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Ishizuka

(54) ACTIVE MATRIX TYPE ORGANIC EL DISPLAY DEVICE AND ITS DRIVING METHOD

(75) Inventor: **Shinichi Ishizuka**, Mitaka (JP)

(73) Assignee: **PIONEER CORPORATION**, Kawasaki-shi, Kanagawa (JP)

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(57) **ABSTRACT**

To control a chronological luminance decrease of an organic EL element in an active matrix drive type organic EL display and to provide a reliable organic EL display. An organic EL display comprising a luminance decrease detector to detect a luminance decrease of an organic EL element; a reverse bias voltage generator to generate a reverse bias voltage pulse according to an amount of the luminance decrease; and a controller to control applying the above reverse bias voltage pulse to a driving transistor in a time period in which the organic EL element emits no light.

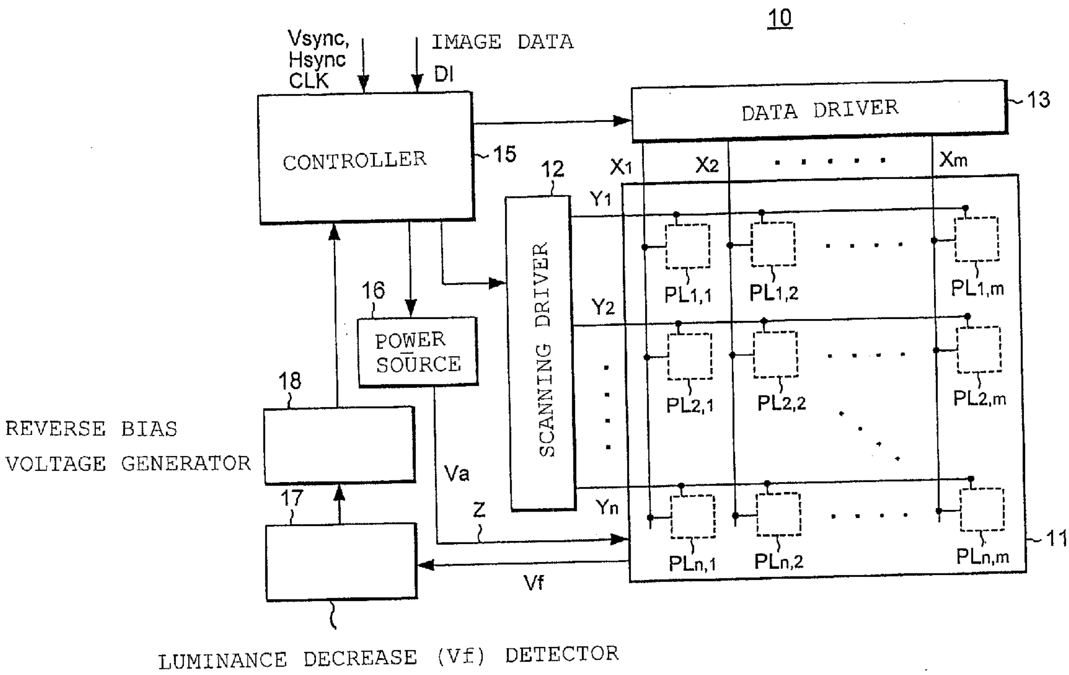


FIG. 1

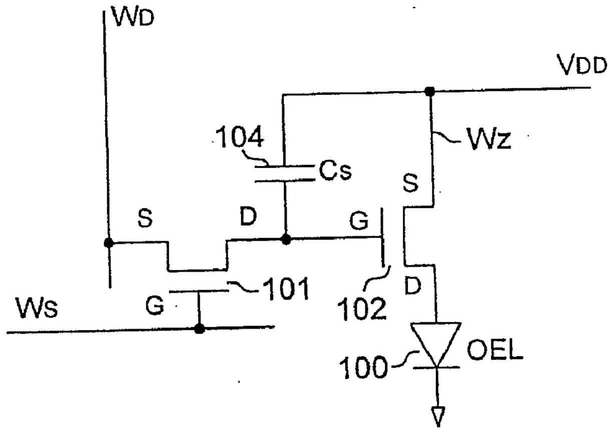

WD
VDD
104
Cs
Wz
S
S
D
G
101
102
D
Ws
G
OEL
100

FIG. 2

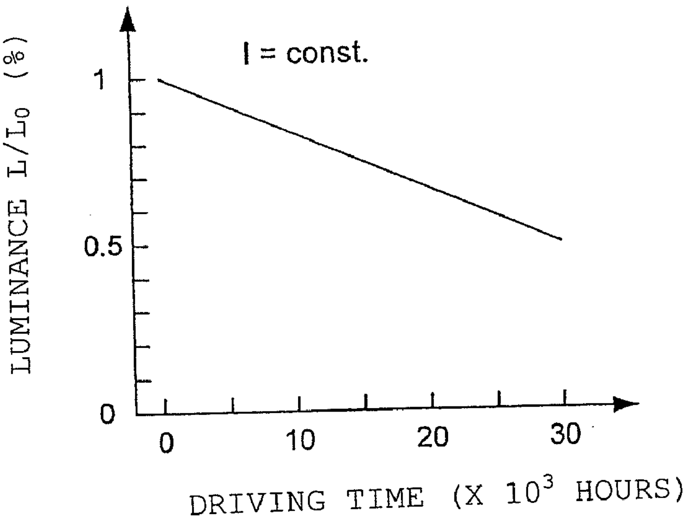

I = const.
LUMINANCE L/L0 (%)
1
0.5
0
0
10
20
30
DRIVING TIME (X 10³ HOURS)

