaining discharge is performed. Referring now to the drawing, wherein like numerals are utilized to designate like parts throughout the several views, reference numeral 60 denotes a positive electric charge particles and reference numeral 61 denotes negative electric charge particles. The condition of the electric charge particles in the drawings is illustrated in a center cell of three cells.

Fig. 29 is a sectional view of a plasma display panel in which a condition of electric charge particles .



1 6 DEC 1997

in a cell after supplying sustaining pulses is illustrated in accordance with an embodiment shown in Fig. 28(a)-28(e) of the present invention. The negative electric charge particles 61 are gathered on the dielectric layer 26 of the common X electrode 22 side and the positive electric charge particles 60 are gathered on the dielectric layer 26 of the independent Y electrode 23 side after a final pulse of the sustaining pulses 243 is supplied to the common X electrode 22.

Fig. 30 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell during discharging by a selection electric discharge pulse is illustrated in accordance with the embodiment shown in Fig. 28(a)-28(e) of the present invention. Electric discharges are caused by the voltage of the selection electric discharge pulses 252a, 252b, 252c, 252d,--- and the voltage of positive electric charge particles gathered on the dielectric layer at the independent Y electrode 23 and caused between the independent Y electrode 23 and the common X electrode 22 when selection electric discharge pulses 252a, 252b, 252c, 252d,---, are supplied to the independent Y electrode. Thereby many positive and negative electric charge particles are generated in the discharging space.

Fig. 31 is a sectional view of a plasma display panel in which a condition of electric charge particles



16 DEC 1997

in a cell when electric charge particle control pulse is supplied is illustrated in accordance with the embodiment shown in Fig. 28(a)-28(e) of the present invention. The positive electric charge particles are gathered on the address A electrode 29 when the electric charge particle control pulse 244 is supplied to the common X electrode 22 because the voltages of the common X electrode 22 and the independent Y electrode 23 are almost same and the voltages are higher than the voltage of address A electrode 29. Erasing of electric charge particles by erase pulse are still needed because there still remains electric charge particles on the common X electrode 22 side, on the independent Y electrode 23 side and in the discharging space which are not neutralized and not erased.

Fig. 32 is a sectional view of a plasma display panel in which a condition of electric charge particles in a cell after supplying a fine line erasing pulse is illustrated in accordance with the embodiment shown in Fig. 28(a)-28(e) of the present invention. The positive electric charge particles 60 are gathered on the address A electrode 29 side and the negative electric charge particles 61 are gathered on the common X electrode 22 side and the independent Y electrode 23 side. The condition of electric charge particles is the same after the full writing erase period 210a is finished.

A condition of electric charge particles after



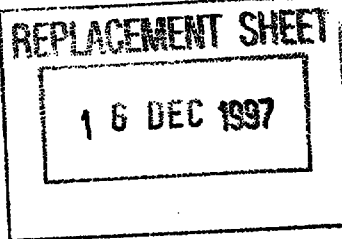
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the full writing erasing period 210a is finished is maintained in the sustaining period 202b because the address electric discharges are not performed in the cells in which no sustaining electric discharge is performed. Also, any electric discharge is not performed by the selection electric discharge pulses 252a, 252b, 252c, 252d,---, and there is no change in the condition of electric charge particles even if electric charge particle control pulse 244 and erasing pulse are supplied. Therefore, the condition of electric charge particles in all cells is almost same as the condition after the full writing erasing period 210a and the address electric discharge or a writing electric discharge is caused in next sub-field 203, thereby increasing the contrast by double.

By increasing the voltage of the address pulses 249a and 249b in the sub-field 203, 205, 207, 209 in which the full writing erasing period is not arranged, comparing with the voltage of the address pulses 249a and 249b in the other sub-field 202, 204, 206 and 208, the address electric discharges are caused surely even in the cell in which sustaining electric discharges are not performed, because the positive electric charge particles 60 on the address A electrode 29 side are reduced gradually by neutralization.

Fig. 33 is a time chart of sub-fields illustrating a driving system in accordance with a third

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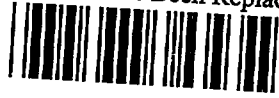
embodiment of the present invention. Referring to the drawing, a horizontal axis illustrates time, and a vertical axis illustrates lines of cells. Reference numeral 270 denotes one field period, 271-276 denote sub-fields, 271a-276a denote address periods, 271b-276b denote sustaining periods, 277 and 278 denote field blocks, 277a and 278a denote full writing erasing periods.

One field period 270 is divided into six sub-fields 271-276, and consecutive first three sub-fields 271-273 construct the field block 277 and succeeding consecutive three sub-fields 274-276 construct the other field block 278.

In the first period of these field blocks 277 and 278, the full writing erasing period 277a and 278a are arranged. In each sub-field 271-276, the address period 271a-276a and the sustaining period 271b-276b are arranged but the full writing erasing period 277a and 278a are not provided. That is, the full writing erasing period 277a and 278a are arranged at the first part of the first sub-fields 271 and 274 of the field blocks 277 and 278. The numbers of the light emitting are allotted for the sustaining period 271b-276b, and gradations of display are performed by the combining of the numbers of the light emitting. According to the fifteenth embodiment, the numbers of the light emitting are increased in order of the sub-fields 271, 272, 273.

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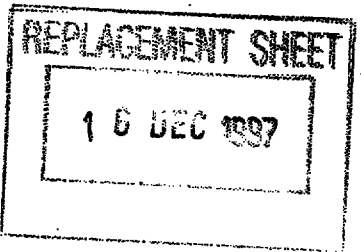
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The selection electric discharge pulse 252a-252d, the electric charge particle control pulse 244 and fine line erasing pulse 245, 253a-253b which are used in the fourteenth embodiment are provided in the first two sub-fields 271, 272, 274, 275 of each field blocks 277 and 278, and these pulses are not provided in the other(last) sub-field. Further, these selection electric discharge pulses, electric charge particle control pulse and fine line erasing pulses are arranged in the last part of the sustaining period 271b, 272b, 274b and 275b, thereby the condition of electric charge particles in all cells after sustaining period 271b, 272b, 274b and 275b are finished is maintained the same condition after the full writing erasing period 277a is finished, so the full writing erasing period 210a is deleted in the sub-fields 272, 273, 275 and 276 other than the first sub-fields 271 and 274, and the address electric discharges are performed in the address period 272a, 273a, 275a and 276a without supplying the selection electric discharge pulses 252a-252d and electric charge particle control pulse 244 in the last sub-field. Therefore, the contrast is multiplied by three.

Fig. 34 is a time chart of sub-fields illustrating a driving system in accordance with a fifteenth embodiment of the present invention. Referring to the drawing, a horizontal axis illustrates

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time, and a vertical axis illustrates lines of cells. Reference numeral 280 denotes one field period, 281-286 denote sub-fields, 281a-288a denote address periods, 281b-288b denote sustaining periods, 289 and 290 denote field blocks, 289a and 290a denote full writing erasing periods.

One field period 280 is divided into eight sub-fields 281-288, and consecutive first four sub-fields 281-284 construct the field block 289 and succeeding consecutive four sub-fields 285-288 construct the other field block 290.

The first period of these field blocks 289 and 290 include the full writing erasing period 289a and 290a, and the address period 281a-288a and the sustaining period 281b-288b are arranged in each sub-field 281-288. That is, the full writing erasing period 289a and 290a are arranged at the first part of the first sub-fields 281 and 285 of the field blocks 289 and 290. The numbers of the light emitting are allotted for the sustaining periods 281b-288b, and gradations of display are performed by the combining the numbers of the light emitting. According to the sixteenth embodiment, the numbers of the light emitting are increased in order of the sub-fields 281, 282, 283,---.

The selection electric discharge pulse 252a-252d, the electric charge particle control pulse 244 and fin line erasing pulse 245, 253a-253b which are used in the



16 DEC 1997

fourteenth embodiment are provided in the sustaining period 281b, 282b, 283b, 285b, 286b and 287b of the first three sub-fields 281, 282, 284, 285, 286 and 287 in each field blocks 287 and 290, and these pulses are not provided in the other(last) sub-field.

The condition of electric charge particles in all cells after sustaining period 281b, 282b and 283b of the sub-fields 281, 282 and 283 in the field block 289 and sustaining periods 285b, 286b and 287b of the sub-fields 285, 286 and 287 in the field block 290 are finished is maintained the same condition after the full writing erasing period 289a is finished, so the full writing erasing periods 210a are deleted in the three sub-fields 282, 283, 284, 286, 287 and 288 other than the first sub-fields 281 and 285, and the address electric discharges are performed in the address period 282a, 273a, 284a, 286a, 287a and 288a without supplying the selection electric discharge pulses 252a-252d and electric charge particle control pulse 244 in the last sub-field. Therefore, the contrast is multiplied by four.

Fig. 35 is a time chart of sub-fields illustrating a driving system in accordance with a seventeenth embodiment of the present invention. Referring to the drawing, a horizontal axis illustrates time, and a vertical axis illustrates lines of cells. Reference numeral 300 denotes one field period, 301-308



16 DEC 1997

denote sub-fields, 301a-308a denote address periods, 301b-308b denote sustaining periods, 309 denote field blocks, 309 denote a full writing erasing period.

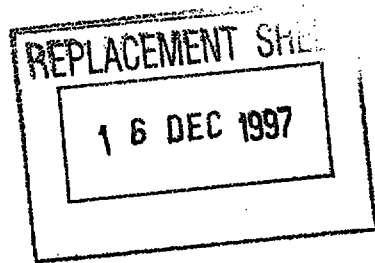
One field period 300 is divided into eight sub-fields 301-308, and the field block 309 is constructed by all sub-fields 301-308 in the one field. The first period of these field blocks 309 includes the full writing erasing period 309a. The address period 301a-308a and the following sustaining period 301b-308b are arranged in each sub-field 301-308. That is, the full writing erasing period 309a are arranged at the first part of the first sub-fields 302. The numbers of the light emitting are allotted for the sustaining period 301b-308b and gradations of display are performed by the combining the numbers of the light emitting.

The selection electric discharge pulses 252a-252d, the electric charge particle control pulses 244 and fin line erasing pulses 245, 253a-253b which are used in the fourteenth embodiment are provided in the sustaining periods 301b-307b of the first seven sub-fields 301-307, and the full writing erasing period 309a is arranged only in the first sub-field 301. The address electric discharges in these address periods 302a-308a are possible, even if the full writing erasing periods 309a in the sub-fields 302-308 which follow the first sub-field 301 is deleted. Thereby the contrast is multiplied by eight.

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80



According to these embodiments, by deleting full writing erasing period in some sub-field, the contrast is improved. The practical contrast of cathode ray tube display is , for example, 150:1, and in the plasma display according to the embodiments shown in Fig. 33 or Fig. 34, corresponding contrast is accomplished.

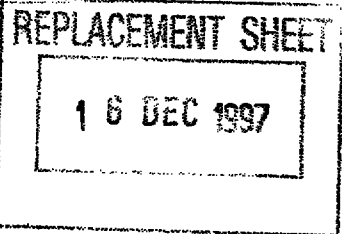
The numbers of sub-fields in one field and the numbers of the sub-fields in one field block are optional and not limited above mentioned embodiments, and any combination will be applicable.

According to the present invention, full writing electric discharge and erasing electric discharge are deleted or reduced, thereby improving the contrast of the display.

According to the present invention, full writing erasing period can be arranged one time per several sub-fields, thereby improving the contrast.

While we have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to those skilled in the art, and we therefore do not wish to be limited to the details shown and described herein but intend to cover all such change and modifications as are encompassed by the scope of the appended claims.

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WHAT WE CLAIM IS:

1. A plasma display panel driving system for a display panel having a first electrode group arranged on a permeable substrate and being capable of driving in common, a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of driving independently, a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of driving independently, said driving system comprising the step of performing at least one electric discharge for equalizing of electric charge particle in a cell in which another electric charge particle is caused beforehand.

2. A plasma display panel driving apparatus comprising:

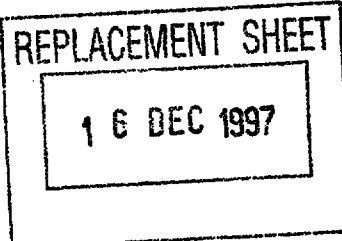
a first electrode group arranged on a permeable substrate and being capable of driving in common;

a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of driving independently;

a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of driving independently;

and means for performing at least one electric discharge for equalizing of electric charge particle in a cell in which another electric charge particles is





caused beforehand.

3. A plasma display comprising:

a first electrode group arranged on a permeable substrate and being capable of driving in common;

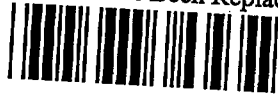
a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of driving independently;

a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of driving independently;

and means for performing at least one electric ischarge for equalizing of electric charge particles in a cell in which another electric charge particles is caused beforehand, whereby improving linearity of display gradation.

4. A plasma display panel driving system for a display panel having a first electrode group arranged on a permeable substrate and being capable of driving in common, a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of driving independently, a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of driving independently, a equalizing means for equalizing electric charge particles in all cells by a discharge between said first and said second electrode group, an address electric discharge means for





16 DEC 1997

determining a cell to be emitted by a discharge between said second and said third electrode groups, and a sustaining electric discharge means for performing light emitting by a electric discharge between said first and said second electrode groups, said driving system comprising the step of performing discharge by a fine line erasing pulse supplied after a sustaining electric discharge is finished and erasing and polarizing of electric charge particles in a cell in which sustaining electric discharge is performed, the step of gathering said electric charge particles in all cells by way of said electric discharge caused by the fine line erasing pulse, and canceling the voltage of a equalizing pulse supplied to one of said first and said second electrode groups by said electric charge particles resulting in no discharge, the step of polarizing said electric charge particles into a positive electric charge particles and a negative electric charge particles, the step of supplying a regulating pulse to the other electrode groups of said first and said second electrode groups after supplying said equalizing pulse to one of said first and said second electrode groups for gathering the same electric charge particles gathered on said one of electrode groups supplied with said equalizing pulse, and the step of gathering a electric charge particles having the other polarity on said third electrode group

5. A plasma display panel driving system for

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a display panel having a first electrode group arranged on a first substrate and being capable of driving in common, a second electrode group arranged in parallel with said first electrode group on said first substrate and being capable of driving independently, a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate and being capable of driving independently, said driving system comprising the step of performing a sustaining electric discharge by supplying a sustaining pulse to said first and said second electrode groups, the step of polarizing electric charge particles in a cell by supplying a fine line erasing pulse to one of said first and said second electrode groups, the step of gathering electric charge particles having one of the polarities in vicinity of said first and said second electrode groups and gathering said electric charge particles having the other polarity in the vicinity of said third electrode group by supplying a equalizing pulse to said one of electrode groups and supplying a regulating pulse rising later than said equalizing pulse to the other electrode group of said first and said second electrode groups without performing electric discharge.

6. A plasma panel display driving system according to the claim 4 or 5, further comprising the step of performing a electric discharge between said first electrode group and said second electrode group by

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1 6 DEC 1997

supplying said equalizing pulse to said one of the electrode groups after supplying a power, and gathering electric charge particles having one of the polarities in the vicinity of said first and said second electrode groups and gathering electric charge particles having the other polarity in the vicinity of said third electrode group by supplying said regulating pulse after said equalizing pulse is supplied.

7. A plasma display panel driving system according to claim 4 or 5, further comprising the step of performing a address electric discharge between said second electrode group and said third electric group after gathering electric charge particles having one of the polarities in the vicinity of the said first and said second electrode groups and gathering electric charge particles having the other polarity in the vicinity of said third electrode group, and performing sustaining electric discharge.

8. A plasma display panel driving system according to claim 4 or 5, further comprising the step of supplying said regulating pulse to said other electrode group within 0.3 μ sec-2 μ sec after supplying said equalizing pulse to said one of said electrode groups.

9. A plasma display panel driving system according to claim 4 or 5, further comprising the step of arranging several fine line erasing pulses having a



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16 DEC 1997

first fine line erasing pulse whose pulse width is within 0.5 μ sec-2 μ sec and having at least a second fine line erasing pulse whose pulse width is equal to or less than the pulse width of said first pulse width for performing erasing and polarization of said electric charge particle.

10. A plasma display panel driving system according to claim 4 or 8 further, comprising the step of supplying said equalizing pulse to said second electrode group, and maintaining supply of said regulating pulse to said first electrode group until deciding cells to be emitted for gathering electric charge particles predetermined electrode group.

11. A plasma display panel driving system according to claim 4, 5 of 10, further comprising the step of dividing said regulating pulse into a first pulse for equalizing electric charge particles in all cells and a second regulating pulse supplied during a period for deciding cells to be emitted.

12. A plasma display panel driving system according to claim 4 or 5, further comprising the step of selecting the voltage of said regulating pulse substantially equal to the voltage of said sustaining pulse for performing display electric discharge.

13. A plasma display panel driving system according to claim 13, further comprising the step of falling the edge of said equalizing pulse after falling



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16 DEC 1997

the edge of said first regulating pulse, and falling said edge of said equalizing pulse within 1 μ sec.

14. A plasma display panel driving system according to claim 4 or 5, further comprising the step of performing a discharge in all cells by supplying full electric discharge pulse to one of said first and said second electrode groups one or several times per one field or several fields after performing sustaining discharge, and then supplying said fine line erasing pulse for performing a discharge in said all cells for erasing electric charge particles so as to gather positive electric charge particles in the vicinity of said first and said second electrode groups.

15. A plasma display panel driving system according to claim 4 or 5, further comprising the step of supplying plurality of fine line erasing pulses to said first and second electrode groups alternatively, and shortening the pulse width of said fine line erasing pulses which supplied afterward, and supplying the last fine line erasing pulse to said one of electrode group.

16. A plasma display panel driving system according to claim 4, 5 or 8, further comprising the step of supplying said equalizing pulse to one of electrode group, and falling the edge of said equalizing pulse in a time more than 1 μ sec.