FIG. 3

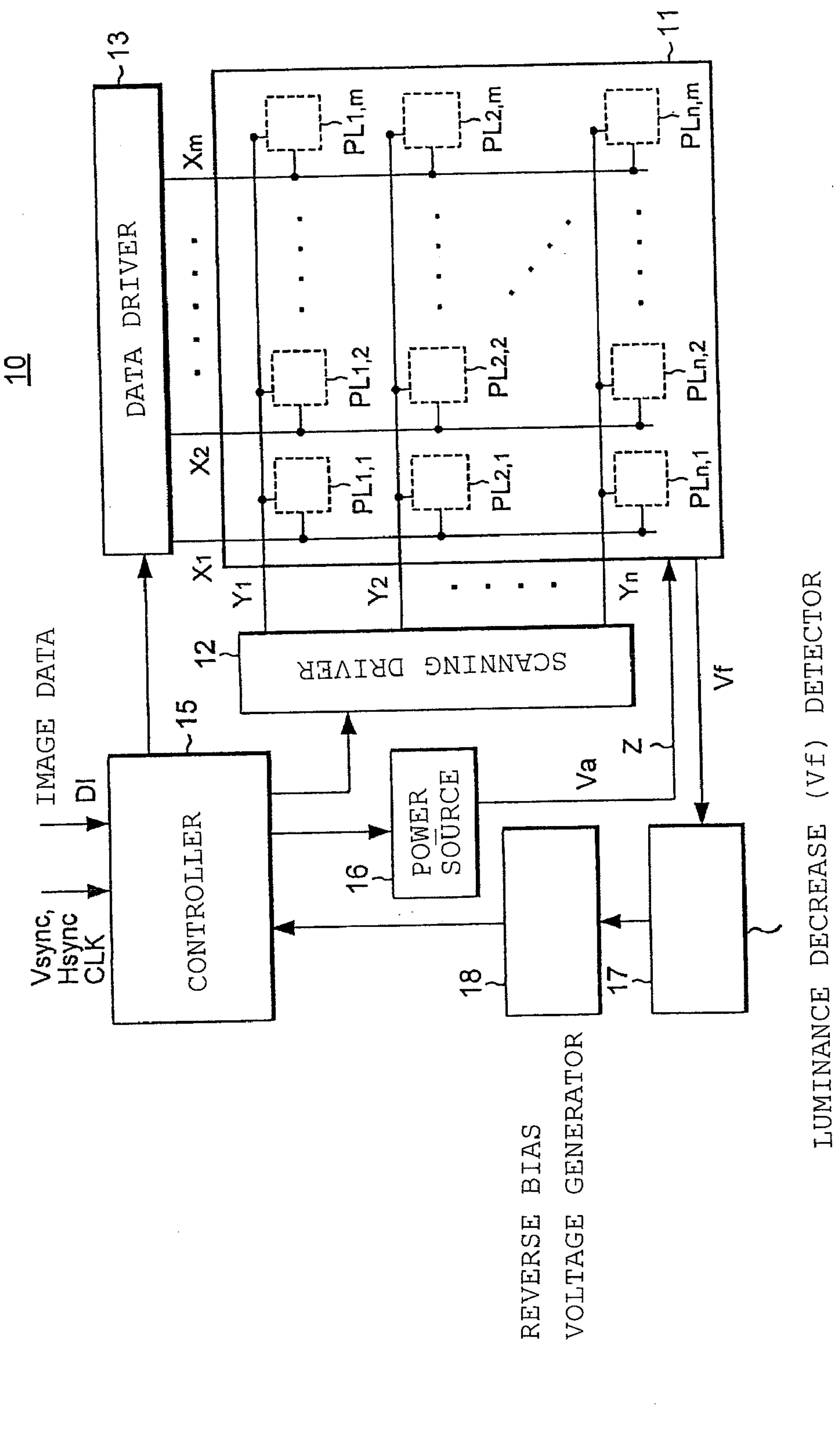

10
DATA DRIVER
13
11
X1
X2
Xm
Y1
Y2
Yn
PL1,1
PL1,2
PL1,m
PL2,1
PL2,2
PL2,m
PLn,1
PLn,2
PLn,m
12
SCANNING DRIVER
IMAGE DATA
DI
Vsync,
Hsync
CLK
CONTROLLER
15
POWER SOURCE
16
Va
Z
Vf
18
17
REVERSE BIAS
VOLTAGE GENERATOR
LUMINANCE DECREASE (Vf) DETECTOR

FIG. 4

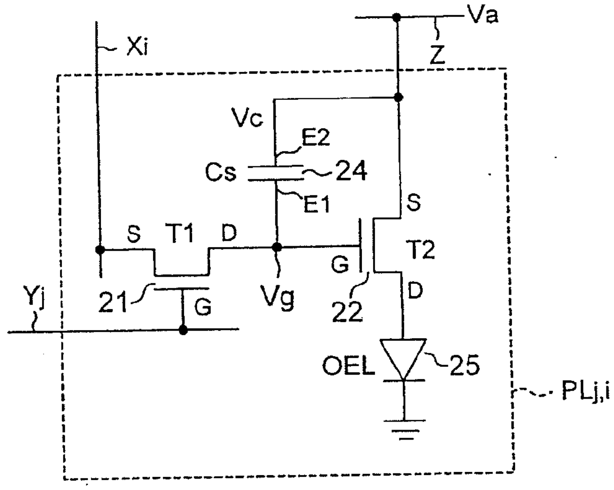

Xi
Va
Z
Vc
E2
Cs
24
E1
S
T1
D
S
T2
G
D
Yj
21
G
Vg
22
OEL
25
PLj,i

FIG. 5

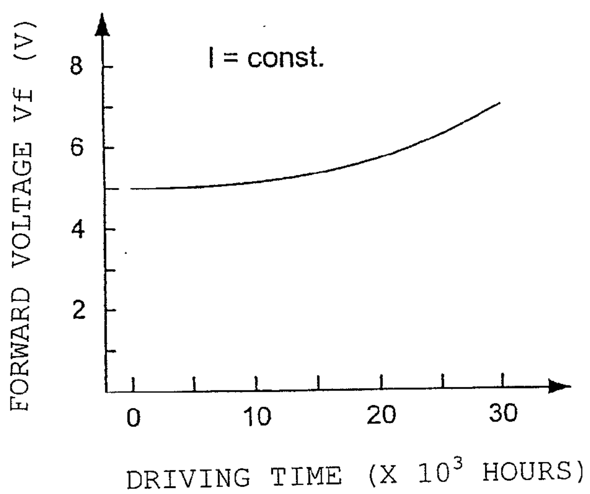

I = const.
FORWARD VOLTAGE Vf (V)
8
6
4
2
0
10
20
30
DRIVING TIME (X 10^3 HOURS)

FIG. 6

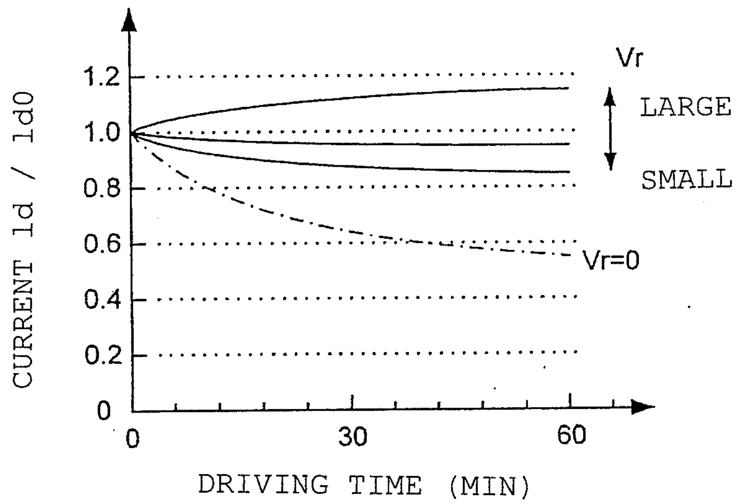
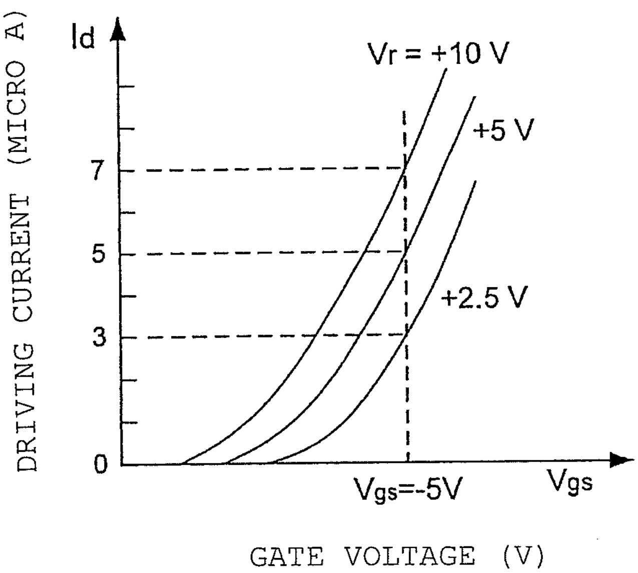

CURRENT ld / ld0
1.2
1.0
0.8
0.6
0.4
0.2
0
0
30
60
DRIVING TIME (MIN)
Vr
LARGE
SMALL
Vr=0

FIG. 7


DRIVING CURRENT (MICRO A)
Id
7
5
3
0
Vr = +10 V
+5 V
+2.5 V
Vgs=-5V
Vgs
GATE VOLTAGE (V)