1 6 DEC 1997

17. A plasma display panel driving circuit comprising:

a first electrode group arranged on a first substrate and driven in common;

a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate provided faced on said first substrate and controlled independently;

a first driving circuit connected to said first electrode group for supplying a first driving pulse;

a second driving circuit connected to said second electrode group for supplying a second driving pulse;

a third driving circuit connected to said third electrode group for supplying an address driving pulse;

means for supplying a fine line erasing pulse to one of the electrode group of said first and second electrode groups from said driving circuit connected to said one of the electrode group after sustaining discharging;

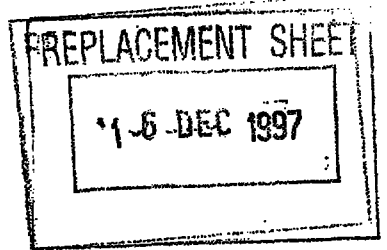
means for supplying a equalizing pulse to said one of the electrode group from said driving circuit connected to said one of the electrode group;

means for supplying a regulating pulse delaying



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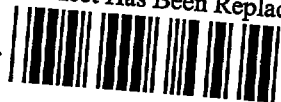
a bit from rising edge of said equalizing pulse to the other electrode group of said first and said second electrode groups from said driving circuit connected said other electrode group, and for gathering electric charge particles having one of the polarities in the vicinity of said first and said second electrode groups and for gathering electric charge particles having the other polarity in the vicinity of said third electrode group.

18 A plasma display panel driving circuit according to claim 17, further comprising means for supplying said regulating pulse to said other electrode group within 0.3 μ sec-2 μ sec after supplying said equalizing pulse to said one of said electrode groups.

19. A plasma display panel driving circuit according to claim 17 or 18, further comprising means for generating plurality of fine line erasing pulses from said first and said second driving circuits and selecting pulse width of a first fine line erasing pulse within 0.5 μ sec-2 μ sec and selecting pulse width of a second fine line erasing pulse equal to or shorter than said first fine line erasing pulse.

20. A plasma display panel driving circuit according to claim 17, 18 or 19, further comprising means for supplying from said second driving circuit said equalizing pulse to said second electrode group and for supplying said regulating pulse from said first





16 DEC 1997

driving circuit to said first electrode group during addressing cells to be emitted.

21 A plasma display panel driving circuit according to claim 17, 18 or 19, further comprising means for generating a first and a second regulating pulses from said driving circuit connected to said one of electrode group.

22. A plasma display panel driving circuit according to claim 17, further comprising means for selecting the voltage of said regulating pulse substantially identical with the voltage of said sustaining pulse.

23. A plasma display panel driving circuit according to claim 17, 18 or 20, further comprising means for falling the edge of said equalizing pulse after lapse of time more than 1 μ sec by said driving circuit connected to said one of electrode.

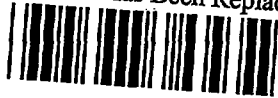
24. A plasma display panel driving circuit according to claim 17, further comprising means for supplying after performing sustaining discharge a full writing electric discharge pulse one time or several times per one field or several fields generated from one of driving circuit of said first and said second driving circuit which is connected to said one of electrode group.



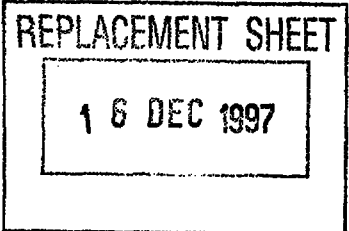
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91



25. A plasma display panel driving circuit according to claim 21, further comprising means for falling the edge of said equalizing pulse after falling the edge of said first regulating pulse, and falling said edge of said equalizing pulse within 1 μ sec.

26. A plasma display comprising :

a first electrode group arranged on a first substrate and driven in common;

a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate provided faced on said first substrate and controlled independently;

cells constructed at the cross point of said first and said second and said third electrode group;

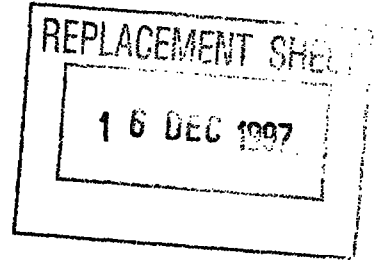
means for performing a electric discharge for erasing and polarizing electric charge particles in cells performed a sustaining discharging during a period after sustaining discharging and just before the beginning of an address period;

means for equalizing of electric charge particle in all cells by said discharge for erasing and polarizing.

27. A plasma display comprising:

a first electrode group arranged on a first





substrate and driven in common;

a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate provided faced on said first substrate and controlled independently;

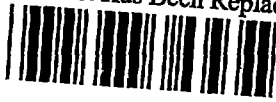
cells constructed at the cross point of said first and said second and said third electrode group;

means for performing a discharge by a fine line erasing pulse supplied to one of the electrode of said first and said second electrode group after a sustaining discharge and for erasing and polarizing electric charge particles in cells generated by said sustaining discharge;

means for gathering electric charge particles having one of polarities in the vicinity of said first and said second electrode groups and for gathering electric charge particles having the other one of the polarities in the vicinity of said third electrode group by supplying a equalizing pulse to said one of electrodes and by supplying a regulating pulse to the other electrode of said first and said second electrode groups so as to be able to discharge for addressing which determines light emitting cells by said third electrode group.



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93

REPLACEMENT SHEET

1 6 DEC 1997

28. A plasma display according to claim 27, further comprising means for supplying said regulating pulse to said other electrode within $0.3 \mu\text{sec}$ - $2 \mu\text{sec}$ after supplying said equalizing pulse to said one of said electrode groups for collecting electric charge particles having one of polarities in the vicinity of said first and said second electrode group and electric charge particles having the other one of polarities in the vicinity of said third electrode group.

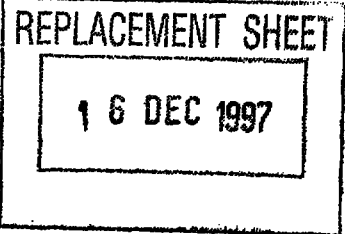
29. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, means for generating plurality of said fine line erasing pulses including a first fine line erasing pulse having pulse width within $0.5 \mu\text{sec}$ - $2 \mu\text{sec}$ and a second fine line erasing pulse having pulse width equal to or less than said second fine line erasing pulse, and means for erasing and polarizing electric charge particles by supplying last pulse of said fine line erasing pulses to said one of said first and second electrode groups.

30. A plasma display according to claim 27, further comprising means for supplying from said second driving circuit said equalizing pulse to said second electrode group and for maintaining supply of said regulating pulse supplied from said first driving circuit to said first electrode group during addressing



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cells to be emitted.

31. A plasma display according to claim 27, further comprising means for generating from one of said first driving circuit connected said first electrode group and said second driving circuit connected to said second electrode group a first and a second regulating pulses.

32. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, and means for selecting the voltage of said regulating pulse substantially identical with the voltage of said sustaining pulse by means of one of driving circuit of said first and said second driving circuits.

33. A plasma display according to claim 27, further comprising a driving circuit connected one of said first and said second electrode groups, and means for falling the edge of said equalizing pulse after lapse of time more than 1 μ sec by said driving circuit connected to said one of electrode group.

34. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, and means for generating a full writing pulse one time or several times per one field or several fields from one of





16 DEC 1997

driving circuit of said first and said second driving circuit and for performing a discharge in all cells after sustaining discharge is finished.

35. A plasma display panel driving system comprising the step of dividing one field into several sub-fields and providing an address period for setting cells to be emitted and a sustaining period for light emitting, and the step of constructing field block by plurality of sub-fields and arranging full writing electric discharge and full erasing electric discharge in a first sub-field of said field block.

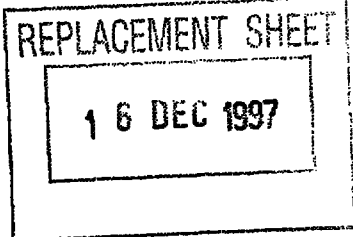
36. A plasma display panel driving system according to claim 35, further comprising the step of performing discharge in selected cells in which light emitting is performed by said sustaining electric discharge in said sub-fields of said sub-field block except the last sub-field of said sub-field thereby keeping the condition of electric charge particles almost same condition after performing full writing electric discharge and full erasing electric discharge.

37. A plasma display panel driving system according to claim 35 or 36, wherein said plasma display pane having a first electrode group covered with a dielectric layer and arranged on a first glass substrate and driven in common, a second electrode group covered with a dielectric layer arranged parallel to said first electrode group on said first glass substrate and



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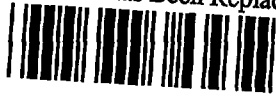
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controlled independently, a third electrode group covered with a dielectric layer and arranged perpendicular to said first and said second electrode groups on a second glass substrate provided faced on said first substrate and controlled independently, and said driving system comprising the step of performing discharge in selected cells in which light emitting is performed by said sustaining electric discharge in said sub-fields of said sub-field block except the last sub-field of said sub-field, thereby gathering positive electric charge particles on said dielectric layer covering said third electrode group and gathering negative electric charge particles on said dielectric layer covering said first and said second electrode group for leaving condition of electric charge particle unchanged without selection electric discharge.

38. A plasma display panel driving system according to claim 37, further comprising the step of performing said address electric discharge for determining cells to be emitted by discharging between said first and said second electrode groups and performing said sustaining discharge between said first and second electrode groups, and the step of supplying after supplying said last sustaining pulse to said first and said second electrode groups in all sub-fields of each sub-field block except each last sub-field a first pulse having almost the same voltage as the voltage of





16 DEC 1997

said sustaining pulse to one of electrode group of said first and second electrode groups to which the last sustaining pulse is not supplied and performing electric discharge in said cell in which said sustaining electric discharge has performed, and the step of arranging a second pulse rising after 0.3 μ sec-1.5 μ sec from the rising edge of said first pulse and supplying said second pulse to the other electrode group of said first and said second electrode groups to which said first pulse is not supplied, and providing plurality of fine line erasing pulses after supplying said first and said second pulses for erasing electric charge particles in the vicinity of said first and second electrode groups.

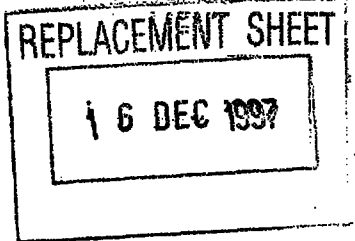
39. A plasma display panel driving system according to claim 38, wherein the voltage of said first and said second pulses and said fine line erasing pulse supplied after the supply of said sustaining pulse having a voltage the same as the sustaining voltage selected so as to cause sustaining electric discharge in cells performed said address electric discharge and to cause no sustaining electric discharge in cells in which no electric discharge is not performed.

40. A plasma display panel driving system according to claim 38 or 39, wherein further comprising a first address pulse supplied to cells in which no full writing electric discharge and no full erasing electric discharge are not performed, and said first address



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pulse having a voltage higher than a voltage of a second address voltage supplied to the other cells in which said full writing electric discharge and said full erasing electric discharge are performed.

41. A plasma display comprising:

a first electrode group arranged on a first substrate and driven in common;

a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate provided faced on said first substrate and controlled independently;

a field block constructed from plurality of sub-fields;

means for performing a full writing electric discharge between said first and said second electrode groups in a first field of said field block;

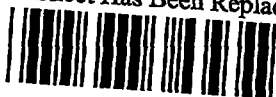
means for performing a electric discharge by supplying a selection electric discharge pulse to one of the electrode group of said first and said second electrode groups in said sub-fields of each field block except each last sub-field in cells in which light emitting is performed by a sustaining discharge;

means for gathering electric charge particles having one of polarities in the vicinity of said first

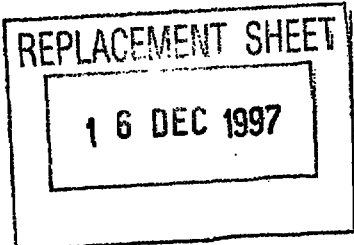


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99



and second electrode groups and gathering electric charge particles having the other polarity in the vicinity of said third electrode groups by supplying said selection electric discharge pulse to said one of electrode group and by supplying a electric charge particle control pulse to the other one of said first and second electrode groups;

means for performing no selection electric discharge in cells in which light emitting is not performed by said sustaining electric discharge.

42. A plasma display according to claim 41, further comprising means for supplying a sustaining pulse to said first and said second electrode groups and means for supplying the last sustaining pulse to said other electrode group.

43. A plasma display according to claim 41, wherein the rising edge of said electric charge particle control pulse having time lag of 0.3 μ sec-1.5 μ sec from rising edge of said selection electric discharge pulse.

44. A plasma display according to claim 41, further comprising means for supplying said fine line erasing pulse to said first and said second electrode group after selection electric discharge pulse is supplied.



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16 DEC 1997

100

ABSTRACT

PLASMA DISPLAY, DRIVING APPARATUS OF PLASMA DISPLAY
PANEL AND DRIVING SYSTEM THEREOF.

A plasma display panel driving system having a common X electrode 22 arranged on a front glass substrate 21 driven in common, a independent Y electrode 23 arranged parallel to the common X electrode 22 on the front glass substrate 21 driven independently, an address A electrode arranged perpendicular to the common X electrode and the independent Y electrode on the back glass substrate driven independently, and means for performing at least one electric discharge for equalizing of electric charge particle in a cell in which another electric charge particle is caused beforehand, thereby improving contrast.

Erasing and polarization of electric charge particles are performed by the fine line erasing pulse 46a after sustaining period 2c, and a equalizing pulse having a high voltage is supplied to the independent Y electrode to which the last fine line erasing pulse 46a or 86a is supplied, and a regulating pulse 40 is supplied to the common X electrode after supplying of the equalizing pulse.

Further, a field bloc having plurality of sub-fields are provided, and a full writing electric discharge and a fine line erasing electric discharge are performed in the first sub-field of each field block for reducing the number of electric discharging.

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SPECIFICATION

TITLE OF THE INVENTION

PLASMA DISPLAY, DRIVING APPARATUS FOR A PLASMA DISPLAY
PANEL AND DRIVING METHOD THEREOF

BACKGROUND OF THE INVENTION

The invention relates to plasma display, driving apparatus for a plasma display panel and driving method thereof for use, for example, as a display apparatus for a personal computer or workstation, a flat type wall hanging television receiver, or for a display apparatus for advertising and information. This invention is preferably applicable to AC type plasma display devices.

In plasma display, one field is divided into several sub-fields, and each pixel (cell) emits light by exciting a phosphor using ultraviolet rays that are generated by a electric discharge carried out in the cell. The cell that emits light is selected by an address electric discharge between two set of electrodes which are provided perpendicular to each other on a front side glass substrate and a back side glass substrate, respectively, and are capable of being driven independently.

A first example of a plasma display device is disclosed, for example, in Japanese Patent Application Laid-Open No. 1994/186927. In this first example, the condition of electrically charged particles in all cells is equalized for surely prohibiting the lighting of some cells which are not intended to emit light, and two sets of light

emitting discharges, that is, a full writing electric discharge and a full erasing electric discharge in each sub-field are carried out so as to be able to use a low voltage for an address electric discharge. Therefore, the contrast is deteriorated because light emitting occurs on the full panel when black is displayed.

A second example is disclosed, for example, in Japanese Patent Application Laid-Open No. 1995/49663. In the second example, a plurality of sub-fields having the same brightness gradations are arranged to form a sub-field block, and several blocks are provided. In sub-field blocks, a preliminary discharge, including a full writing electric discharge and a fine line erasing electric discharge, is performed in one sub-field, and a writing electric discharge and a erasing electric discharge for a pixel is carried out one time. Therefore, deterioration of the panel is reduced and the contrast of the display is improved. The second example discloses one solution to improve the contrast, but no means is disclosed to improve the contrast in an arrangement in which plural sub-fields having different brightness gradations are provided for forming one sub-field block.

About 3 μ sec to 4 μ sec is needed to write one line of plasma panel, and an ordinary television display has 480 lines. The writing period of a screen is 1.44 msec, if the writing period of one line is 3 μ sec, so that $1.44 \text{ msec} \times 9 = 13 \text{ msec}$ is needed for one field. However, the period of one field is 16.7 msec. The sustaining period is

16.7 msec minus a writing period and preliminary discharge period, and so this period is not long enough. Further, if a display has 760 lines per screen, like a high definition display, or if a display has 8 sub-fields for providing 256 gradations, the period for writing will not be sufficient.

SUMMARY OF THE INVENTION

It is an object of the present invention to improve contrast in a display.

It is another object of the present invention to improve contrast in a display by reducing a full erasing electric discharge and full writing electric discharge.

It is still another object of the invention to improve contrast in a display by reducing a preliminary discharge without changing the number of sub-fields.

According to a feature of the present invention, to achieve the above objects, a plasma display and a plasma display driving method include a first electrode group, which is arranged on a permeable substrate and in which the electrodes are capable of being driven in common, a second electrode group, which is arranged in parallel with the first electrode group on the permeable substrate and in which the electrodes are capable of being driven independently, a third electrode group, which is arranged perpendicular to the first and second electrode groups on the other substrate and in which the electrodes are capable of being driven independently, and a plasma panel, and wherein the driving method comprises means for performing at least one electric discharge for equalizing electrically

09 FEB 1998

charged particles in a cell in which another electrically charged particle is produced beforehand.

According to another feature of the present invention, to achieve the above objects, a plasma display, and a plasma display panel driving method and circuit include a first electrode group in which the electrodes are driven in common, a second electrode group in which the electrodes are driven independently, a third electrode group for producing an address electric discharge, means for erasing and polarizing electrically charged particles by a fine line erasing pulse after a sustaining period and for supplying an equalizing pulse to one electrode of the one of the first and second electrode groups to which the last fine line erasing pulse was supplied and for supplying a regulating pulse to an electrode of the other of the first and the second electrode groups after the equalizing pulse has been supplied, thereby controlling the electrically charged particles without fully erasing the electric discharge and fully writing an electric discharge, while improving the contrast without a light emitting discharge in the case of a black display.

According to still another feature of the present invention, to achieve the above objects, a plasma display and a plasma display panel driving method and circuit include means for forming a field block from a plurality of sub-fields and for performing a full writing electric discharge and a fine line erasing electric discharge in a first sub-field of the field block for decreasing the

09 FEB 1998

number of electric discharges, means for gathering positive electrically charged particles in the vicinity of an address electrode by the full writing electric discharge and fine line erasing electric discharge, thereby decreasing the voltage level of an address pulse, and means for reproducing the condition of electrically charged particles to the same condition as after performing full writing electric discharge and fine line erasing electric discharge are performed by utilizing a sustaining electric discharge in a cell in which the address electric discharge occurred, thereby reducing the voltage of a address electric discharge in the next field, without the full writing electric discharge and the fine line electric discharge. In a cell having no address electric discharge, the condition of electrically charged particles after the full writing electric discharge and fine line erasing electric discharge are performed is maintained during one field, so that it is sufficient to perform full writing electric discharge and fine line electric discharge only one time.

These and other objects, features and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a exploded perspective view illustrating a plasma display panel of the present invention.

Fig. 2 is a sectional view of a plasma display panel

09 FEB 1998

as seen in the direction of arrow A in Fig. 1.

Fig. 3 is a sectional view of a plasma display panel as seen in the direction of arrow B in Fig. 1.