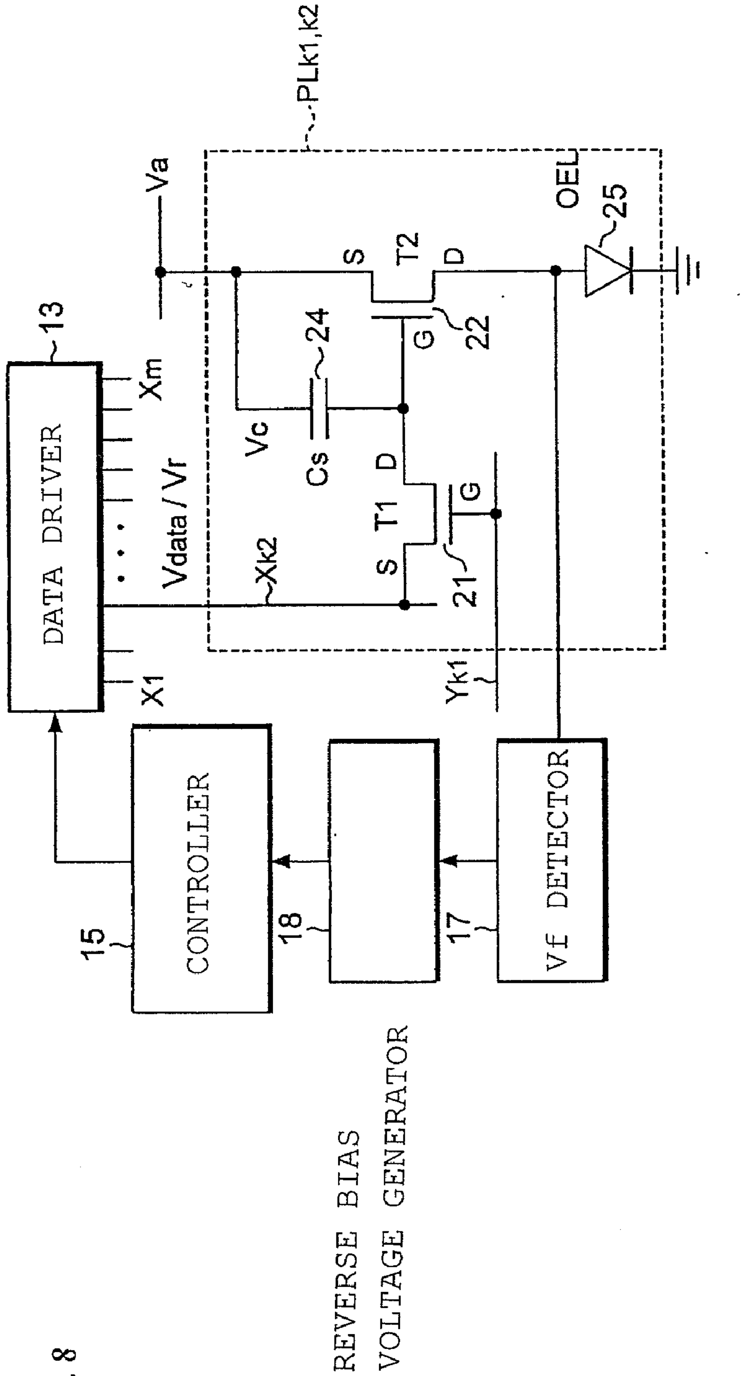

PLk1,k2
Va
OEL
25
S
T2
D
22
G
24
Vc
Cs
D
G
T1
S
21
13
DATA DRIVER
Xm
Vdata / Vr
Xk2
X1
Yk1
CONTROLLER
15
18
17
VF DETECTOR
REVERSE BIAS
VOLTAGE GENERATOR

FIG. 8

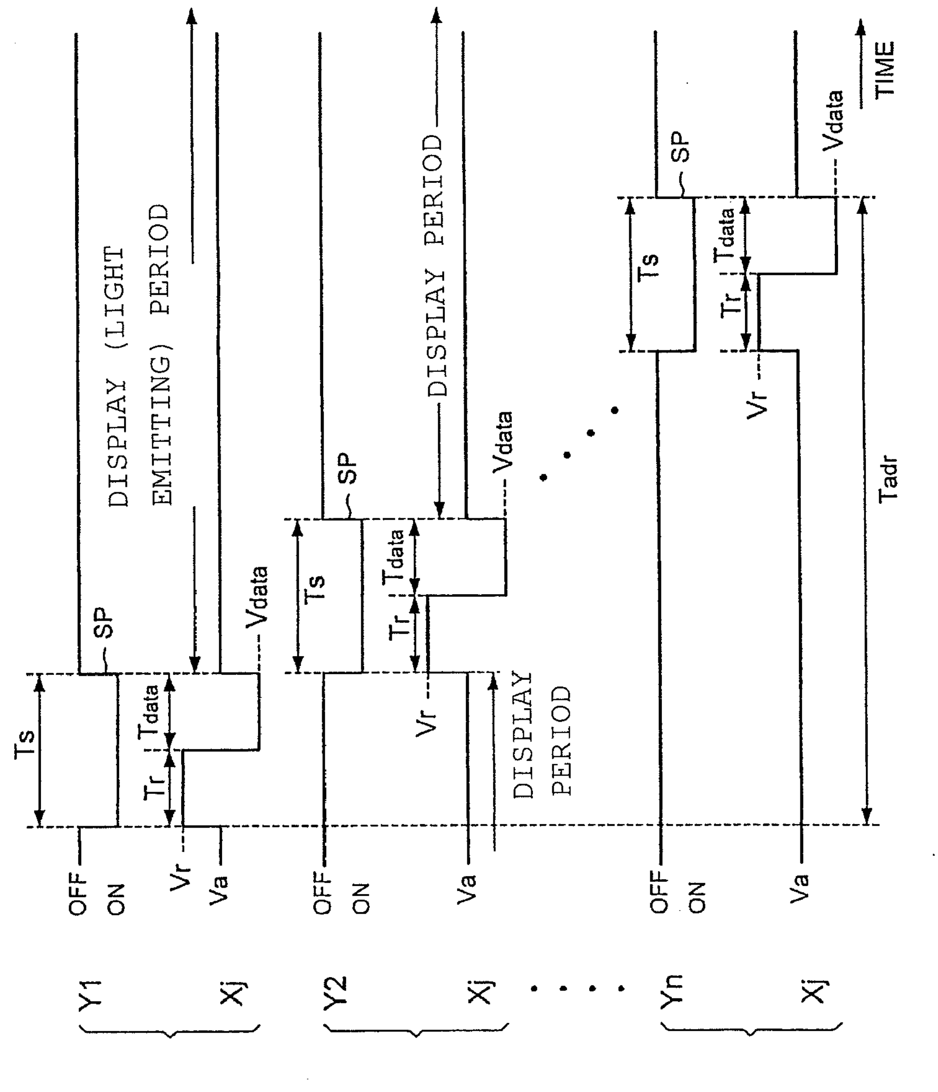
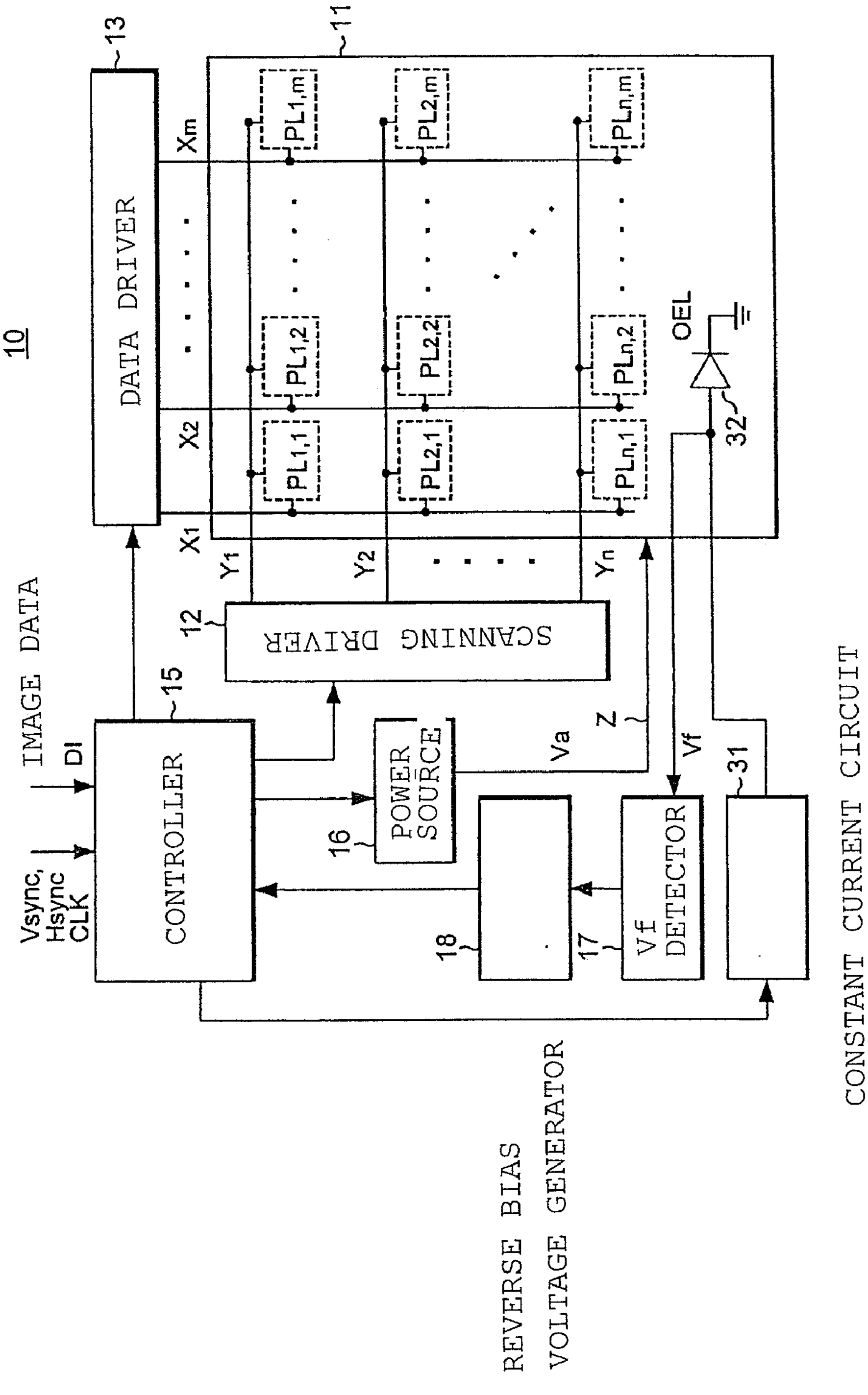