Fig. 4 is a diagram which illustrates electrodes and circuits connected to the electrodes of the plasma display panel of Fig. 1.

Fig. 5(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the first embodiment of the present invention.

Fig. 5(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the first embodiment of the present invention.

Fig. 5(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the first embodiment of the present invention.

Fig. 5(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the first embodiment of the present invention.

Fig. 5(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the first embodiment of the present invention.

Fig. 6 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell is illustrated immediately after power is supplied and

09 FEB 1998

then equalizing pulse and a protecting pulse are supplied.

Fig. 7 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after performing an address electric discharge is illustrated.

Fig. 8 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after supplying a fine line erasing pulse is illustrated.

Fig. 9 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after supplying an equalizing pulse in a second field is illustrated.

Fig. 10 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after supplying a regulating pulse in a second field is illustrated.

Fig. 11(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 11(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the second embodiment of the present invention.

Fig. 11(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the second embodiment of the present invention.

09 FEB 1998

Fig. 11(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the second embodiment of the present invention.

Fig. 11(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the second embodiment of the present invention.

Fig. 12(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 12(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the third embodiment of the present invention.

Fig. 12(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the third embodiment of the present invention.

Fig. 12(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the third embodiment of the present invention.

Fig. 12(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the third embodiment of the present invention.

Fig. 13(a) is a time chart illustrating an arrangement

of sub-fields in one field in accordance with the invention.

Fig. 13(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the fourth embodiment of the present invention.

Fig. 13(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the fourth embodiment of the present invention.

Fig. 13(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the fourth embodiment of the present invention.

Fig. 13(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the fourth embodiment of the present invention.

Fig. 14(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the invention.

Fig. 14(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the fifth embodiment of the present invention.

Fig. 14(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the fifth embodiment of the present invention.

Fig. 14(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the fifth embodiment of the present invention.

Fig. 14(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the fifth embodiment of the present invention.

Fig. 15(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 15(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the sixth embodiment of the present invention.

Fig. 15(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the sixth embodiment of the present invention.

Fig. 15(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the sixth embodiment of the present invention.

Fig. 15(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the sixth embodiment of the present invention.

Fig. 16(a) is a time chart illustrating an arrangement

09 FEB 1998

of sub-fields in one field in accordance with the invention.

Fig. 16(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the seventh embodiment of the present invention.

Fig. 16(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the seventh embodiment of the present invention.

Fig. 16(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the seventh embodiment of the present invention.

Fig. 16(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the seventh embodiment of the present invention.

Fig. 17(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 17(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the eighth embodiment of the present invention.

Fig. 17(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the eighth embodiment of the present invention.

invention.

Fig. 17(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the eight embodiment of the present invention.

Fig. 17(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the eight embodiment of the present invention.

Fig. 18(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 18(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the ninth embodiment of the present invention.

Fig. 18(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the ninth embodiment of the present invention.

Fig. 18(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the ninth embodiment of the present invention.

Fig. 18(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the ninth embodiment of the present invention.

09 FEB 1998

13

Fig. 19 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell is illustrated immediately after power is supplied and then an equalizing pulse and a regulating pulse are supplied in accordance with the ninth embodiment.

Fig. 20 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after performing an address electric discharge is illustrated in accordance with ninth embodiment of the present invention.

Fig. 21 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after supplying a fine line erasing pulse is illustrated in accordance with the ninth embodiment of the present invention.

Fig. 22 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after supplying an equalizing pulse in a second field is illustrated in accordance with the ninth embodiment of the present invention.

Fig. 23 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after supplying a regulating pulse in a second field is illustrated in accordance with the ninth embodiment of the present invention.

Fig. 24(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

09 FEB 1998

Fig. 24(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the tenth embodiment of the present invention.

Fig. 24(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the tenth embodiment of the present invention.

Fig. 24(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the tenth embodiment of the present invention.

Fig. 24(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the tenth embodiment of the present invention.

Fig. 25(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

Fig. 25(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the eleventh embodiment of the present invention.

Fig. 25(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the eleventh embodiment of the present invention.

Fig. 25(d) is a waveform diagram which illustrates a

09 FEB 1998

driving wave-form supplied to a first independent Y electrode in accordance with the eleventh embodiment of the present invention.

Fig. 25(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the eleventh embodiment of the present invention.

Fig. 26(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention.

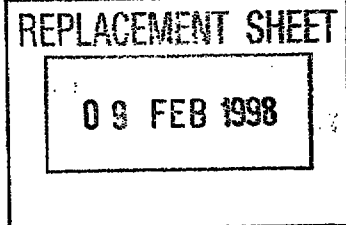
Fig. 26(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the twelfth embodiment of the present invention.

Fig. 26(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the twelfth embodiment of the present invention.

Fig. 26(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the twelfth embodiment of the present invention.

Fig. 26(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the twelfth embodiment of the present invention.

Fig. 27(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present



invention.

Fig. 27(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the thirteenth embodiment of the present invention.

Fig. 27(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the thirteenth embodiment of the present invention.

Fig. 27(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the thirteenth embodiment of the present invention.

Fig. 27(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the thirteenth embodiment of the present invention.

Fig. 28(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with a second embodiment of the present invention.

Fig. 28(b) is a waveform diagram which illustrates a driving wave-form supplied to a common X electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 28(c) is a waveform diagram which illustrates a driving wave-form supplied to an address A electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 28(d) is a waveform diagram which illustrates a driving wave-form supplied to a first independent Y electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 28(e) is a waveform diagram which illustrates a driving wave-form supplied to a second independent Y electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 28(f) is a waveform diagram which illustrates a driving wave-form supplied to a third independent Y electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 28(g) is a waveform diagram which illustrates a driving wave-form supplied to a fourth independent Y electrode in accordance with the fourteenth embodiment of the present invention.

Fig. 29 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after supplying sustaining pulses is illustrated in accordance with an embodiment shown in Fig. 28(a)-28(g) of the present invention.

Fig. 30 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell during discharging by a selection electric discharge pulse is illustrated in accordance with the embodiment shown in Fig. 28(a)-28(g) of the present invention.

Fig. 31 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a

cell during the supplying of an electrically charged particle control pulse is illustrated in accordance with the embodiment shown in Fig. 28(a)-28(g) of the present invention.

Fig. 32 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after supplying a fine line erasing pulse is illustrated in accordance with the embodiment shown in fig. 28(a)-Fig. 28(g) of the present invention.

Fig. 33 is a time chart of sub-fields illustrating a driving method in accordance with the fifteenth embodiment of the present invention.

Fig. 34 is a time chart of sub-fields illustrating a driving method in accordance with the sixteenth embodiment of the present invention.

Fig. 35 is a time chart of sub-fields illustrating a driving method in accordance with the seventeenth embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the present invention will be described with reference to the drawings hereinafter.

Fig. 1 illustrates an exploded perspective view of a plasma display panel relating to the first embodiment of the present invention.

A transparent common X electrode 22 and a transparent independent Y electrode 23 are provided under a front glass substrate 21, and a X bus electrode 24 and a Y bus

09 FEB 1998

electrode 25 are laminated on the electrodes 21 and 22, respectively. A dielectric layer 26 and a protecting layer 27, such as acid magnesium (MgO), are provided on these electrodes 22, 23, 24 and 25. An address A electrode 29 provided on a back glass substrate 28 is arranged perpendicular to the common X electrode 22 and the independent Y electrode 23 on the front glass substrate 21. The address A electrode 29 is covered by a dielectric layer 30, and a partition wall 31 arranged parallel to the address A electrode 29 is provided on the electrode 29. A phosphor 32 is coated on the partition wall 31 and the address A electrode 29.

Fig. 2 is a sectional view of a plasma display panel as seen in the direction of arrow A in Fig. 1. The address A electrode 29 is centered with respect to the two partition walls. A discharge gas, such as a neon gas or a xenon gas, is filled in a space 33 that is provided between the front glass substrate 21 and the back glass substrate 38.

Fig. 3 is a sectional view of a plasma display panel as seen in the direction of arrow B in Fig. 1. A border of each cell is shown by a dotted line, and the common X electrode 22 and the independent Y electrode 23 are arranged alternatively. In an AC type plasma display panel, the electrically charged particles on the dielectric layer in the vicinity of the common X electrode 22 and the independent Y electrode 23 are divided into positive electrically charged particles and negative electrically

charged particles for forming an electric field, so that a discharge is generated by means of an electric field.

Fig. 4 illustrates electrodes and circuits connected to the electrodes of the plasma display panel of Fig. 1. The common X electrode 22 is connected to an output terminal or several terminals of a X electrode driving circuit 35 that generates a driving pulse for supplying a voltage to the common X electrode 22. Each independent Y electrode 23 is connected to respective output terminals of a Y electrode driving circuit 36. Each address A electrode 29 is connected to respective output terminals of an A electrode driving circuit 37.

Figs. 5(a) to 5(e) illustrate a first driving system in accordance with a first embodiment of the present invention. Fig. 5(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the invention, wherein reference numeral 1 denotes one field, the horizontal axis illustrates time and the vertical axis illustrates a line of the cell. The one field is divided into eight sub-fields, that is, a first sub-field 2 to an eighth sub-field 9. An electrically charged particle equalizing period 2a-9a, an address period 2b-9b and a sustaining period 2c-9c are arranged in order in each sub-field. Numbers of electric discharges are allotted for each sub-field, and display on gradations are determined by the total numbers of the discharges. The order for arranging the sub-fields having predetermined numbers of discharges is free, but in the embodiment, the

09 FEB 1998

sub-fields are arranged in order from a sub-field having a fewer number of electric discharges.

Fig. 5(a)-Fig. 5(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrodes, respectively. A pulse waveform 10 illustrates a part of the driving wave-form supplied to the common X electrode 22 in one field. A pulse wave-form 11 illustrates a part of the driving wave-form supplied to the one of the address A electrodes 29. Pulse wave-forms 12 and 13 illustrate parts of a driving wave-form supplied, for example, to first and second independent Y electrodes 23.

The pulse wave-form 10, which is supplied to the common X electrode 22 during a first sub-field includes a regulating pulse 40 lasting from a first part of the electrically charged particle equalizing period 2a through the address period 2b and the sustaining pulses 41 in the sustaining period 2c. In this embodiment, the voltage of the regulating pulse 40 is lower than the voltage of the sustaining pulses 41. The pulse wave-form 11, which is supplied to one of the address A electrodes 29, includes the address pulse 42 in the address period 2b, which address pulse 42 corresponds to the cell which is to emit light. The address pulse 42 is not supplied when there is no cell to be illuminated. That is, the address pulses 42 are supplied to the cells to be illuminated, and the address pulse 42 is not supplied to the other cells which are not to be illuminated. The pulse wave-forms 12 and 13,

09 FEB 1998

which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23, includes electrically charged particle equalizing pulses 43a, 43b,--- in the electrically charged particle equalizing period 2a of the first sub-field, scan pulses 44a, 44b,--- in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. In the embodiment, the voltage of the scan pulses 44a, 44b,--- is lower than the voltage of the sustaining pulses 45a, 45b,---. The fine line erasing pulses 46a, 46b,--- and the equalizing pulses 43a, 43b,--- are supplied to the same electrodes. Further, it is preferable to select the pulse width of the fine line erasing pulses 46a, 46b,--- between $0.5 \mu\text{sec}$ - $2 \mu\text{sec}$.

The actions in the panel will be explained hereinafter. In this embodiment, electric discharges in all cells are performed between the independent Y electrodes 23 and the common X electrodes 22 by supplying the equalizing pulses 43a, 43b,--- to the independent Y electrodes 23, whereby negative electrically charged particles are formed on the dielectric layer 26 in the vicinity of the independent Y electrode 23 during the equalizing period 2a occurring immediately after the power is supplied to the display. The electric discharge generated by the equalizing pulses 43a, 43b,--- occurs only one time, and the discharge is not generated after this. That is, the discharge occurs only one time other than when the space 33 of the cell

becomes in an abnormal condition. The regulating pulse 40 is supplied to the common X electrode 22 within the time between $0.3 \mu\text{sec}$ - $2 \mu\text{sec}$ from the rising edge of the equalizing pulses 43a, 43b,---. The negative electrically charged particles are formed in the vicinity of the common X electrode 22, and the positive electrically charged particles are formed in the vicinity of the address A electrode 29.

The reason the time between the rising edge of the equalizing pulses 43a, 43b,--- and the rising edge of the regulating pulse 40 is determined as described the above is that too many negative electrically charged particles are gathered in the vicinity of the independent Y electrode 23 and the negative electrically charged particles gather at the common X electrode 22 when the time between edges of both pulses 43a, 43b,--- and 40 is selected to be too long. When the time is too short, on the other hand, the negative electrically charged particles are not gathered on the independent Y electrode 23 and also the positive electrically charged particles are not gathered on the address A electrode 22.

The main purpose for supplying the regulating pulse 40 is to attract the negative electrically charged particles toward the common X electrode 22 and to form positive electrically charged particles on the address A electrode 29. Another purpose is to assist the electric discharges between the common X electrode 22 and the independent Y electrode 23 when the address electric discharge is

09 FEB 1998

24

performed between the address A electrode 29 and the independent Y electrode 23.

An address electric discharge is performed in the cell which is formed at the cross point of the first line of the independent Y electrode 23 and one of the address A electrodes 22 when the scan pulse 44a is supplied to the first line of the independent Y electrode 23 and the address pulse 42 is supplied to one of the address A electrodes 29 at the same time, with the result that the positive electrically charged particles are gathered on the independent Y electrode 23. On the other hand, no discharge occurs when the address pulse 42, which corresponds to the scan pulse 44b, is not supplied to the second line of the independent Y electrode 23; therefore, no electrically charged particle is gathered on the independent Y electrode 23. The address pulses 42 are supplied to the address A electrodes 29 which correspond to the cell to be illuminated, and select all the cells at the cross points of all address A electrodes 29, and the scan pulses 44a or 44b are supplied to the independent Y electrodes 23, so that the electric discharges are performed between the address A electrode 29 and the independent Y electrodes 23.

Next, in the sustaining period 2c, the electric discharges for emitting light are performed by the sustaining pulses 41, 45a, 45b,--- between the common X electrode 22 and the independent Y electrodes 23 in the cell in which the positive electrically charged particles are gathered on the independent Y electrodes 23 side by the

09 FEB 1998

25

electric discharges performed during the address period 2b. After that, electric discharges occur between the independent Y electrodes 23 and the common X electrode 22 by supplying the fine line erasing pulses 46a, 46b,--- to the independent Y electrodes 23, whereby the electrically charged particles in the cells are erased, so that all electrically charged particles generated for emitting light in the cell are erased. The pulse width of the fine line erasing pulses 46a, 46b,--- is a little longer than the electric discharge duration time, therefore, the negative electrically charged particles are gathered on the dielectric layer in the vicinity of the independent Y electrodes 23. In the cells in which no electric discharge has occurred, the erasing discharges are not performed because no electrically charged particle is in the cell. Therefore, the negative electrically charged particles formed in the vicinity of the independent Y electrodes 23 are kept unchanged.

In this situation, no electric discharge occurs when supplying the equalizing pulses 43a, 43b,--- to the independent Y electrodes 23 because the negative electrically charged particles in the cell negate the voltage of the equalizing pulses 43a, 43b,--- and sufficient electric fields needed for the electric discharge are not formed. After that, no electric discharge is performed through all sub-fields even if the equalizing pulses are supplied. Therefore, the electric discharges are not performed, except for the first sub-field immediately

after the power is turned on, therefore no light emitting occurs in the black display.

Further, for the linearity of display gradations determined by the numbers of sustaining pulses, one electric discharge will have less influence than two electric discharges. According to the present invention, the equalization of electrically charged particles is effected by one electric discharge in the cell in which the sustaining electric discharge is performed, therefore, the influence on the linearity for display gradations is very small.

The same driving method is performed during the second sub-field 3 to the eighth sub-field 9, and so a screen of one field is formed.

Fig. 6-Fig. 10 are sectional views of the plasma display panel in which the condition of the electrically charged particles in the cell during a sustaining electric discharge are illustrated from the first sub-field after the power is supplied to the second sub-field until the equalizing pulses and the regulating pulse are supplied. In these figures, reference numeral 60 denotes a positive electrically charged particles, and reference numeral 61 denotes negative electrically charged particles. Further the condition of electrically charged particles is illustrated in a cell at a center position in Fig. 6-Fig. 10.

Fig. 6 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a

cell is illustrated immediately after power is supplied and then an equalizing pulse and a regulating pulse are supplied. The figure illustrates the condition of electrically charged particles in the first sub-field after power is supplied at first and then the equalizing pulses 43a, 43b are supplied to the independent Y electrodes 23 and finally the regulating pulse 40 is supplied. The electric discharges in all cells occur between the common X electrode 22 and the independent Y electrodes 23 by supplying the equalizing pulses 43a, 43b,--- to the independent Y electrodes 23, whereby the negative electrically charged particles 61 are gathered on the dielectric layer in the vicinity of the independent Y electrodes 23a and the common X electrode 22 and the positive electrically charged particles 60 are gathered on the address A electrodes 29 side.

Fig. 7 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after performing an address electric discharge is illustrated. In Fig. 7, the condition of electric discharges is illustrated after the address pulse 42 is supplied to the address A electrode 29 and address electric discharges occur between the address A electrode 29 and the independent Y electrodes 23. The positive electrically charged particles 60 are gathered on the dielectric layer in the vicinity of the independent Y electrode 23 because the voltage of the independent Y electrode 23 is lower than the voltages of the address A electrode 29 and the common X

electrode 22. The condition of the electrically charged particles is shown in Fig. 7. The electric discharge occurs between the independent Y electrode 23 and the common X electrode 22 by the positive electrically charged particles 60 and the first pulse of the sustaining pulses 45a, 45b,--- supplied to the independent Y electrode 23. This is a sustain discharge. This time, the negative electrically charged particles 61 are gathered around the independent Y electrode 23 and the positive charges 62 are gathered around the common X electrode 22 by the electric discharge generated by the sustaining pulses 45a, 45b. As a result, sustaining electric discharges occur between the independent Y electrode 23 and the common X electrode 22 by the first pulse of sustaining pulses 41. These electric discharges are repeated during the sustaining period 2c.

Fig. 8 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell after supplying a fine erase pulse is illustrated. In Fig. 8, the condition of the electric discharge after the last sustaining pulses 41 is supplied to the common X electrode 22 and then the fine line erasing pulses 46a, 46b,--- are supplied is illustrated.

The condition of the electrically charged particles after the discharges have occurred due to the final sustaining pulses 41 is the same as the condition shown in Fig. 7.

The pulse width of the fine line erasing pulses 46a, 46b,--- is longer than the discharge duration time, so that

09 FEB 1988

negative electrically charged particles 61 which move so quickly are gathered on the dielectric layer in the vicinity of the independent Y electrode 23. As a result, separation of the electrically charged particles is performed. The positive electrically charged particles that move slowly in space float in the cell. The negative charges float in the discharge space for a while.

Fig. 9 is a sectional view of a plasma display panel in which a condition of the electrically charged particles in a cell after supplying an equalizing pulse in a second field is illustrated. In Fig. 9, a condition of the electric discharge after the equalizing pulses 43a, 43b,--- in the second sub-field are supplied is illustrated. The voltage of the equalizing pulses 43a, 43b,--- is canceled by the negative charges and does not reach the discharge voltage, so that no discharge is performed. The voltage of the independent Y electrode 23 is higher than the voltage of the other electrodes, so the negative charges are attracted toward the independent Y electrode 23.

Fig. 10 is a sectional view of a plasma display panel in which a condition of the electrically charged particles in a cell after supplying a regulating pulse in a second field is illustrated.

Referring to the drawing, the condition of the electrically charged particles after the regulating pulse 40 is supplied to the common X electrode 22 is illustrated. The negative electrically charged particles are gathered on the dielectric layer in the vicinity of the common X

electrode 22 and the positive charges are gathered at the address A electrode 29. By this, the same driving as the first sub-field is performed without electric discharge by the equalizing pulses 43a, 43b,---. In this case, the voltage of the equalizing pulses 43a, 43b,--- is reduced by the negative electrically charged particles at the independent Y electrode 23, so that an electric discharge between the independent Y electrode 23 and the common X electrode 22 is not performed.

The driving of the panel is capable of being performed without using the full writing electric discharge and fine line erasing electric discharge for each sub-field. As a result, unnecessary light emitting is erased for displaying a black brightness, so that the contrast is improved.

A second embodiment of the present invention will be described hereinafter. Figs. 11(a) to 11(e) illustrate a driving method in accordance with a second embodiment of the present invention. Fig. 11(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields, similar to the case of Fig. 5(a). The horizontal axis shows time and the vertical axis shows lines of cells.

Fig. 11(b)-Fig. 11(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and second independent Y electrodes, respectively.

A pulse wave-form 70 illustrates a part of the driving

09 FEB 1998

wave-form supplied to the common X electrode 22 in one field. A pulse wave-form 71 illustrates a part of the driving wave-form supplied to one of the address A electrodes 29. Pulse wave-forms 72 and 73 illustrate parts of a driving wave-form supplied, for example, to first and second independent Y electrodes 23.

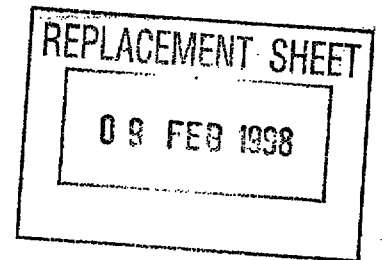
The pulse wave-form 70, which is supplied to the common X electrode 22 during the first sub-field, includes a regulating pulse 40 lasting from a first part the electrically charged particle equalizing period 2a through the address period 2b and the sustaining pulses 41 and a fine line erasing pulse 74 in the sustaining period 2c. The pulse waveform 71 which is supplied to one of the address A electrodes 29 illustrates the address pulse 42 in the address period 2b which corresponds to the light emitting cell. The address pulse 42 is not supplied when there is no cell to be illuminated. The pulse waveforms 71 and 72, which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23, includes an electrically charged particle equalizing pulse 43a 43b,--- in the equalizing period 2a of the first sub-field, scan pulses 44a, 44b,--- in the address period 2b, sustaining pulses 45a, 45b,--- and first fine line erasing pulses 75a, 75b,--- in the sustaining period 2c.

Under these circumstances, the pulse width of the first fine line erasing pulses 75a, 75b,--- is the same as or shorter than the pulse width of the second fine line

erasing pulse 74. The number of the fine line erasing pulses is an even number as shown in Fig. 11(c), that is, the first and the second fine line erasing pulses 75a, 75b and 74, the first fine line erasing pulses 75a, 75b,--- which are the last erasing pulses, and the equalizing pulses 43a, 43b,---are supplied to the same electrodes, that is, the independent Y electrode 23. The second fine line erasing pulse 74 is supplied to the other electrode, that is, the common X electrode 22.

In the embodiment, the last sustaining pulse is supplied to the independent Y electrode 23. A condition of electrically charged particles after supplying the first fine line erasing pulses 75a, 75b,--- is almost the same as the condition shown in Fig. 8 in accordance with the first embodiment. The condition of the electric discharges in the other sub-fields 3-9 are the same condition. Further, the erasing and polarizing of the electrically charged particles are performed by these fine line erasing pulses, so that these erasing pulses may be designated as a polarization pulse group. In this embodiment, by using the first and the second fine line erasing pulses 75a, 75b and 74, the erasing and polarization are effectively performed, and the electric discharging time during the address discharging time is maintained constant.

A third embodiment of the present invention will be described hereinafter. Figs. 12(a) to 12(e) illustrate a driving method in accordance with the third embodiment of the present invention. Fig. 12(a) is a time chart



illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields, similar to the case of Fig. 5(a). The horizontal axis illustrates time and the vertical axis illustrates a line of cells.

Fig 12(b)-Fig. 12(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and the second independent Y electrodes, respectively.

A pulse wave-form 80 illustrates a part of the driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 81 illustrates a part of the driving wave-form supplied to the one of the address A electrodes 29. Pulse wave-forms 82 and 83 illustrate parts of the driving wave-forms supplied, for example to first and second independent Y electrodes 23.

The pulse wave-form 80, which is supplied to the common X electrode 22 during the first sub-field, includes a regulating pulse 40 lasting from a first part of the electrically charged particle equalizing period 2a through the address period 2b and the sustaining pulses 41 in the sustaining period 2c and second fine line erasing pulse 84. The pulse wave-form 81, which is supplied to one of the address A electrodes 29, includes the address pulse 42 in the address period 2b which corresponds to the light emitting cell. The address pulse 42 is not supplied when there is no cell to be illuminated. The pulse wave-forms 82

and 83 which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23 includes electrically charged particle equalizing pulses 43a 43b,--- in the equalizing period 2a of the first sub-field, scan pulses 44a, 44b,--- in the address period 2b, sustaining pulses 45a, 45b,--- and third fine line erasing pulses 85a, 85b,--- and first fine line erasing pulses 86a, 86b,--- in the sustaining period 2c.

Under these circumstances, the pulse width of the second fine line erasing pulses 84 is the same as or shorter than the pulse width of a third fine line erasing pulses 85a, 85b,---. The pulse width of the first fine line erasing pulses 86a, 86b,--- is also the same as or shorter than the pulse width of the second fine line erasing pulse 84.

If the numbers of the fine line erasing pulses are an odd number, as shown in Fig. 12(d), that is, the first to the third fine line erasing pulses, the first fine line erasing pulses 86a, 86b,--- which are the last supplied erasing pulses and the equalizing pulses 43a, 43b,--- are supplied to the same electrodes, that is, the independent Y electrode 23. The third fine line erasing pulse 85, which is first supplied fine line erasing pulse, is supplied to the same electrode to which the first supplied fine line erasing pulses 86a and 86b are supplied, that is, the independent Y electrode 23. Therefore, the last sustaining pulse is supplied to the common X electrode 22. A condition

09 FEB 1998

35

of the electrically charged particles after supplying the first fine line erasing pulses 86a, 86b,--- is almost the same condition as shown in Fig. 8 in accordance with the first embodiment. The condition of the electric discharges in the other sub-fields 3-9 is the same condition. In this embodiment, by using the first, the second and the third fine line erasing pulses 86a, 86b, 84, 85a and 85b, the erasing and polarization are more effectively performed, and the electric discharging time during address discharging time is maintained constant. According to an experiment performed by the present inventors, it was found that it is effective for erasing to use up to three fine line erasing pulses, but using more than four fine line erasing pulses is not so effective.

A fourth embodiment of the present invention will be described hereinafter. Figs. 13(a) to 13(e) illustrate a driving method in accordance with a fourth embodiment of the present invention. Fig. 13(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields, similar to the case of Fig. 5(a). The horizontal axis illustrates time and the vertical axis illustrates a line of cells.

Fig. 13(b)-Fig. 13(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and second independent Y electrodes, respectively.

A pulse wave-form 90 illustrates a part of the driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 91 illustrates a part of the driving wave-form supplied to one of the address A electrodes 29. Pulse wave-forms 92 and 93 illustrate parts of the driving wave-forms supplied, for example, to first and second independent Y electrodes 23.

The pulse wave-form 90, which is supplied to the common X electrode 22 during the first sub-field, includes a regulating pulse 94 lasting from a first part of the electrically charged particle equalizing period 2a to the address period 2b and the sustaining pulses 41 in the sustaining period 2c.

The voltage of the regulating pulse 94 and the voltage of the sustaining pulses 41 are the same, and thereby the driving circuit is simplified because the same power is used. The pulse wave-form 91, which is supplied to one of the address A electrodes 29, includes the address pulse 42 in the address period 2b which corresponds to the light emitting cell. The address pulse 42 is not supplied when there is no cell to be emitted. The pulse wave-forms 92 and 93, which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23, includes electrically charged particle equalizing pulses 43a 43b,--- in the electric charge particle equalizing period 2a of the first sub-field, scan pulses 44a, 44b,--- in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing

09 FEB 1998

pulses 46a, 46b,--- in the sustaining period 2c. A condition of electrically charged particles after supplying the fine line erasing pulses 46a, 46b,--- is almost the same condition as shown in Fig. 8, which illustrates the condition of electrically charged particles in accordance with the first embodiment. The condition of the electric discharge in the other sub-fields 3-9 is the same condition. In this embodiment, the voltage of the regulating pulse 94 supplied to the common X electrode 22 and the voltage of the sustaining pulses are the same, therefore simplifying the driving circuit construction.

A fifth embodiment of the present invention will be described hereinafter. Figs. 14(a) to 14(e) illustrate a driving method in accordance with the fifth embodiment of the present invention. Fig. 14(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields, similar to the case of Fig. 5(a). The horizontal axis illustrates time and the vertical axis illustrates a line of cells. Fig. 14(b)-Fig. 14(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and second independent Y electrodes, respectively.

A pulse wave-form 100 illustrates a part of the driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 101 illustrates a part of the driving wave-form supplied to the one of the

address A electrodes 29. Pulse wave-forms 102 and 103 illustrate parts of the driving wave-forms supplied, for example, to first and second independent Y electrodes 23.

The pulse wave-form 100, which is supplied to the common X electrode 22 during the first sub-field, includes a regulating pulse 94 lasting from a first part of the electrically charged particle equalizing period 2a through the address period 2b and the sustaining pulses 41 in the sustaining period 2c. The voltage of the regulating pulse 94 and the voltage of the sustaining pulses 41 are the same as the fourth embodiment shown in Fig. 13(d), thereby the driving circuit is simplified because the same power is used. The pulse wave-form 101, which is supplied to one of the address A electrodes 29, includes the address pulse 42 in the address period 2b which corresponds to the light emitting cell. The address pulse 42 is not supplied when there is no cell to be illuminated. The pulse wave-forms 102 and 103, which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23, includes electrically charged particle equalizing pulses 43a 43b,--- in the equalizing period 2a of the first sub-field, scan pulses 104a, 104b,--- in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. The voltage of the independent Y electrode 23 during the address period 2c and the voltage of the sustaining pulses 45a, 45b,--- are the same, thereby the driving circuit is simplified because the

same power is used. A condition of the electrically charged particles after supplying the fine line erasing pulses 46a, 46b,--- is almost the same condition as shown in Fig. 8, which illustrates the condition of the electrically charged particles in accordance with the first embodiment. The condition of the electrically charged particles in the other sub-fields 3-9 is the same condition.

A sixth embodiment of the present invention will be described hereinafter. Figs. 15(a) to 15(e) illustrate a driving method in accordance with a sixth embodiment of the present invention. Fig. 15(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields, similar to the case of Fig. 5(a). The horizontal axis illustrates time and vertical axis illustrates a line of cells. Fig. 15(b)-Fig. 15(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and first and second independent Y electrodes, respectively.

A pulse wave-form 110 illustrates a part of the driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 111 illustrates a part of the driving wave-form supplied to the one of the address A electrodes 29. Pulse wave-forms 112 and 113 illustrate parts of the driving wave-forms supplied, for example, to first and second independent Y electrodes 23.

The pulse wave-form 110, which is supplied to the common X electrode 22 during the first sub-field, includes

09 FEB 1998

a first regulating pulse 114 in the electrically charged particle equalizing period 2a, a second regulating pulse 115 in the address period 2b and the sustaining pulses 41 in the sustaining period 2c. In this embodiment, the regulating pulse supplied to the common X electrode 22 is divided into a first regulating pulse 114 in the equalizing period 2a and a second regulation pulse 115 in the address period 2b. The pulse wave-form 111, which is supplied to one of the address A electrodes 29, includes the address pulse 42 in the address period 2b which corresponds to the light emitting cell. The address pulse 42 is not supplied when there is no cell to be illuminated. The pulse wave-forms 112 and 113, which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23, includes electrically charged particle equalizing pulses 43a 43b,--- in the equalizing period 2a of the first sub-field, scan pulses 114a, 114b,--- in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. A condition of electrically charged particles after supplying the fine line erasing pulses 46a, 46b,--- is almost the same condition as shown in Fig. 8, which illustrates the condition of electrically charged particles in accordance with the first embodiment. The condition of the electric discharge in the other sub-fields 3-9 is the same condition. As seen Figs. 15(b) and 15(d), the rising edge of the first regulating pulse slightly earlier than that of

09 FEB 1998

41

the equalizing pulse 43a, thereby preventing electric discharging by mistake between the common X electrode 22 and the independent Y electrode. Further, a rising edge of the second regulating pulse 115 and a rising edge of the scan pulses 116a, 116b is effected at the same time, thereby preventing electric discharge by mistake between the common X electrode 22 and the independent Y electrode 23.

The first regulating pulse 114 supplied to the common X electrode 22 and the sustaining pulses 41 may use the same voltage.

A seventh embodiment of the present invention will be described hereinafter. Figs. 16(a) to 16(e) illustrate a driving method in accordance with a seventh embodiment of the present invention. Fig. 16(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields, similar to the case of Fig. 5(a). The horizontal axis illustrates time and the vertical axis illustrates a line of cells. Fig. 16(b)-Fig. 16(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and second independent Y electrode, respectively.

A pulse wave-form 130 illustrates a part of the driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 131 illustrates a part of the driving wave-form supplied to one of the

09 FEB 1998

address A electrodes 29. Pulse wave-forms 132 and 133 illustrate parts of the driving wave-forms supplied, for example, to first and second independent Y electrodes 23.

The pulse wave-form 130, which is supplied to the common X electrode 22 during the first sub-field, includes a first regulating pulse 134 in the electrically charged particle equalizing period 2a, a second regulating pulse 135 in the address period 2b and the sustaining pulses 41 in the sustaining period 2c. The pulse wave-form 131, which is supplied to one of the address A electrodes 29, includes the address pulse 42 in the address period 2b of the first sub-field which corresponds to the light emitting cell. The address pulse 42 is not supplied when there is no cell to be illuminated. The pulse wave-forms 132 and 133, which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23, includes electrically charged particle equalizing pulses 136a, 136b,--- in the equalizing period 2a of the first sub-field, scan pulses 137a, 137b,--- in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c.

A falling edge of the equalizing pulse 136a, 136b,--- becomes zero voltage within a time less than 1 μ s in accordance with the present embodiment, which is different from the above mentioned embodiment. As the voltage of the second regulating pulse 135 and the scan pulses 137a, 137b, the same voltage as the sustaining pulses 41, 45a, 45b,---

09 FEB 1998

is employed. A condition of the electrically charged particles after supplying the fine line erasing pulses 46a, 46b,--- is almost the same condition as shown in Fig. 8, which illustrates the condition of electrically charged particles in accordance with the first embodiment. The condition of the electric discharge in the other sub-fields 3-9 is the same condition.

In this embodiment, the edge of the first regulating pulse 134 falls before the edge of the equalizing pulse falls, as shown in Fig. 16(d), thereby preventing electric discharge by mistake between the common X electrode 22 and the independent Y electrode.

An eighth embodiment of the present invention will be described hereinafter. Figs. 17(a) to 17(e) illustrate a driving method in accordance with an eighth embodiment of the present invention. Fig. 17(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields, similar to the case of Fig. 5(a). The horizontal axis illustrates time and the vertical axis illustrates a line of cells. Fig. 17(b)-Fig. 17(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and second independent Y electrodes, respectively.

A pulse wave-form 140 illustrates a part of the driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 141 illustrates a

part of the driving wave-form supplied to one of the address A electrodes 29. Pulse wave-forms 142 and 143 illustrate part of the driving wave-form supplied, for example, to first and second independent Y electrodes 23.

The pulse wave-form 140, which is supplied to the common X electrode 22 during the first sub-field, includes a first regulating pulse 144 in the electrically charged particle equalizing period 2a, a second regulating pulse 145 in the address period 2b and the sustaining pulses 41 in the sustaining period 2c.

According to the present embodiment, the voltage of the first regulating pulse 144 is set higher than the voltage of the sustaining pulses 41. The pulse wave-form 141, which is supplied to one of the address A electrodes 29, includes the address pulse 42 in the address period 2b of the first sub-field which corresponds to the light emitting cell. The address pulse 42 is not supplied when there is no cell to be illuminated. The pulse wave-forms 142 and 143 which are supplied to the first electrode of the independent electrodes 23 and adjacent second electrode of the independent Y electrodes 23, includes electrically charged particle equalizing pulses 136a 136b,--- in the equalizing period 2a of the first sub-field, scan pulses 137a, 137b,--- in the address period 2b, sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c.

The voltage of the second regulating pulse 135 and the scan pulses 137a, 137b,--- can be set to the same voltage

as the sustaining pulses 41, 45a, 45b,---. A condition of the electrically charged particles after supplying the fine line erasing pulses 46a, 46b,--- is almost the same condition as shown in Fig. 8, which illustrates the condition of electrically charged particles in accordance with the first embodiment. The condition of the electric discharge in the other sub-fields 3-9 is the same.