Y1
Xj
Y2
Xj
Yn
Xj
OFF
ON
Vr
Va
Ts
Tr
Tdata
SP
Vdata
DISPLAY (LIGHT EMITTING) PERIOD
DISPLAY PERIOD
DISPLAY PERIOD
Tadr
TIME

FIG. 9

FIG. 10


10
DATA DRIVER
13
11
Xm
X2
X1
Y1
Y2
Yn
PL1,1
PL1,2
PL1,m
PL2,1
PL2,2
PL2,m
PLn,1
PLn,2
PLn,m
OEL
32
12
SCANNING DRIVER
IMAGE DATA
DI
Vsync, Hsync CLK
CONTROLLER
15
POWER SOURCE
16
Va
Z
Vf
Vf DETECTOR
17
18
31
REVERSE BIAS VOLTAGE GENERATOR
CONSTANT CURRENT CIRCUIT

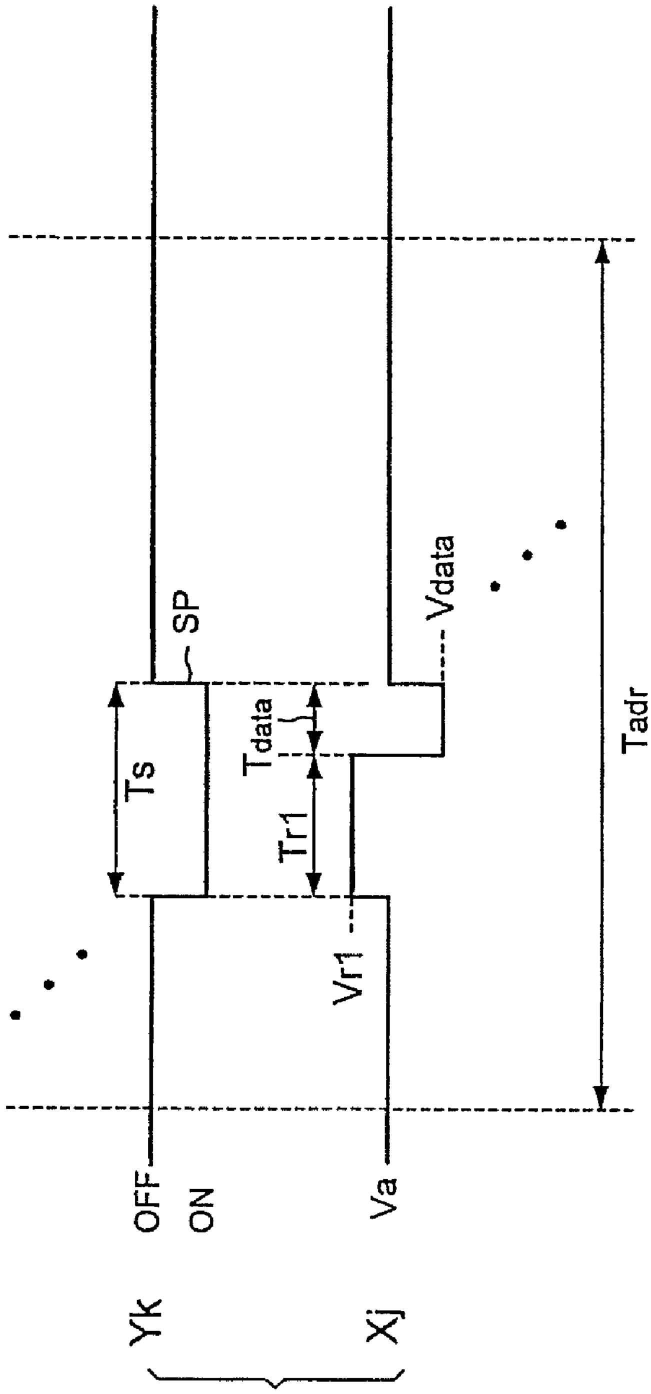
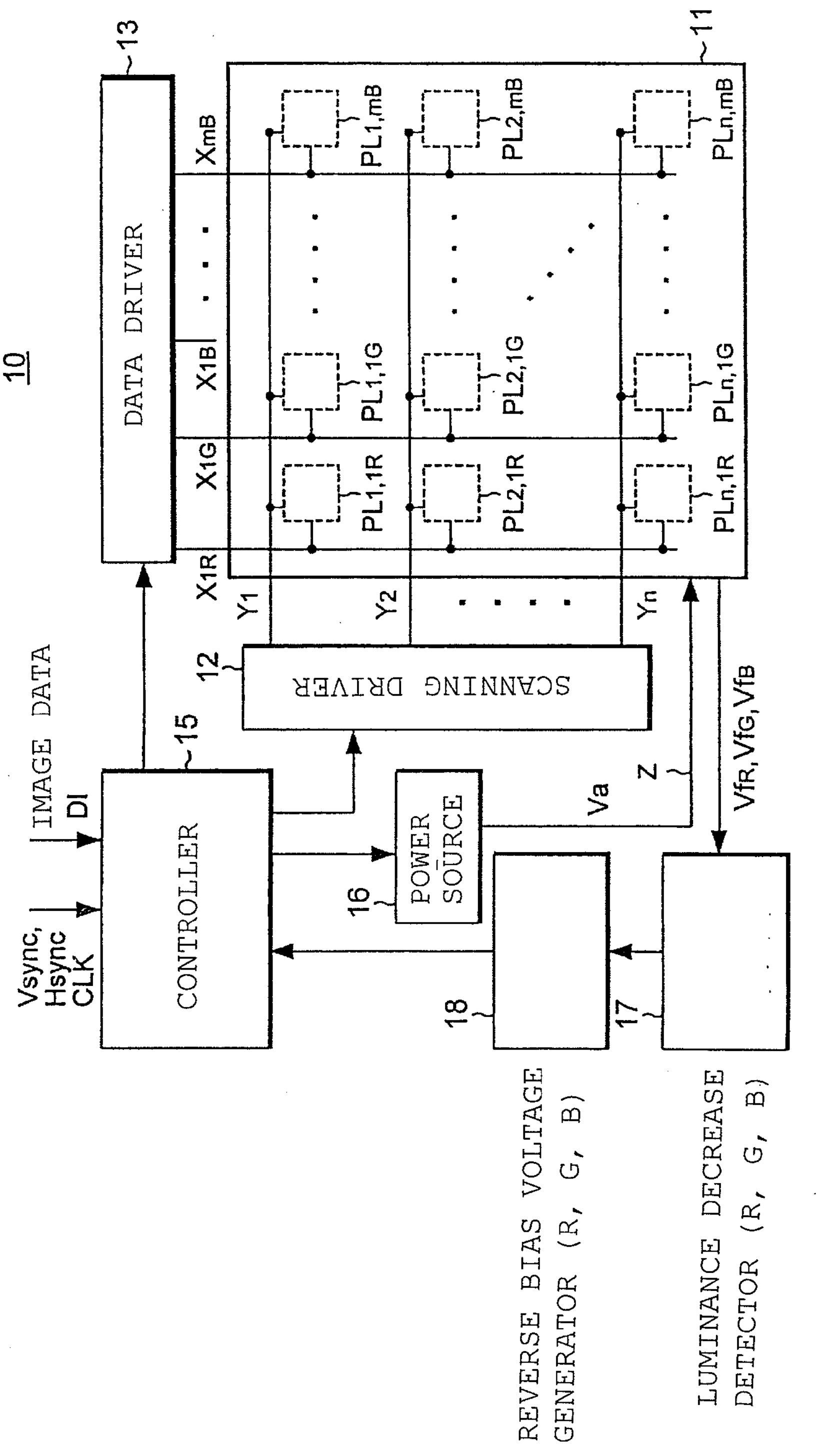


FIG. 11

FIG. 12


10
DATA DRIVER
13
11
X1R
X1G
X1B
XmB
PL1,1R
PL1,1G
PL1,mB
PL2,1R
PL2,1G
PL2,mB
PLn,1R
PLn,1G
PLn,mB
Y1
Y2
Yn
SCANNING DRIVER
12
IMAGE DATA
DI
Vsync,
Hsync
CLK
CONTROLLER
15
POWER SOURCE
16
Va
Z
VfR, VfG, VfB
18
17
REVERSE BIAS VOLTAGE GENERATOR (R, G, B)
LUMINANCE DECREASE DETECTOR (R, G, B)

ACTIVE MATRIX TYPE ORGANIC EL DISPLAY DEVICE AND ITS DRIVING METHOD

TECHNICAL FIELD

[0001] The present invention relates to an active matrix type organic EL display device having an organic EL element as a light emitting element and its driving method.

BACKGROUND ART

[0002] Active matrix type organic EL displays are thin and enable to realize a high quality image display and have been actively researched and developed. FIG. **1** illustrates one example of an equivalent circuit of a driving circuit of an organic EL (Organic Electroluminescent) element (OEL) **100** by using one pixel of the display. By referencing FIG. **1**, this equivalent circuit includes two p-channel TFTs (Thin Film Transistor) **101**, **102** that are active elements and a capacitor (Cs) **104**. A scanning line W_s is connected to a gate of the selective TFT **101**, a data line W_D is connected to a source of the selective TFT **101**, and a power source line W_z that supplies a constant power source voltage V_{DD} is connected to a source of the driving TFT **102**. A drain of the selective TFT **101** is connected to a gate of the driving TFT **102**, wherein the capacitor **104** is formed between the gate and the source of the driving TFT **102**. An anode of the OEL **100** is connected to a drain of the driving TFT **102**, while a cathode thereof is connected to a common potential respectively.

[0003] When a selective pulse is applied to the scanning line W_s, the selective TFT **101** that serves as a switch is turned on and the state between the source and the drain becomes conductive. At this time, a data voltage is supplied from the data line W_D via the source and the drain of the selective TFT **101** to be accumulated in the capacitor Cs **104**. Since the data voltage accumulated in the capacitor **104** is applied between the gate and the source of the driving TFT **102**, a drain current ld corresponding to the voltage (hereafter, referred to as a gate voltage) Vgs between the gate and the source of the driving TFT **102** flows so as to be supplied to the OEL **100**.

[0004] However, the emission luminance of the organic EL element (OEL) decreases with a driving time. FIG. **2** is a graph illustrating a change of the luminance (L) to the driving time of the organic EL element (OEL). This illustrates the change in a pattern diagram when a driving current (I) is constant. Furthermore, the luminance (L) of the organic EL element is illustrated by normalizing the luminance (L_0) in an initial state (point in which the driving time is 0) to be 1 (100%). As illustrated in FIG. **2**, even if the organic EL element is driven by a constant current, the luminance-current (L-I) characteristic changes with the driving time, wherein the emission luminance decreases chronologically.

[0005] On the other hand, it is known that in the organic TFTs (driving transistor), a threshold voltage shifts with the driving time (for example, refer to Non-Patent Literature 1). Such a shift of a threshold voltage of the driving transistor causes the OEL to lose the emission luminance. A driving circuit and a driving method to compensate the shift of a threshold voltage of the organic TFT are disclosed in the Patent Documents 1-3, for example. However, it is extremely important to control the chronological luminance decrease of the organic EL elements as described above and to realize reliable organic EL displays.

CITATION LIST

[0006] Non Patent Literature

[0007] NPL 1: S. J. Zilker, C. Detcheverry, E. Cantatore, and D. M. deLeeuw, "Bias stress in organic thin-film transistors and logic gates," Applied Physics Letters Vol 79 (8) pp. 1124-1126, Aug. 20, 2001.

[0008] Patent Literature

[0009] PTL 1 Japanese Translation of PCT International Application Publication No. 2002-514320 (pp. 13-15, FIGS. 2, 3)

[0010] PTL 2: Japanese Patent Kokai No. 2002-351401 (p. 4, FIG. 1)

[0011] PTL 3: Japanese Patent Kokai No. 2006-351401 (p. 11, FIG. 5)

SUMMARY OF INVENTION

Technical Problem

[0012] As problems to be solved by the present invention, the above problem can be cited as one example. A purpose of the present invention is to control a chronological luminance decrease of an organic EL element in an active matrix drive type organic EL display and to provide a reliable organic EL display. Other purpose is to provide a reliable color display device having an excellent color rendering property.

Solution To Problem

[0013] A display device of the present invention has an active matrix type display panel consisting of a plurality of display cells, each of which has an organic EL (Electroluminescent) element and a driving transistor which drives the organic EL element on the basis of a data signal wherein each scanning line of the display panel is scanned in sequence, and the data signal is supplied to the display cell according to the scanning, to perform displays, the display device comprising:

[0014] a luminance decrease detector to detect a luminance decrease of the organic EL element;

[0015] a reverse bias voltage generator to generate a reverse bias voltage pulse according to an amount of the above luminance decrease; and

[0016] a controller to control applying the above reverse bias voltage pulse to the driving transistor in a time period in which the organic EL element emits no light.

[0017] The driving method of the present invention is a driving method of a display device comprising an active matrix type display panel consisting of a plurality of display cells each having an organic EL (Electroluminescent) element and a driving transistor which drives the organic EL element on the basis of a data signal wherein each scanning line of the display panel is scanned in sequence, and the data signal is supplied to the display cell according to the above scanning, to perform displays, the driving method comprising:

[0018] a step to detect a luminance decrease of the organic EL element;

[0019] a step to generate a reverse bias voltage pulse according to an amount of the above luminance decrease; and

[0020] a step to control applying the above reverse bias voltage pulse to the driving transistor in a time period in which the organic EL element emits no light.