According to the present embodiment, the voltage of the first regulating pulse 144 is higher than that of the sustaining pulses 41. By using a higher voltage for the first regulating pulse 144, a lot of negative electrically charged particles can be collected, and as a result, a lot of positive electrically charged particles are collected on the address electrode 29 side, thereby address discharging is performed very easily.

A ninth embodiment of the present invention will be described hereinafter. Figs. 18(a) to 18(e) illustrate a driving method in accordance with a ninth embodiment of the present invention. Fig. 18(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields, similar to the case of Fig. 5(a). The horizontal axis illustrates time and the vertical axis illustrates a line of cells. Fig. 18(b)-Fig. 18(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and second independent Y electrodes, respectively.

A pulse wave-form 150 illustrates a part of the

09 FEB 1998

driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 151 illustrates a part of the driving wave-form supplied to one of the address A electrodes 29. Pulse wave-forms 152 and 153 illustrate parts of the driving wave-forms supplied, for example, to first and second independent Y electrodes 23.

The pulse wave-form 150, which is supplied to the common X electrode 22 during the first sub-field, includes an equalizing pulse 153 in the equalizing period 2a, a regulating pulse 154 in the address period 2b and the sustaining pulses 41 and a fine line erasing pulse 155 in the sustaining period 2c.

According to the present embodiment, only one fine line erasing pulse 155 is provided. The equalizing pulse 153 is supplied to the electrode to which the fine line erasing pulse 155 is supplied, such as in the case of the fifth embodiment. In case two or three fine line erasing pulses are provided, as shown in the second and the third embodiment (see Figs. 11(b), 11(d) and Figs. 12(b), 12(d)), the equalizing pulses are supplied to the electrode to which the last fine line erasing pulse is supplied.

The pulse wave-form 151, which is supplied to one of the address A electrodes 29, includes the address pulse 42 in the address period 2b of the first sub-field which corresponds to the light emitting cell. The address pulse 42 is not supplied when there is no cell to be illuminated. The pulse wave-forms 152 and 153, which are supplied to the first electrode of the independent Y electrodes 23 and

09 FEB 1998

adjacent second electrode of the independent Y electrodes 23, include first regulating pulses 156a, 156b,--- in the electrically charged particle equalizing period 2a of the first sub-field, scan pulses 137a, 137b,--- in the address period 2b, and sustaining pulses 45a, 45b,--- in the sustaining period 2c.

In this embodiment, the first regulating pulses 156a, 156b,--- are supplied within 0.3 μ sec to 2 μ sec from the rising edge of the equalizing pulse 153.

The voltage of the second regulating pulse 154 and the scan pulses 137a, 137b,--- can be set to the same voltage as that of the sustaining pulses 41, 45a, 45b,--- as shown in the fifth embodiment (see Fig. 14(b)). A condition of the electrically charged particles after supplying the fine line erasing pulses 46a, 46b,--- is almost the same condition as shown in Fig. 8, which illustrates the condition of the electrically charged particles in accordance with the first embodiment. The condition of electric discharge in the other sub-fields 3-9 is the same.

According to the present embodiment, the first regulating pulses 156a, 156b,--- are similar to the equalizing pulses 43a, 43b,--- as shown in Fig. 15(d) and Fig. 15(e), but an equalizing pulse according to the present invention is a pulse that rises first during the electrically charged particle equalizing period. The reason for providing a 0.3 μ sec to 2 μ sec period between the rising edge of the equalizing pulse 153 and the rising edge of the first regulating pulses 156a, 156b,--- has already

09 FEB 1998

been explained.

Fig. 19 to Fig. 23 are sectional views of the plasma display panel in accordance with the ninth embodiment in which the condition of electrically charged particles in the cell for effecting an electric discharge for light emission are illustrated from the first sub-field after the power is supplied to the second sub-field until the equalizing pulses and the regulating pulses are supplied. In these drawings, reference numeral 60 denotes a positive electrically charged particle, and reference numeral 61 denotes a negative electrically charged particle. Further, the condition of the electrically charged particles is illustrated in a cell at a center position in Fig. 19 through Fig. 23.

Fig. 19 is a sectional view of a plasma display panel in which a condition of electrically charged particles in a cell is illustrated immediately after power is supplied and then an equalizing pulse and regulating pulses are supplied. The figure illustrate the condition of electrically charged particles in a first sub-field after power is supplied at first and then the equalizing pulse 153 is supplied to the common X electrode 22 and finally the first regulating pulses 156a, 156b,--- are supplied. The electric discharge occurs between the common X electrode 22 and the independent Y electrodes 23 by supplying the equalizing pulse 153 to the independent Y electrodes 23 in all cells, so that the negative electrically charged particles 61 are gathered on the

09 FEB 1998

49

dielectric layer in the vicinity of the independent Y electrodes 23a and the common X electrode 22, and the positive electrically charged particles 60 are gathered on the address A electrode 29 side.

Fig. 20 is a sectional view of a plasma display panel in accordance with the ninth embodiment in which a condition of the electrically charged particles in a cell after performing an address electric discharge is illustrated. In Fig. 20, the condition of the electric discharge is illustrated after the address pulse 42 is supplied to the address A electrode 29 and address electric discharges are performed between the address A electrode 29 and the independent Y electrodes 23. The positive electrically charged particles 60 are gathered on the dielectric layer in the vicinity of the independent Y electrode 23 because the voltage of the independent Y electrode 23 is lower than the voltages of the address A electrode 29 and the common X electrode 22. The negative electrically charged particles 61 are gathered on the other electrode side.

The condition of the electrically charged particles is shown in Fig. 20. The sustaining electric discharge is produced between the independent Y electrode 23 and the common X electrode 22 by the positive electrically charged particles 60 and the first pulse of the sustaining pulses 45a, 45b, --- supplied to the independent Y electrode 23. This is a sustain discharge.

Fig. 21 is a sectional view of a plasma display panel

09 FEB 1998

50

in which a condition of electrically charged particles in a cell after supplying a fine line erasing pulse is illustrated. In Fig. 21, the condition of the electric discharge after the last sustaining pulses 45a, 45b, --- are supplied to the independent Y electrode and then the fine line erasing pulses 155 are supplied to the common X electrode 22 is illustrated.

The pulse width of the fine line erasing pulse 155 is longer than the discharge duration time, so that negative electrically charged particles 61, which move so quickly, are gathered on the dielectric layer in the vicinity of the common X electrode 22. The positive electrically charged particles that move slowly in space float in the cell. The negative charges float in the discharge space for a while.

Fig. 22 is a sectional view of a plasma display panel in accordance with the ninth embodiment in which a condition of electrically charged particles in a cell after supplying an equalizing pulse in a second sub-field is illustrated. Fig. 22 illustrates a condition of the electric discharge after the equalizing pulse 153 in the second sub-field is supplied. The voltage of the equalizing pulse 153 is canceled by the negative charged particles 61 and does not reach the discharge voltage, so that no electric discharge occurs.

Fig. 23 is a sectional view of a plasma display panel in which a condition of electric charges in a cell after supplying a regulating pulse in a second sub-field is illustrated. In the figure, the condition of electrically

09 FEB 1998

51

charged particles after the first regulating pulses 156a, 156b,--- are supplied to the independent Y electrodes 23 is illustrated. The negative electrically charged particles 61 are gathered on the dielectric layer in the vicinity of the common X electrode 22 and the independent Y electrodes 23, and the positive electrically charged particles 60 are gathered on the address A electrode 29 side. By this, the same driving as the first sub-field is performed without electric discharge by the equalizing pulses 153.

A tenth embodiment of the present invention will be described hereinafter. Figs. 24(a) to 24(e) illustrate a driving method in accordance with a tenth embodiment of the present invention. Fig. 24(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields, similar to the case of Fig. 18(a). The horizontal axis illustrates time and the vertical axis illustrates a line of cells. Fig. 24(b)-Fig. 24(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and second independent Y electrodes, respectively.

A pulse wave-form 160 illustrates a part of the driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 161 illustrates a part of the driving wave-form supplied to one of the address A electrodes 29. Pulse wave-forms 162 and 163 illustrate parts of the driving wave-forms supplied, for

example, to first and second independent Y electrodes 23.

The pulse wave-form 160, which is supplied to the common X electrode 22 during the first sub-field, includes an equalizing pulse 164 in the equalizing period 2a, a regulating pulse 165, which continues from the equalizing pulse 164 in the equalizing period 2a and continues through the address period 2b, and the sustaining pulses 41 and a fine line erasing pulse 155 in the sustaining period 2c.

According to the present embodiment, only one fine line erasing pulse is provided. The equalizing pulse 164 is supplied to the electrode to which the fine line erasing pulse 155 is supplied as in the first embodiment. In case two or three fine line erasing pulses are provided, as in the second embodiment and the third embodiment (see Fig. 11(b), 11(d) and Fig. 12(b), 12(d)), the equalizing pulse is supplied to the electrode to which the last fine line erasing pulse is supplied. The pulse wave-form 161, which is supplied to one of the address A electrodes 29, includes the address pulse 42 in the address period 2b of the first sub-field which corresponds to the light emitting cell. The address pulses 42 are not supplied when there is no cell to be illuminated. The pulse wave-forms 162 and 163, which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23, includes first regulating pulses 156a, 156b,--- in the electrically charged particle equalizing period 2a of the first sub-field, scan pulses 137a, 137b,---in the address period 2b, and sustaining

pulses 45a, 45b,--- in the sustaining period 2c. In this embodiment, the first regulating pulses 156a, 156b,--- are supplied within 0.3 μ sec to 2 μ sec from the rising edge of the equalizing pulse 164. The voltage of the regulating pulse 165 and the scan pulses 137a, 137b,--- can be set to the same voltage as the sustaining pulses 41, 45a, 45b,--- as shown in the ninth embodiment (see Fig. 18(b)). The other sub-fields 3-9 are constructed the same as the first sub-field.

A condition of the electrically charged particles after supplying the fine line erasing pulses 46a, 46b,--- is almost the same condition as shown in Fig. 8, which illustrates the condition of electrically charged particles in accordance with the first embodiment. The condition of the electric discharge in the other sub-fields 3-9 is the same condition.

According to the present embodiment, the reason for setting the voltage of the equalizing pulse 164 at a higher voltage is to collect the negative electrically charged particles on the common X electrode side, and to collect lots of positive electrically charged particles on the address A electrode 29 side. Further, the reason for setting the voltage of the regulating pulse 165 in the address period 2b is to protect an electric discharge from taking place by mistake between the common X electrode 22 and the independent Y electrode 23.

An eleventh embodiment of the present invention will be described hereinafter. Figs. 25(a) to 25(d) illustrate a

driving system in accordance with an eleventh embodiment of the present invention. Fig. 25(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields, similar to the case of Fig. 5(a). The horizontal axis illustrates time and the vertical axis illustrates line of cells. Fig. 25(b)-Fig. 25(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and second independent Y electrodes, respectively.

A pulse wave-form 170 illustrates a part of the driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 171 illustrates a part of the driving wave-form supplied to the one of the address A electrodes 29. Pulse wave-forms 172 and 173 illustrate parts of the driving wave-forms supplied, for example, to first and second independent Y electrodes 23.

The pulse wave-form 170, which is supplied to the common X electrode 22 during the first sub-field, includes a regulating pulse 40 in the period continuing from the first part of the equalizing period 2a through the address period 2b and the sustaining pulses 41 in the sustaining period 2c. The pulse wave-form 171, which is supplied to one of the address A electrodes 29, includes a voltage holding pulse 174 whose voltage is determined so that a discharge is not produced by the scan pulses 44a, 44b,--- and the address pulse 42 in the first address period 2b

09 FEB 1998

which corresponds to the light emitting cell and between the address electrode 29 and the independent Y electrode 23. The address pulse 42 is not supplied when there is no cell to be illuminated. According to the present embodiment, the voltage needed for the address electric discharging to occur is the sum of the voltage of the voltage holding pulse 174 and the voltage of the address pulse 175, thereby making it possible to reduce the voltage of the address pulse 175. The address pulse 175 is not supplied when there is no cell to be illuminated. The pulse wave-forms 172 and 173, which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23, include equalizing pulses 43a, 43b,--- in the electrically charged particle equalizing period 2a of the first sub-field, scan pulses 44a, 44b,---in the address period 2b, and sustaining pulses 45a, 45b,--- in the sustaining period 2c. The voltage of the regulating pulse 40 and the scan pulses 44a, 44b,--- can be determined to be the same voltage as sustaining pulses 41, 45a, 45b,---.

A condition of the electrically charged particles after supplying the fine line erasing pulses 46a, 46b,---is almost the same condition as shown in Fig. 8, which illustrates the condition of electrically charged particles in accordance with the first embodiment. The condition of the electric discharge in the other sub-fields 3-9 is the same condition.

A twelfth embodiment of the present invention will be

described hereinafter. Figs. 26(a) to 26(e) illustrate a driving method in accordance with a twelfth embodiment of the present invention. Fig. 26(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure illustrates a division of one field into several sub-fields, similar to the case of Fig. 5(a). The horizontal axis illustrates time and the vertical axis illustrates a line of cells. Fig. 26(b)-Fig. 26(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and second independent Y electrodes, respectively.

A pulse wave-form 180 illustrates a part of the driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 181 illustrates a part of the driving wave-form supplied to one of the address A electrodes 29. Pulse wave-forms 182 and 183 illustrate parts of the driving wave-forms supplied, for example, to first and second independent Y electrodes 23.

The pulse wave-form 180, which is supplied to the common X electrode 22 during the first sub-field includes a regulating pulse 184 in the equalizing period 2a and sustaining pulses 41 in the sustaining period 2c. The pulse wave-form 181, which is supplied to one of the address A electrodes 29, includes the address pulse 42 in the address period 2b of the first address period which corresponds to the light emitting cell. The address pulse 42 is not supplied when there is no cell to be illuminated. The pulse

09 FEB 1998

wave-forms 132 and 183, which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23, include equalizing pulses 43a, 43b,--- in the electric charging equalizing period 2a of the first sub-field, scan pulses 137a, 137b,--- in the address period 2b, sustaining pulses 185a, 185b,--- in the address period 2b, and sustaining pulses 45a, 45b,--- and fine line erasing pulses 46a, 46b,--- in the sustaining period 2c. The voltage level of the regulating pulse 184 can be the same as the voltage of the sustaining pulses 41.

A condition of the electrically charged particles after supplying the fine line erasing pulses 46a, 46b,--- is almost the same condition as shown in Fig. 8, which illustrates the condition of electrically charged particles in accordance with the first embodiment. The condition of the electric discharge in the other sub-fields 3-9 is the same condition. According to the present embodiment, the voltage of the scan pulses 185a, 185b,--- is a minus voltage and the voltage of the address pulses 42 is a plus voltage, therefore the voltage differences become so large that the electric discharge is performed surely.

A thirteenth embodiment of the present invention will be described hereinafter. Figs. 27(a) to 27(e) illustrate a driving method in accordance with a thirteenth embodiment of the present invention. Fig. 27(a) is a time chart illustrating an arrangement of sub-fields in one field in accordance with the present invention. The figure

09 FEB 1998

illustrates a division of one field into several sub-fields, similar to the case of Fig. 18(a). The horizontal axis illustrates time and the vertical axis illustrates a line of cells. Fig. 27(b)-Fig. 27(e) illustrate wave-forms of pulses supplied to the common X electrode, the address A electrode, and the first and second independent Y electrodes, respectively.

A pulse wave-form 190 illustrates a part of the driving wave-form supplied to the common X electrode 22 in the first sub-field. A pulse wave-form 191 illustrates a part of the driving wave-form supplied to one of the address A electrodes 29. Pulse wave-forms 192 and 193 illustrate parts of the driving wave-forms supplied, for example, to first and second independent Y electrodes 23.

The wave-form 190, which is supplied to the common X electrode 22 during the eighth sub-field, and the field blank period 9d thereafter includes a regulating pulse 40 from the first part of the electric charge particle equalizing period 2a through the address period 2b, sustaining pulses 41 and a full writing pulse 194 in the sustaining period 2c. In this embodiment, the voltage of the full writing pulse 194 is high enough to produce a discharge regardless of whether a sustaining discharge occurs or not. As a result, the electrically charged particles in all cells are equalized. The field blank period 9d can be provided between the sub-fields. And also, the field blank period 9d can be provided several times in one field. The pulse waveform 191, which is supplied to one

09 FEB 1998

59

of the address A electrodes 29, includes the address pulse 42 in the address period 2b. The address pulse 42 is not supplied when there is no cell to be illuminated. The pulse wave-forms 192 and 193, which are supplied to the first electrode of the independent Y electrodes 23 and adjacent second electrode of the independent Y electrodes 23, include the equalizing pulses 43a, 43b,--- in the electric charging equalizing period 2a, the scan pulses 44a, 44b,--- in the address period 2b, the sustaining pulses 45a, 45b,--- in the sustaining period 2c, and fine line erasing pulses 195a, 195b,--- in the field blank period 9d. The voltage level of the regulating pulse 40 and the scan pulses 44a, 44b,--- can be the same as the voltage of the sustaining pulses 41. A condition of the electrically charged particles after supplying the fine line erasing pulses 195a, 195b,--- is almost the same condition as shown in Fig. 8, which illustrates the condition of electrically charged particles in accordance with the first embodiment. The condition of the electric discharge in the other sub-fields 3-9 is the same condition.

According to the present embodiment, no electrically charged particle remain in the cells when a black portion continues across several sub-fields, and so the address electric discharges are not performed well in the coming address period. To prevent this situation, discharges are forced by the field full writing pulse 194 between the common X electrode 22 and the independent Y electrode 23.

As explained above, the plasma display driving system

09 FEB 1998

in accordance with the first through the twelfth embodiments can drive the panel without using the full writing electric discharge and erasing discharge for all the cells for equalizing the electrically charged particles.

Still other embodiments of the present invention will be explained hereinafter.

Figs. 28(a) to 28(g) illustrate a driving method for a plasma display panel in accordance with a fourteenth embodiment of the present invention. Fig. 28(a) is a time chart illustrating an arrangement of sub-fields in the first sub-field. The horizontal axis illustrates time, and the vertical axis illustrates a line of cells. Fig. 28(b)-Fig. 28(g) are wave-forms illustrating pulse wave-forms supplied to a common X electrode, an address A electrode and four independent Y electrodes, respectively. In the figure, reference numeral 201 denotes a field, reference numerals 202-203 denote sub-fields, reference numerals 202a-209a denote address periods, reference numerals 202b-209b denote sustaining periods, reference numerals 210-213 denote field blocks, and reference numerals 210a-213a denote full writing periods. A wave-form 220 is a driving wave-form supplied to the common X electrode. A wave-form 221 is a driving wave-form supplied to the address A electrode 29. The wave-forms 222-225 are driving wave-forms supplied to first, second, third and fourth electrodes of the independent Y electrodes 23, respectively.

In Fig. 28(a), one field period 201 is divided into eight sub-fields 202-209, and one field block is formed by two successive sub-fields, therefore one field period 201 is constructed of four field blocks.

In each field block, the full writing periods 210a, 211a, 212a and 213a, which are arranged as the first period of sub-fields, are provided in each first sub-field 202, 204, 206 and 208 of the field blocks 210-213, and following the writing period 210a-213a, the address periods 202a, 204a, 206a and 208a and sustaining periods 202b, 204b, 206b and 208b are provided, respectively. In the second sub-fields 203, 205, 207 and 209, which follow the first sub-fields 202-208, the address periods 203a, 205a, 207a and 209a are provided first, and then the sustaining periods 203b, 205b, 207b and 209b are provided, respectively.

The numbers of light emissions are allotted for each sustaining period 202b-209b, and display graduations are effected by the combinations of the numbers of the light emissions. The numbers of light emissions and the order of the sub-fields are optional. In this embodiment, the numbers of light emissions of the sustaining periods 202b, 204b, 206b, 208b, 203b, 205b, 207b and 209b are arranged in this order from few numbers. The sustaining periods 202b, 204b, 206b and 208b just before the sub-fields 203, 205, 207 and 209 in which a full writing erase period is not provided have fewer numbers of light emissions.

Fig. 28(b) illustrates the field block 210, and the

other field blocks are constructed similarly. The driving wave-form 220 supplied to the common X electrode 22 includes in the first sub-field 202 a full writing pulse 240 and a polarizing pulse 241 in the first full writing erasing period 210a, a high pulse 242 in the succeeding address period 202a and sustaining pulses 243 and an electrically charged particle control pulse 244 and a fine line erasing pulse 245 in the succeeding sustaining period 202b, and further includes in the succeeding sub-field a high pulse 246 and sustaining pulses 247.

The voltage level of the electrically charged particle control pulse 244 and the fine line erasing pulse 245 is the same as or less than the voltage level of the sustaining pulses 243. Next to the sustaining pulses 247 is the field block 211. The voltage of the full writing pulse 240 is stepped up a level. The voltage is usually determined to be about 300 volts, and the reason for stepping up the level thereof is to allow the circuit to be constructed simply, therefore the stepping up the voltage of the full writing pulse 240 is not always necessary.

The driving wave-form 221 supplied to the address A electrode 29 shown in Fig. 28(c) includes, in the first sub-field, a plurality of the address pulses 248a, 248b,--- which relates to the cells to be illuminated in the address period 202a, and, in the succeeding sub-field 203, a plurality of address pulses 249a, 249b,--- in the address period 203a.

Fig. 28(d)-28(g) show wave-forms 222, 223, 224 and 225

supplied to four independent Y electrodes 23 whose electrodes 23 are arranged side by side, and these waveforms include, in the first sub-field 202, scan pulses 250a, 250b, 250c, 250d,--- in the address period 202a, sustaining pulses 251a, 251b, 251c, 251d,---, selection electric discharge pulses 252a, 252b, 252c, 252d---, fine line erasing pulses 253a, 253b, 253c, 253d,--- in the sustaining period 222b and, in the succeeding sub-field 203, scan pulses 254a, 254b, 254c, 254d,---, in the address period 203a, and sustaining pulses 255a, 255b, 255c, 255d,-- in the sustaining period 203b.

The voltage level of the selection electric discharge pulses 252a, 252b, 252c, 252d,--- is almost the same as the voltage level of the electrically charged particle control pulse 244, which rises with a time lag from the rising edge of the selection electric discharge pulses 252a, 252b, 252c, 252d,---, the delay time t_1 being 0.1 μ sec-1.5 μ sec. The electrically charged particle control pulse 244 falls earlier than the selection electric discharge pulses 252a, 252b, 252c, 252d,---. The time t_2 is about 0.1 μ sec-1.0 sec. The reason for setting the time lag from the rising edge of the selection electric discharge pulses 252a-252d to the rising edge of the electrically charged particle control pulse 244 as above mentioned is that, if the time longer than that is set, a lot of negative electrically charged particles gather on the independent Y electrode 23 side, and a few negative electrically charged particles gather on the common X electrode 22 side. Further, the

reason for starting the selection electric discharge pulses 252a-252d a little earlier than the electrically charged particle control pulse 244 is to produce an electric discharge by generating a selection electric discharge between the common X electrode 22 and independent Y electrode 23. The reason for ending the electrically charged particle control pulse 244 is to defend the electric charge between the common X electrode 22 and the independent Y electrode 23 when the selection electric discharge pulses 252a-252d fall.

The selection electric discharge pulses 252a, 252b, 252c, 252d,---, the fine line erasing pulses 253a, 253b, 253c, 253d,--- and the electrically charged particle control pulse 244 are not provided in the succeeded sub-field 203 of the field block 210 of Fig. 28(a).

The sustaining pulses of the sub-field 203 terminate with the sustaining pulses 255a, 255b, 255c, 255d,--- supplied to the independent Y electrodes 23. The same driving wave-forms are used in the other field blocks 211-213, but the numbers of the sustaining pulses are different. The selection electric discharge pulses, the electrically charged particle control pulse and the fine line erasing pulses are provided in the first sub-field 204, 206, 208 of the field blocks 210-213.

The operation of this embodiment will be explained with reference to Fig. 29-Fig. 32. The electric discharges occur in all the cells in response to the full writing pulse 240 supplied to the common X electrode 22 in the

field block 210 of Fig. 28(a)-Fig. 28(b), and so the electrically charged particles are formed. Under these circumstances, the negative electrically charged particles 61 are gathered on the address A electrode 29 side. The electric discharge for polarization occurs in response to the polarization pulse 241, and electrically charged particles on the common X electrode 22 side and the independent Y electrode 23 side are polarized.

The scan pulses 250a of the wave-form 222 are supplied to the first line of the independent Y electrode 23, and at the same time, the address pulses 248a are supplied to a predetermined address A electrode 29 in the succeeded address period 202a, thereby generating a full writing electric discharge and forming electrically charged particles in the cell positioned at the cross point of the first line of the independent Y electrode 23 and the address A electrode 29, so that positive electrically charged particles are gathered on the independent Y electrode 23 side in the cell.

In a similar way, when the scan pulses 250c of the driving wave-form 224 are supplied to the third independent Y electrode 23 and the address pulse 248b is supplied to a predetermined address A electrode 29, thereby generating a full writing electric discharge and forming electrically charged particles in the cell positioned at the cross point of the third line of the independent Y electrode 23 and the address A electrode 29, positive electrically charged particles 60 are gathered on the independent Y electrode 23

side in the cell.

The address pulses which correspond to the scan pulses 250b, 250d of the driving wave-form 223, 225 supplied to the second and the fourth independent Y electrodes 23 are not supplied when the predetermined cells are not illuminated, therefore, writing electric discharges do not occur and electrically charged particles are not formed on the independent Y electrode 23 side.

The sustaining discharge or light emitting discharge in the sustaining period 202b occurs in response to the sustaining pulses 234 of the driving wave-form 220 and the sustaining pulses 251a, 251b, 251c, 251d,---, of the driving wave-forms 222, 223, 224, 225 in the cell in which the positive electrically charged particles are gathered on the independent Y electrode 23 side.

The optional or selecting electric discharges occur in response to the selection electric discharge pulses 252a, 252b, 252c and 252d in the cell in which a sufficient number of electrically charged particles are formed by the electric discharge for light emission. The positive electrically charged particles 60 are gathered on the address A electrode 29 side by supplying electrically charged particle control pulse 244 to the common X electrode 22 before the electric discharges by the selection electric discharge pulses 252a, 252b, 252c, 252d,---, cease.

After that, the erasing electric discharge is caused by the fine line erasing pulse 245 of the waveform 220

09 FEB 1998

supplied to the common X electrode 22 and the fine line erasing pulses 253a, 253b, 253c, 253d,---, of the wave-form 222 supplied to the independent Y electrode 23, so that the electrically charged particles on the common X electrode 22 side and on the independent Y electrode 23 side are mainly erased. Thereby, the condition of the electrically charged particles in all cells in which electric discharges are produced is almost the same as the condition of the electrically charged particles after the full writing erasing period 210a is finished.

On the other hand, the writing electric discharges or the address electric discharges are not generated in the cells in which the electric discharges for light emission are not produced, and the condition of electrically charged particles is the same condition after the full writing erasing period 210a is finished.

As explained above, the electrically charged particles in all cells at a point of time after the final erasing pulses 245, 253a, 253b, 253c, 253d,---, are supplied in the first sub-field 202 can be made to have the same condition after the full writing erasing period 210a is finished. By this, in the succeeding sub-field, address electric discharges in all of the cells can be produced without providing a full writing erasing period.

The same functions are repeated in the field blocks 211-213, whereby a screen of one field is formed.

Fig. 29-Fig. 32 are sectional views of a plasma display panel illustrating a condition of the electrically

09 FEB 1998

charged particles in a cell in which a sustaining discharge is performed. The condition of the electrically charged particles in the drawings is illustrated in a center cell of three cells.

Fig. 29 is a sectional view of the plasma display panel in which a condition of the electrically charged particles in a cell after supplying sustaining pulses is illustrated in accordance with the embodiment shown in Fig. 28(a)-28(g) of the present invention. The negative electrically charged particles 61 are gathered on the dielectric layer 26 of the common X electrode 22 side and the positive electrically charged particles 60 are gathered on the dielectric layer 26 of the independent Y electrode 23 side after a final pulse of the sustaining pulses 243 is supplied to the common X electrode 22.

Fig. 30 is a sectional view of the plasma display panel in which a condition of the electrically charged particles in a cell during discharging by a selection electric discharge pulse is illustrated. Electric discharges are caused by the voltage of the selection electric discharge pulses 252a, 252b, 252c, 252d,--- and the voltage of positive electrically charged particles gathered on the dielectric layer at the independent Y electrode 23, and these discharges are produced between the independent Y electrode 23 and the common X electrode 22 when selection electric discharge pulses 252a, 252b, 252c, 252d,---, are supplied to the independent Y electrode. Thereby, many positive and negative electrically charged

particles are generated in the discharging space.

Fig. 31 is a sectional view of the plasma display panel in which a condition of the electrically charged particles in a cell when electric charge particle control pulse is supplied is illustrated. The positive electrically charged particles are gathered on the address A electrode 29 when the electrically charged particle control pulse 244 is supplied to the common X electrode 22, because the voltages of the common X electrode 22 and the independent Y electrode 23 are almost the same and these voltages are higher than the voltage of address A electrode 29. Erasing of electrically charged particles by the erase pulse is still needed because there still remains electrically charged particles on the common X electrode 22 side, on the independent Y electrode 23 side and in the discharging space, which are not neutralized and not erased.

Fig. 32 is a sectional view of the plasma display panel in which a condition of the electrically charged particles in a cell after supplying a fine line erasing pulse is illustrated. The positive electrically charged particles 60 are gathered on the address A electrode 29 side and the negative electrically charged particles 61 are gathered on the common X electrode 22 side and the independent Y electrode 23 side. The condition of the electrically charged particles is the same after the full writing erase period 210a is finished.

A condition of the electrically charged particles after the full writing erasing period 210a is finished is

09 FEB 1998

maintained in the sustaining period 202b because address electric discharges are not generated in the cells in which no sustaining electric discharge is performed. Also, no electric discharge is performed by the selection electric discharge pulses 252a, 252b, 252c, 252d,---, and there is no change in the condition of the electrically charged particles even if the electrically charged particle control pulse 244 and erasing pulse are supplied. Therefore, the condition of the electrically charged particles in all cells is almost same as the condition after the full writing erasing period 210a and the address electric discharge or a writing electric discharge is produced in the next sub-field 203, thereby increasing the contrast by double.

By increasing the voltage of the address pulses 249a and 249b in the sub-fields 203, 205, 207, 209 in which the full writing erasing period is not carried out, compared with the voltage of the address pulses 249a and 249b in the other sub-fields 202, 204, 206 and 208, the address electric discharges are caused surely even in a cell in which sustaining electric discharges are not performed, because the positive electrically charged particles 60 on the address A electrode 29 side are reduced gradually by neutralization.

Fig. 33 is a time chart of sub-fields illustrating a driving method in accordance with a fifteenth embodiment of the present invention. Referring to the drawing, the horizontal axis illustrates time, and the vertical axis

illustrates lines of cells. Reference numeral 270 denotes one field period, 271-276 denote sub-fields, 271a-276a denote address periods, 271b-276b denote sustaining periods, 277 and 278 denote field blocks, and 277a and 278a denote full writing erasing periods.

One field period 270 is divided into six sub-fields 271-276, and the consecutive first three sub-fields 271-273 form the field block 277, while the succeeding consecutive three sub-fields 274-276 form the other field block 278.

In the first period of the field blocks 277 and 278, full writing erasing periods 277a and 278a are arranged, respectively. In each sub-field 271-276, the address periods 271a-276a and the sustaining periods 271b-276b are provided, but the full writing erasing periods 277a and 278a are not provided. That is, the full writing erasing periods 277a and 278a are arranged at the first part of the first sub-fields 271 and 274 of the field blocks 277 and 278, respectively. The numbers of light emissions are allotted for the sustaining periods 271b-276b, and gradations of display are produced by combining the numbers of light emissions. According to this fifteenth embodiment, the numbers of the light emissions are increased in the order of the sub-fields 271, 272, 273.

Referring to Figs. 28(b) to 28(g), the selection electric discharge pulses 252a-252d, the electrically charged particle control pulse 244 and fine line erasing pulses 245, 253a-253b, which are used in the fourteenth embodiment, are provided in the first two sub-fields 271,

09 FEB 1998

272, 274, 275 of the field blocks 277 and 278, and these pulses are not provided in the other (last) sub-field. Further, these selection electric discharge pulses, the electrically charged particle control pulse and the fine line erasing pulses are arranged in the last part of the sustaining period 271b, 272b, 274b and 275b, thereby the condition of electrically charged particles in all cells after the sustaining periods 271b, 272b, 274b and 275b are finished is maintained in the same condition after the full writing erasing period 277a is finished, so that the full writing erasing period 210a can be deleted in the sub-fields 272, 273, 275 and 276, although it is provided in the first sub-fields 271 and 274, and the address electric discharges are produced in the address periods 272a, 273a, 275a and 276a without supplying the selection electric discharge pulses 252a-252d and electrically charged particle control pulse 244 in the last sub-field. Therefore, the contrast is multiplied by three.

Fig. 34 is a time chart of sub-fields illustrating a driving method in accordance with a sixteenth embodiment of the present invention. Referring to the drawing, the horizontal axis illustrates time, and the vertical axis illustrates a line of cells. Reference numeral 280 denotes one field period, 281-286 denote sub-fields, 281a-288a denote address periods, 281b-288b denote sustaining periods, 289 and 290 denote field blocks, and 289a and 290a denote full writing erasing periods.

One field period 280 is divided into eight sub-fields

09 FEB 1998

281-288, and the consecutive first four sub-fields 281-284 form the field block 289, while the succeeding consecutive four sub-fields 285-288 form the other field block 290.

The first period of these field blocks 289 and 290 include the full writing erasing periods 289a and 290a, respectively, and the address periods 281a-288a and the sustaining periods 281b-288b are arranged in each sub-field 281-288, respectively. That is, the full writing erasing periods 289a and 290a are arranged at the first part of the first sub-fields 281 and 285 of the field blocks 289 and 290, respectively. The numbers of the light emissions are allotted for the sustaining periods 281b-288b, and gradations of display are performed by combining the numbers of the light emissions. According to the sixteenth embodiment, the numbers of the light emissions are increased in order of the sub-fields 281, 282, 283,---.

Referring to Figs. 28(b) to 28(g), the selection electric discharge pulses 252a-252d, the electrically charged particle control pulse 244 and the fine line erasing pulses 245, 253a-253b, which are used in the fourteenth embodiment, are provided in the sustaining periods 281b, 282b, 283b, 285b, 286b and 287b of the first three sub-fields 281, 282, 284, 285, 286 and 287b in the field blocks 287 and 290, and these pulses are not provided in the other (last) sub-field.

The condition of the electrically charged particles in all cells after the sustaining periods 281b, 282b and 283b of the sub-fields 281, 282 and 283 in the field block 289

09 FEB 1998

and sustaining periods 285b, 286b and 287b of the sub-fields 285, 286 and 287 in the field block 290 are finished is maintained in the same condition after the full writing erasing period 289a is finished, so that the full writing erasing periods 210a can be deleted in the three sub-fields 282, 283, 284, 286, 287 and 288, although they are retained in the first sub-fields 281 and 285, and the address electric discharges are produced in the address periods 282a, 283a, 284a, 286a, 287a and 288a without supplying the selection electric discharge pulses 252a-252d and the electrically charged particle control pulse 244 in the last sub-field. Therefore, the contrast is multiplied by four.

Fig. 35 is a time chart of sub-fields illustrating a driving method in accordance with a seventeenth embodiment of the present invention. Referring to the drawing, the horizontal axis illustrates time, and the vertical axis illustrates a line of cells. Reference numeral 300 denotes one field period, 301-308 denote sub-fields, 301a-308a denote address periods, 301b-308b denote sustaining periods, 309 denotes a field block, and 309a denotes a full writing erasing period.

One field period 300 is divided into eight sub-fields 301-308, and the field block 309 is formed by all the sub-fields 301-308 in the one field. The first period of this field block 309 includes the full writing erasing period 309a. The address periods 301a-308a and the following sustaining periods 301b-308b are arranged in each sub-field 301-308, respectively. That is, the full writing

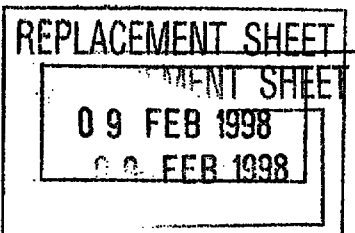
erasing period 309a are arranged at the first part of the first sub-field 301. The numbers of the light emissions are allotted for the sustaining periods 301b-308b and gradations of display are performed by combining the numbers of the light emissions.

Referring to Figs. 28(b) to 28(g), the selection electric discharge pulses 252a-252d, the electrically charged particle control pulses 244 and the fine line erasing pulses 245, 253a-253b, which are used in the fourteenth embodiment, are provided in the sustaining periods 301b-307b of the first seven sub-fields 301-307, and the full writing erasing period 309a is arranged only in the first sub-field 301. The address electric discharges in the address periods 302a-308a are possible, even if the full writing erasing periods 309a in the sub-fields 302-308 which follow the first sub-field 301 are deleted. Thereby the contrast is multiplied by eight.

According to the invention, by deleting the full writing erasing period in some sub-fields, the contrast is improved. The practical contrast of a cathode ray tube display is , for example, 150:1, and in the plasma display according to the embodiments shown in Fig. 33 or Fig. 34, a corresponding contrast is accomplished.

The numbers of sub-fields in one field and the numbers of the sub-fields in one field block are optional and not limited to the above mentioned embodiments, and so any combination will be applicable.

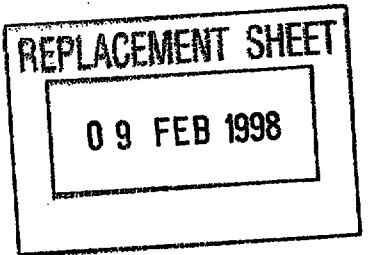
According to the present invention, full writing



electric discharge and erasing electric discharge are deleted or reduced, thereby improving the contrast of the display.

According to the present invention, a full writing erasing period can be arranged one time per several sub-fields, thereby improving the contrast.

While we have shown and described several embodiments in accordance with the present invention, it is understood that the invention is not limited thereto, but is susceptible of numerous changes and modifications as known to those skilled in the art, and we therefore do not wish to be limited to the details shown and described herein, but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.



WHAT IS CLAIMED IS :

1. A plasma display panel driving method for a display panel having a plurality of electrodes forming cells, including a first electrode group arranged on a permeable substrate and being capable of being driven in common, a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of being driven independently, a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of being driven independently, said driving method comprising the steps of:
supplying a voltage so as to produce an electric discharge in a cell in which an electric discharge was performed beforehand; and
supplying another voltage without causing any electric discharge.

2. A plasma display panel driving apparatus for a display panel having a plurality of cells, comprising:

a first electrode group arranged on a permeable substrate and being capable of being driven in common;

a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of being driven independently;

a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of being driven independently; and





09 FEB 1998

means for supplying a voltage so as to produce an electric discharge in a cell in which an electric discharge was performed beforehand, and means for supplying other voltages without causing any electric discharge.

3. A plasma display having a plurality of cells,
comprising:

a first electrode group arranged on a permeable substrate
and being capable of being driven in common;

a second electrode group arranged in parallel with said
first electrode group on said permeable substrate and being
capable of being driven independently;

a third electrode group arranged perpendicular to said
first and second electrode groups on another substrate and
being capable of being driven independently; and

means for supplying a voltage so as to occur electric discharge in a cell to which the electric discharge was performed beforehand, and means for supplying other voltage without causing any electric discharge, thereby improving linearity of display gradation.



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09 FEB 1998

4. A plasma display panel driving method for a display panel having a plurality of electrodes forming cells, including first electrode group arranged on a permeable substrate and being capable of being driven in common, a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of being driven independently, a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of being driven independently, equalizing means for equalizing electrically charged particles in all cells by producing a discharge between said first electrode group and said second electrode group, address electric discharge means for determining a cell to be illuminated by producing a discharge between said second and said third electrode groups, and sustaining electric discharge means for performing light emission by producing an electric discharge between said first and said second electrode groups, said driving method comprising the steps of: generating a discharge using a fine line erasing pulse supplied after a sustaining electric discharge is finished to erase and polarize electrically charged particles in a cell in which a sustaining electric discharge has been carried out;

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09 FEB 1998

gathering said electrically charged
 particles present in all cells due to said
 electric discharge caused by the fine line erasing pulse, and
 canceling the voltage of an equalizing pulse supplied to
 one of said first and said second electrode groups by said
electrically charged particles resulting in
 no discharge;

polarizing said electrically charged
 particles into positive electrically
charged particles and negative
electrically charged particles;
 supplying a regulating pulse to the other
 of said first and said second electrode groups after
 supplying said equalizing pulse to said one of said first and
 said second electrode groups, for gathering
one polarity of electrically charged particles which
were gathered on said one of said electrode groups supplied
 with said equalizing pulse ; and
 gathering electrically
charged particles having the other polarity on said third
 electrode group.

5. A plasma display panel driving
method for a display panel having a plurality of electrodes
forming cells, including first electrode group arranged on a
 first substrate and being capable of being driven in
 common, a second electrode group arranged in parallel with





09 FEB 1998

said first electrode group on said first substrate and being capable of being driven independently, a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate and being capable of being driven independently, said driving method comprising the steps of:

generating a sustaining electric discharge by supplying a sustaining pulse to said first and said second electrode groups i

polarizing electrically charged particles in a cell by supplying a fine line erasing pulse to one of said first and said second electrode groups

i
gathering electrically charged particles having one of the polarities in the vicinity of said first and said second electrode groups i

gathering said electrically charged particles having the other polarity in the vicinity of said third electrode group by supplying a equalizing pulse to said one of electrode groups; i and

supplying a regulating pulse rising later than said equalizing pulse to the other electrode group of said first and said second electrode groups without producing an electric discharge.

6. A plasma panel display driving method according to the claim 4 or 5, further comprising the



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09 FEB 1998

82

steps of producing an electric discharge between said first electrode group and said second electrode group by supplying said equalizing pulse to said one of the electrode groups after supplying power, and gathering electrically charged particles having one of the polarities in the vicinity of said first and said second electrode groups and gathering electrically charged particles having the other polarity in the vicinity of said third electrode group by supplying said regulating pulse after said equalizing pulse is supplied.

7. A plasma display panel driving method according to claim 4 or 5, further comprising the steps of producing an address electric discharge between said second electrode group and said third electric group after gathering electrically charged particles having one of the polarities in the vicinity of the said first and said second electrode groups and gathering electrically charged particles having the other polarity in the vicinity of said third electrode group, and performing a sustaining electric discharge.

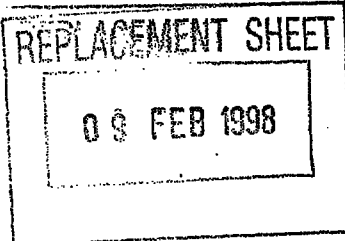
8. A plasma display panel driving method according to claim 4 or 5, further comprising the step of supplying said regulating pulse to said other electrode group within 0.3 μ sec-2 μ sec after supplying said equalizing pulse to said one of said electrode groups.

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83



9. A plasma display panel driving method according to claim 4 or 5, further comprising the step of providing several fine line erasing pulses including a first fine line erasing pulse whose pulse width is within 0.5 μ sec-2 μ sec and at least a second fine line erasing pulse whose pulse width is equal to or less than said first pulse width for performing erasing and polarization of said electrically charged particles.

10. A plasma display panel driving method according to claim 4 or 5 further, comprising the steps of supplying said equalizing pulse to said second electrode group, and maintaining the supply of said regulating pulse to said first electrode group until selecting cells to be illuminated for gathering electrically charged particles to a predetermined electrode group.

11. A plasma display panel driving method according to claim 4 or 5, further comprising the step of dividing said regulating pulse into a first pulse for equalizing electrically charged particles in all cells and a second regulating pulse supplied during a period for selecting cells to be illuminated.

12. A plasma display panel driving method according to claim 4 or 5, further comprising the step





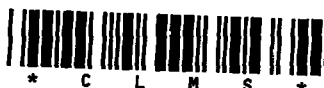
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of setting the voltage of said regulating pulse to be substantially equal to the voltage of said sustaining pulse for performing display electric discharge.

13. A plasma display panel driving method according to claim 11, further comprising the step of setting the falling edge of said equalizing pulse after the falling edge of said first regulating pulse by within 1 μ sec.

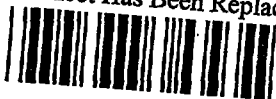
14. A plasma display panel driving method according to claim 4 or 5, further comprising the steps of performing a discharge in all cells by supplying full electric discharge pulse to one of said first and said second electrode groups one or several times per one field or several fields after performing a sustaining discharge, and then supplying said fine line erasing pulse for performing a discharge in all cells for erasing electrically charged particles so as to gather electrically charged particles having the positive and negative polarities in the vicinity of said first and said second electrode groups, respectively.

15. A plasma display panel driving method according to claim 4 or 5, further comprising the steps of supplying a plurality of fine line erasing pulses to said first and second electrode groups alternatively, and shortening the pulse width of said fine line erasing pulses which are supplied afterward, and supplying the last fine line erasing pulse to said one electrode group.

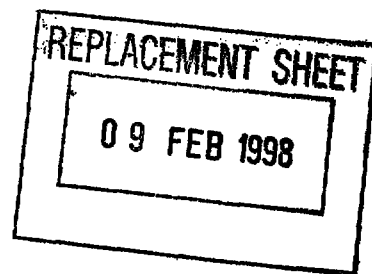


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85



16. A plasma display panel driving method according to claim 4 or 5, further comprising the step of supplying said equalizing pulse to said one electrode group, and setting the falling edge of said equalizing pulse : to a time more than 1 μ sec.

17. A plasma display panel driving circuit comprising:

a first electrode group arranged on a first substrate and driven in common;

a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate facing said first substrate and controlled independently;

a first driving circuit connected to said first electrode group for supplying a first driving pulse;

a second driving circuit connected to said second electrode group for supplying a second driving pulse;

a third driving circuit connected to said third electrode group for supplying an address driving pulse;

means for supplying a fine line erasing pulse to one of
said first and second electrode



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69 FEB 1998

groups from said driving circuit connected to said
electrode group after sustaining discharging;
means for supplying : the equalizing pulse to said one
electrode group from said driving circuit connected
to said one electrode group;
means for supplying a regulating pulse,
which is delayed from the rising edge of said equalizing pulse
to the other electrode group of said first and said second
electrode groups from said driving circuit connected said
other electrode group, and for gathering
electrically charged particles having one of opposite
polarities in the vicinity of said first and said second
electrode groups and for gathering
electrically charged particles having the other polarity in
the vicinity of said third electrode group.

18 A plasma display panel driving circuit
according to claim 17, further comprising means for
supplying said regulating pulse to said other electrode
group within 0.3 μ sec-2 μ sec after supplying said
equalizing pulse to said one of said electrode groups.



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09 FEB 1998

19. A plasma display panel driving circuit according to claim 17 or 18, further comprising means for generating a plurality of fine line erasing pulses from said first and said second driving circuits, the pulse width of a first fine line erasing pulse being within 0.5 μ sec-2 μ sec and the pulse width of a second fine line erasing pulse being equal to or shorter than said first fine said line erasing pulse.

20. A plasma display panel driving circuit according to claim 17, 18 or 19, further comprising means for supplying from said second driving circuit said equalizing pulse to said second electrode group and for supplying said regulating pulse from said first driving circuit to said first electrode group during the addressing of cells to be illuminated.

21. A plasma display panel driving circuit according to claim 17, 18 or 19, further comprising means for generating first and second regulating pulses from said driving circuit connected to said one electrode group.

22. A plasma display panel driving circuit according to claim 17, further comprising means for setting the voltage of said regulating pulse to be substantially identical with the voltage of said sustaining pulse.

23. A plasma display panel driving circuit according to claim 17, 18 or 20, further comprising means for setting the falling edge of said equalizing pulse after lapse of time of more than 1 μ sec by said driving circuit connected to said one electrode group.



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88

REPLACEMENT SHEET

09 FEB 1998

24. A plasma display panel driving circuit according to claim 17, further comprising means for supplying, after performing sustaining discharge, a full writing electric discharge pulse one time or several times per one field or several fields generated from, the one driving circuit of said first and said second driving circuits which is connected to said one electrode group.

25. A plasma display panel driving circuit according to claim 21, further comprising means for setting the falling edge of said equalizing pulse after the falling edge of said first regulating pulse by within 1 μ sec.

26. A plasma display comprising:
a first electrode group arranged on a first substrate and driven in common;



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89

REPLACEMENT SHEET

09 FEB 1998

a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate facing said first substrate and controlled independently;

a plurality of cells constructed at the cross points of said first and said second and said third electrode groups;

means for performing an electric discharge for erasing and polarizing electrically charged particles in cells performed a sustaining discharging during a period after sustaining discharging and just before the beginning of an address period; and

means for equalizing electrically charged particles in all cells by said discharge for erasing and polarizing.

27. A plasma display comprising:

a first electrode group arranged on a first substrate and driven in common;

a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate



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09 FEB 1998

facing said first substrate and controlled independently;

a plurality of cells constructed at the cross points of said first and said second and said third electrode groups;

means for generating a discharge using a fine line erasing pulse supplied to one of the electrodes of said first and said second electrode groups after a sustaining discharge and for erasing and polarizing electrically charged particles generated in cells by said sustaining discharge;

means for gathering electrically charged particles having one of opposite polarities in the vicinity of said first and said second electrode groups and for gathering electrically charged particles having the other one of the polarities in the vicinity of said third electrode group by supplying an equalizing pulse to said one of the electrodes and by supplying a regulating pulse to the other of said first and said second electrode groups so as to be able to produce a discharge for addressing which determines light emitting cells by said third electrode group.

28. A plasma display according to claim 27, further comprising means for supplying said regulating pulse to said other electrode group within 0.3 μ sec-2 μ sec after supplying said equalizing pulse to said one of said electrode

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09 FEB 1998

groups for collecting electrically charged particles having one of said polarities in the vicinity of said first and said second electrode groups and electrically charged particles having the other one of said polarities in the vicinity of said third electrode group.

29. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, means for generating a plurality of said fine line erasing pulses including a first fine line erasing pulse having pulse a width within 0.5 μ sec-2 μ sec and a second fine line erasing pulse having a pulse width equal to or less than said second fine line erasing pulse, and means for erasing and polarizing electrically charged particles by supplying a last pulse of said fine line erasing pulses to said one of said first and second electrode groups.

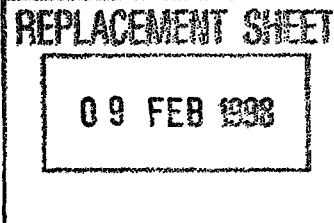
30. A plasma display according to claim 29, further comprising means for supplying from said second driving circuit said equalizing pulse to said second electrode group and for maintaining supply of said regulating pulse supplied from said first driving circuit to said first electrode group during addressing of



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92



cells to be illuminating.

31. A plasma display according to claim 29, further comprising means for generating from one of said first driving circuit connected said first electrode group and said second driving circuit connected to said second electrode group first and second regulating pulses.

32. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, and means for setting the voltage of said regulating pulse to be substantially identical with the voltage of said sustaining pulse by means of one of said first and said second driving circuits.

33. A plasma display according to claim 27, further comprising a driving circuit connected one of said first and said second electrode groups, and means for setting the falling edge of said equalizing pulse after a lapse of time of more than 1 μ sec by said driving circuit connected to said one electrode group.

34. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, and means for generating a full writing pulse one time or several times per one field or several fields from one

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09 FEB 1998

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93



said first and said second driving circuits and for performing a discharge in all cells after sustaining discharge is finished.

35. A plasma display panel driving method comprising the steps of:
dividing one field into several sub-fields and providing an address period for setting cells to be illuminated and a sustaining period for light emission; and
forming a field block
with a plurality of sub-fields and arranging a full writing electric discharge and a full erasing electric discharge in a first sub-field of said field block.

36. A plasma display panel driving method according to claim 35, further comprising the step of performing discharge in selected cells in which light emission is performed by said sustaining electric discharge in said sub-fields of said sub-field block, except for the last sub-field of said sub-field, thereby keeping the

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09 FEB 1998

condition of electrically charged particles
almost the same after performing full writing
electric discharge and full erasing electric discharge.

37.. A plasma display panel driving
method according to claim 35, wherein a plasma display
panel has a first electrode group covered with a
dielectric layer and arranged on a first glass substrate and
driven in common, a second electrode group covered with a
dielectric layer arranged parallel to said first electrode
group on said first glass substrate and controlled
independently, a third electrode group covered with a
dielectric layer and arranged perpendicular to said first and
said second electrode groups on a second glass substrate
facing said first substrate and controlled
independently, and said driving method further
comprising the step of performing discharge in selected cells
in which light emission is to be performed by said
sustaining electric discharge in said sub-fields of said
sub-field block, except for the last sub-field of said
sub-field, thereby gathering positive
electrically charged particles on said dielectric layer
covering said third electrode group and gathering negative
electrically charged particles on said
dielectric layer covering said first and said second electrode
groups for leaving the condition of



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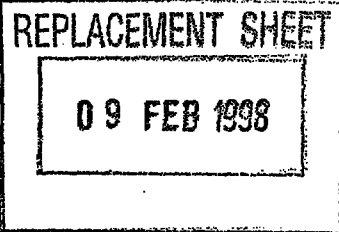
electrically charged particles unchanged without selection of an electric discharge.

38. A plasma display panel driving method according to claim 37, further comprising the steps of: performing said address electric discharge for cells to be illuminated by producing a discharge between said first and said second electrode groups and performing said sustaining discharge between said first and second electrode groups ; and supplying, after supplying the last sustaining pulse to said first and said second electrode groups in all sub-fields of each sub-field block, except for each last sub-field, a first pulse having almost the same voltage level as the voltage of said sustaining pulse to one of said first and second electrode groups to which the last sustaining pulse is not supplied and performing electric discharge in said cell in which said sustaining electric discharge has been performed ; and arranging a second pulse rising after 0.3 μ sec-1.5 μ sec from the rising edge of said first pulse and supplying said second pulse to the other electrode group of said first and said second electrode groups to which said first pulse is not supplied, and providing a plurality of fine line erasing pulses after supplying said first and said second pulses for erasing electrically charged particles in the vicinity of said first and second electrode groups.



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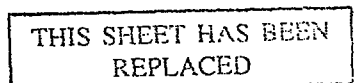
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39. A plasma display panel driving method according to claim 38, wherein the voltage of said first and said second pulses and said fine line erasing pulse, supplied after the supply of said sustaining pulse having a voltage level which is the same as the sustaining voltage, is selected so as to cause sustaining electric discharge in cells in which said address electric discharge is carried out and to cause no sustaining electric discharge in cells in which no electric discharge is produced.

40. A plasma display panel driving method according to claim 38, wherein a first address pulse is supplied to cells in which no full writing electric discharge and no full erasing electric discharge are produced, and said first address pulse has a voltage level higher than a voltage level of a second address voltage supplied to the other cells in which said full writing electric discharge and said full erasing electric discharge are produced.

41. A plasma display comprising:
a first electrode group arranged on a first substrate and driven in common;
a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;





09 FEB 1938

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate facing said first substrate and controlled independently;

a field block constructed from a plurality of sub-fields; means for producing a full writing electric discharge between said first and said second electrode groups in a first field of said field block;

means for producing an electric discharge by supplying a selection electric discharge pulse to one of said first and said second electrode groups in said sub-fields of each field block, except for each last sub-field, in cells in which light emission is produced by a sustaining discharge;

means for gathering electrically charged particles having one of opposite polarities in the vicinity of said first and second electrode groups and gathering electrically charged particles having the other polarity in the vicinity of said third electrode group by supplying said selection electric discharge pulse to said one electrode group and by supplying an electric charge particle control pulse to the other one of said first and second electrode groups; and

means for performing no selection electric discharge in cells in which light emission is not to be produced by said sustaining electric discharge.



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98



42. A plasma display according to claim 41, further comprising means for supplying a sustaining pulse to said first and said second electrode groups and means for supplying a last sustaining pulse to said other electrode group.

43. A plasma display according to claim 41, wherein the rising edge of said electrically charged particle control pulse has a time lag of 0.3 μ sec-1.5 μ sec from the rising edge of said selection electric discharge pulse.

44. A plasma display according to claim 41, further comprising means for supplying said fine line erasing pulse to said first and said second electrode groups after a selection electric discharge pulse is supplied.

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PLASMA DISPLAY, DRIVING APPARATUS FOR A PLASMA DISPLAY
PANEL AND DRIVING METHOD THEREOF

--ABSTRACT OF THE DISCLOSURE

A plasma display panel driving system having common X electrodes arranged on a front glass substrate driven in common, independent Y electrodes arranged parallel to the common X electrodes on the front glass substrate driven independently, address A electrodes arranged perpendicular to the common X electrodes and the independent Y electrodes on the back glass substrate driven independently, and means for performing at least one electric discharge for equalizing electrically charged particles in a cell in which another electrically charged particle is produced beforehand, thereby improving contrast. Erasing and polarization of electrically charged particles are performed by a fine line erasing pulse after a sustaining period, and an equalizing pulse having a high voltage level is supplied to the independent Y electrode to which the last fine line erasing pulse is supplied, and a regulating pulse is supplied to the common X electrode after supplying the equalizing pulse. Further, a field block having plurality of sub-fields are provided, and a full writing electric discharge and a fine line erasing electric discharge are performed in the first sub-field of each field block for reducing the number of electric discharges.--

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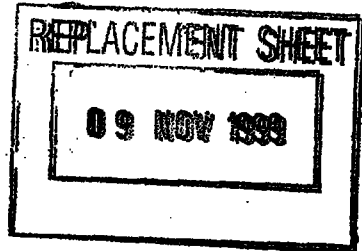


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CLAIMS:

1. A plasma display panel driving method for a display panel having a plurality of electrodes forming cells, including a first electrode group arranged on a permeable substrate and being capable of being driven in common, a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of being driven independently, a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of being driven independently, said driving method comprising the steps of:

supplying a voltage so as to produce an electric discharge in a cell in which an electric discharge was performed one time beforehand except abnormal state occurs in said cell ; and

supplying another voltage without causing any electric discharge.

2. A plasma display panel driving apparatus for a display panel having a plurality of cells, comprising:

a first electrode group arranged on a permeable substrate and being capable of being driven in common;

a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of being driven independently;



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a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of being driven independently; and

means for supplying a voltage so as to produce an electric discharge in a cell in which an electric discharge was performed one time beforehand except abnormal state occurs in said cell ; and

means for supplying other voltages without causing any electric discharge.

3. A plasma display having a plurality of cells, comprising:

a first electrode group arranged on a permeable substrate and being capable of being driven in common;

a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of being driven independently;

a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of being driven independently;

and means for supplying a voltage so as to occur electric discharge in a cell to which the electric discharge was performed one time beforehand except abnormal state occurs in said cell ; and

means for supplying other voltage without causing any electric discharge, whereby improving linearity of display gradation.



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93

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said first and said second driving
circuits and for performing a discharge in all cells
after sustaining discharge is finished.

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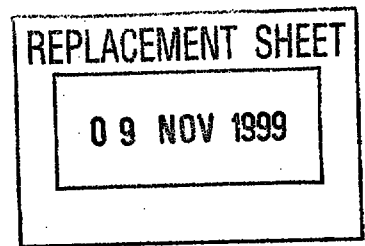


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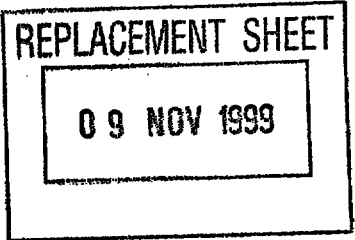
38. (cancelled)



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- 39. (cancelled)
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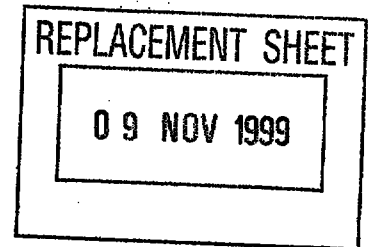


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CLAIMS

1. A plasma display panel driving method for a display panel having a plurality of electrodes forming cells, including a first electrode group arranged on a permeable substrate and being capable of being driven in common, a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of being driven independently, a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of being driven independently, said driving method comprising the steps of :

supplying a voltage so as to produce an electric discharge in a cell in which an electric discharge was performed one time beforehand except abnormal state occurs in said cell; and

supplying another voltage without causing any electric discharge.

2. A plasma display panel driving apparatus for a display panel having a plurality of cells, comprising:

a first electrode group arranged on a permeable substrate and being capable of being driven in common;

a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of being driven independently;



a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of being driven independently;

a first circuit which supplies a voltage so as to produce an electric discharge in a cell in which an electric discharge was performed beforehand; and

a second circuit which supplies another voltages without causing any electric discharge.

3. A plasma display having a plurality of cells, comprising:

a first electrode group arranged on a permeable substrate and being capable of being driven in common;

a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of being driven independently;

a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of being driven independently;

a first circuit which supplies a voltage so as to occur electric discharge in a cell in which the electric discharge was performed beforehand; and

a second circuit which supplies another voltage without causing any electric discharge; whereby improving linearity of display gradation.

4. A plasma display panel driving method for a display panel having a plurality of electrodes forming cells, including first electrode group arranged on a



17 APR 2000

permeable substrate and being capable of being driven in common, a second electrode group arranged in parallel with said first electrode group on said permeable substrate and being capable of being driven independently, a third electrode group arranged perpendicular to said first and second electrode groups on another substrate and being capable of being driven independently, equalizing means for equalizing electrically charged particles in all cells by producing a discharge between said first electrode group and said second electrode group, address electric discharge means for determining a cell to be illuminated by producing a discharge between said second and said third electrode groups, and sustaining electric discharge means for performing light emission by producing an electric discharge between said first and said second electrode groups, said driving method comprising the steps of:

generating a discharge using a fine line erasing pulse supplied after a sustaining electric discharge is finished to erase and polarize electrically charged particles in a cell in which a sustaining electric discharge has been carried out;

gathering said electrically charged particles present in all cells due to said electric discharge caused by the fine line erasing pulse, and canceling the voltage of an equalizing pulse supplied to one of said first and said second electrode groups by said electrically charged particles resulting in no discharge;

polarizing said electrically charged particles into positive electrically charged particles and negative electrically charged particles;



17 APR 2000

supplying a regulating pulse to the other of said first and said second electrode groups after supplying said equalizing pulse to said one of said first and said second electrode groups, for gathering one polarity of electrically charged particles which were gathered on said one of said electrode groups supplied with said equalizing pulse; and

gathering electrically charged particles having the other polarity on said third electrode group.

5. A plasma display panel driving method for a display panel having a plurality of electrodes forming cells, including first electrode group arranged on a first substrate and being capable of being driven in common, a second electrode group arranged in parallel with said first electrode group on said first substrate and being capable of being driven independently, a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate and being capable of being driven independently, said driving method comprising the steps of:

generating a sustaining electric discharge by supplying a sustaining pulse to said first and said second electrode groups;

polarizing electrically charged particles in a cell by supplying a fine line erasing pulse to one of said first and said second electrode groups;

gathering electrically charged particles having one of the polarities in the vicinity of said first and said second electrode groups;



17 APR 2000

gathering said electrically charged particles having the other polarity in the vicinity of said third electrode group by supplying a equalizing pulse to said one of electrode groups; and

supplying a regulating pulse rising later than said equalizing pulse to the other electrode group of said first and said second electrode groups without producing an electric discharge.

6. A plasma panel display driving method according to the claim 4 or 5, further comprising the steps of producing an electric discharge between said first electrode group and said second electrode group by supplying said equalizing pulse to said one of the electrode groups after supplying power, and gathering electrically charged particles having one of the polarities in the vicinity of said first and said second electrode groups and gathering electrically charged particles having the other polarity in the vicinity of said third electrode group by supplying said regulating pulse after said equalizing pulse is supplied.

7. A plasma display panel driving method according to claim 4 or 5, further comprising the steps of producing an address electric discharge between said second electrode group and said third electric group after gathering electrically charged particles having one of the polarities in the vicinity of the said first and said second electrode groups and gathering electrically charged particles having



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17 APR 2000

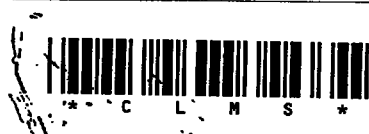
the other polarity in the vicinity of said third electrode group, and performing a sustaining electric discharge.

8. A plasma display panel driving method according to claim 4 or 5, further comprising the step of supplying said regulating pulse to said other electrode group within 0.3 μ sec-2 μ sec after supplying said equalizing pulse to said one of said electrode groups.

9. A plasma display panel driving method according to claim 4 or 5, further comprising the step of providing several fine line erasing pulses including a first fine line erasing pulse whose pulse width is within 0.5 μ sec-2 μ sec and at least a second fine line erasing pulse whose pulse width is equal to or less than said first pulse width for performing erasing and polarization of said electrically charged particles.

10. A plasma display panel driving method according to claim 4 or 5 further, comprising the steps of supplying said equalizing pulse to said second electrode group, and maintaining the supply of said regulating pulse to said first electrode group until selecting cells to be illuminated for gathering electrically charged particles to a predetermined electrode group.

11. A plasma display panel driving method according to claim 4 or 5, further comprising the step of dividing said regulating pulse into a first pulse for equalizing electrically charged particles in all cells and a second



17 APR 2000

regulating pulse supplied during a period for selecting cells to be illuminated.

12. A plasma display panel driving method according to claim 4 or 5, further comprising the step of setting the voltage of said regulating pulse to be substantially equal to the voltage of said sustaining pulse for performing display electric discharge.

13. A plasma display panel driving method according to claim 11, further comprising the step of setting the falling edge of said equalizing pulse after the falling edge of said first regulating pulse by within 1 μ sec.

14. A plasma display panel driving method according to claim 4 or 5, further comprising the steps of performing a discharge in all cells by supplying full electric discharge pulse to one of said first and said second electrode groups one or several times per one field or several fields after performing a sustaining discharge, and then supplying said fine line erasing pulse for performing a discharge in all cells for erasing electrically charged particles so as to gather electrically charged particles having the positive and negative polarities in the vicinity of said first and said second electrode groups, respectively.

15. A plasma display panel driving method according to claim 4 or 5, further comprising the steps of supplying a plurality of fine line erasing pulses to said first and second electrode groups alternatively, and shortening the



pulse width of said fine line erasing pulses which are supplied afterward, and supplying the last fine line erasing pulse to said one electrode group.

16. A plasma display panel driving method according to claim 4 or 5, further comprising the step of supplying said equalizing pulse to said one electrode group, and setting the falling edge of said equalizing pulse to a time more than 1 μ sec.

17. A plasma display panel driving circuit comprising:

a first electrode group arranged on a first substrate and driven in common;

a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate facing said first substrate and controlled independently;

a first driving circuit connected to said first electrode group for supplying a first driving pulse;

a second driving circuit connected to said second electrode group for supplying a second driving pulse;

a third driving circuit connected to said third electrode group for supplying an address driving pulse;

means for supplying a fine line erasing pulse to one of said first and second electrode groups from said driving circuit connected to said electrode group after sustaining discharging;



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17 APR 2000

85

means for supplying the equalizing pulse to said one electrode group from said driving circuit connected to said one electrode group;

means for supplying a regulating pulse, which is delayed from the rising edge of said equalizing pulse to the other electrode group of said first and said second electrode groups from said driving circuit connected said other electrode group, and for gathering electrically charged particles having one of opposite polarities in the vicinity of said first and said second electrode groups and for gathering electrically charged particles having the other polarity in the vicinity of said third electrode group.

18. A plasma display panel driving circuit according to claim 17, further comprising means for supplying said regulating pulse to said other electrode group within 0.3 μ sec-2 μ sec after supplying said equalizing pulse to said one of said electrode groups.

19. A plasma display panel driving circuit according to claim 17 or 18, further comprising means for generating a plurality of fine line erasing pulses from said first and said second driving circuits, the pulse width of a first fine line erasing pulse being within 0.5 μ sec-2 μ sec and the pulse width of a second fine line erasing pulse being equal to or shorter than said first fine said line erasing pulse.



17 APR 2000

20. A plasma display panel driving circuit according to claim 17, 18 or 19, further comprising means for supplying from said second driving circuit said equalizing pulse to said second electrode group and for supplying said regulating pulse from said first driving circuit to said first electrode group during the addressing of cells to be illuminated.

21. A plasma display panel driving circuit according to claim 17, 18 or 19, further comprising means for generating first and second regulating pulses from said driving circuit connected to said one electrode group.

22. A plasma display panel driving circuit according to claim 17, further comprising means for setting the voltage of said regulating pulse to be substantially identical with the voltage of said sustaining pulse.

23. A plasma display panel driving circuit according to claim 17, 18 or 20, further comprising means for setting the falling edge of said equalizing pulse after lapse of time of more than 1 μ sec by said driving circuit connected to said one electrode group.

24. A plasma display panel driving circuit according to claim 17, further comprising means for supplying, after performing sustaining discharge, a full writing electric discharge pulse one time or several times per one field or several fields generated from the one driving circuit of



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said first and said second driving circuits which is connected to said one electrode group.

25. A plasma display panel driving circuit according to claim 21, further comprising means for setting the falling edge of said equalizing pulse after the falling edge of said first regulating pulse by within 1 μ sec.

26. A plasma display comprising:

a first electrode group arranged on a first substrate and driven in common;

a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate facing said first substrate and controlled independently;

a plurality of cells constructed at the cross points of said first and said second and said third electrode groups;

means for performing an electric discharge for erasing and polarizing electrically charged particles in cells performed a sustaining discharging during a period after sustaining discharging and just before the beginning of an address period; and

means for equalizing electrically charged particles in all cells by said discharge for erasing and polarizing.

27. A plasma display comprising:



a first electrode group arranged on a first substrate and driven in common;

a second electrode group arranged parallel to said first electrode group on said first substrate and controlled independently;

a third electrode group arranged perpendicular to said first and second electrode groups on a second substrate facing said first substrate and controlled independently;

a plurality of cells constructed at the cross points of said first and said second and said third electrode groups;

means for generating a discharge using a fine line erasing pulse supplied to one of the electrodes of said first and said second electrode groups after a sustaining discharge and for erasing and polarizing electrically charged particles generated in cells by said sustaining discharge;

means for gathering electrically charged particles having one of opposite polarities in the vicinity of said first and said second electrode groups and for gathering electrically charged particles having the other one of the polarities in the vicinity of said third electrode group by supplying an equalizing pulse to said one of the electrodes and by supplying a regulating pulse to the other of said first and said second electrode groups so as to be able to produce a discharge for addressing which determines light emitting cells by said third electrode group.

28. A plasma display according to claim 27, further comprising means for supplying said regulating pulse to



said other electrode group within 0.3 μ sec-2 μ sec after supplying said equalizing pulse to said one of said electrode groups for collecting electrically charged particles having one of said polarities in the vicinity of said first and said second electrode groups and electrically charged particles having the other one of said polarities in the vicinity of said third electrode group.

29. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, means for generating a plurality of said fine line erasing pulses including a first fine line erasing pulse having pulse a width within 0.5 μ sec-2 μ sec and a second fine line erasing pulse having a pulse width equal to or less than said second fine line erasing pulse, and means for erasing and polarizing electrically charged particles by supplying a last pulse of said fine line erasing pulses to said one of said first and second electrode groups.

30. A plasma display according to claim 29, further comprising means for supplying from said second driving circuit said equalizing pulse to said second electrode group and for maintaining supply of said regulating pulse supplied from said first driving circuit to said first electrode group during addressing of cells to be illuminating.



31. A plasma display according to claim 29, further comprising means for generating from one of said first driving circuit connected said first electrode group and said second driving circuit connected to said second electrode group first and second regulating pulses.

32. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, and means for setting the voltage of said regulating pulse to be substantially identical with the voltage of said sustaining pulse by means of one of said first and said second driving circuits.

33. A plasma display according to claim 27, further comprising a driving circuit connected one of said first and said second electrode groups, and means for setting the falling edge of said equalizing pulse after a lapse of time of more than 1 μ sec by said driving circuit connected to said one electrode group.

34. A plasma display according to claim 27, further comprising a first driving circuit connected to said first electrode group, a second driving circuit connected to said second electrode group, and means for generating a full writing pulse one time or several times per one field or several fields from one of said first and said second driving circuits and for performing a discharge in all cells after sustaining discharge is finished.



PLASMA DISPLAY, DRIVING APPARATUS FOR A PLASMA DISPLAY
PANEL AND DRIVING METHOD THEREOF

--ABSTRACT OF THE DISCLOSURE

A plasma display panel driving system having common X electrodes arranged on a front glass substrate driven in common, independent Y electrodes arranged parallel to the common X electrodes on the front glass substrate driven independently, address A electrodes arranged perpendicular to the common X electrodes and the independent Y electrodes on the back glass substrate driven independently, and means for performing at least one electric discharge for equalizing electrically charged particles in a cell in which another electrically charged particle is produced beforehand, thereby improving contrast. Erasing and polarization of electrically charged particles are performed by a fine line erasing pulse after a sustaining period, and an equalizing pulse having a high voltage level is supplied to the independent Y electrode to which the last fine line erasing pulse is supplied, and a regulating pulse is supplied to the common X electrode after supplying the equalizing pulse. Further, a field block having plurality of sub-fields are provided, and a full writing electric discharge and a fine line erasing electric discharge are performed in the first sub-field of each field block for reducing the number of electric discharges.--