BRIEF DESCRIPTION OF DRAWINGS

[0021] FIG. **1** is a drawing illustrating one example of an equivalent circuit of a pixel of a conventional organic EL element (OEL).

[0022] FIG. **2** is a graph illustrating a change of a luminance (L) to a driving time of an organic EL element.

[0023] FIG. **3** is a drawing illustrating a display device using the active matrix display panel of the present invention.

[0024] FIG. **4** is a drawing illustrating a display cell $PL_{j,i}$ related to a data line Xi and a scanning line Yj of a plurality of display cells $PL_{1,1}$-$PL_{n,m}$ of the display panel illustrated in FIG. **3**.

[0025] FIG. **5** is a graph illustrating a change of a forward voltage (Vf) to a driving time of an organic EL element.

[0026] FIG. **6** is a graph illustrating a current shift (drain current: ld) to a driving time of an organic TFT.

[0027] FIG. **7** is a graph exemplifying a drain current (ld) to a gate voltage (Vgs) of an organic TFT in which a reverse bias voltage (Vr) is set as a parameter.

[0028] FIG. **8** is a drawing illustrating a circuit constitution of Embodiment 1 in a pattern diagram.

[0029] FIG. **9** is a timing chart in a pattern diagram illustrating a scanning pulse applied to each of scanning lines Y**1**-Yn and timing to apply a voltage to data lines X**1**-Xm of the display panel **11** in Embodiment 1.

[0030] FIG. **10** is a drawing illustrating a circuit constitution of Embodiment 2 in a pattern diagram.

[0031] FIG. **11** is a timing chart in a pattern diagram illustrating a scanning pulse applied to the scanning line and timing to apply a voltage to the data line Xj (j=1-m) in Embodiment 2.

[0032] FIG. **12** is a drawing illustrating the constitution of the color display device of Embodiment 4 in a pattern diagram.

DESCRIPTION OF EMBODIMENTS

[0033] Below, the embodiments of the present invention will be described in detail by referencing the drawings. In the drawings described below, parts substantively equivalent are given the same referential marks.

EXAMPLE 1

[0034] FIG. **3** illustrates a display device **10** using the active matrix display panel of the present invention. This display device **10** is equipped with a display panel **11**, scanning driver **12**, data driver **13**, controller **15**, power source driving a light emitting element **16**, luminance decrease detector **17**, and reverse bias voltage generator **18**.

[0035] The display panel **11** is an active matrix type consisting of m×n (m and n are integers equal to or more than two) display cells, which has a plurality of data lines X**1**-Xm (Xi: i=1-m) each of which is disposed in parallel, a plurality of scanning lines Y**1**-Yn (Yj: j=1-n), and a plurality of display cells $PL_{1,1}$-$PL_{n,m}$. The display cells $PL_{1,1}$-$PL_{m,n}$ are disposed at an intersecting part of the data lines X**1**-Xm and the scanning lines Y**1**-Yn, all of which has the same constitution. A driving voltage of a light emitting element (Va) is supplied to the display cells $PL_{1,1}$-$PL_{n,m}$ from a power source **16** via a power source line Z. In the description of this embodiment, the display device **10** is a black-and-white display device and each display cell PL comprises one pixel as an example. However, the display device **10** may be a color display device and in order to display colors, three display cells of red (R), green (G), and blue (B) may comprise one pixel, for example.

[0036] FIG. **4** illustrates a display cell $PL_{j,i}$ out of a plurality of display cells $PL_{1,1}$-$PL_{n,m}$ of the display panel **11** that is related to the data line Xi (i=1, 2, . . . , m) and the scanning line Yj (j=1, 2, . . . , n). More specifically, it is equipped with selective and driving TFTs (thin film transistor) **21**, **22**, a data storing capacitor (Cs) **24**, and an organic EL (Electroluminescent) light emitting element (OEL) **25**. In the description below, the driving TFT **22** is a p-channel TFT as an example, however, it is the same with an n-channel TFT.

[0037] A gate G of the selective TFT (TI) **21** is connected to the scanning line Yj, and a source S thereof is connected to the data line Xi. The gate G of the driving TFT (T**2**) **22** is connected to a drain D of the selective TFT **21**. The source S of the TFT **22** is connected to the power source line Z so that a power source voltage (positive voltage Va) is supplied from the power source **16**. A drain of the TFT **22** is connected to the anode of the EL element **25**. The cathode of the EL element **25** is connected to a given potential (in this embodiment, grounded). One end (first terminal; electrode E**1**) of the capacitor (Cs) **24** is connected to the gate (and the drain of the selective TFT **21**) of the driving TFT, while the other end (second terminal; electrode E**2**) is connected to the source S of the driving TFT. The scanning lines Y**1**-Yn of the display panel **11** are connected to the scanning driver **12**, while the data lines X**1**-Xm are connected to the data driver **13**.

[0038] An image signal DI, vertical synchronization signal Vsync, horizontal synchronization signal Hsync, and system clock CLK are supplied to the controller **15**. The vertical synchronization signal Vsync, horizontal synchronization signal Hsync, and system clock CLK are used to generate a scanning control signal and a data control signal so as to drive and control gradation of the display panel **11** according to the image signal DI. The scanning control signal is supplied to the scanning driver **12**, while the data control signal is supplied to the data driver **13**. The controller **15** controls the entirety of the display device **10**, that is to say, the scanning driver **12**, data driver **13**, power source driving a light emitting element **16**, luminance decrease detector **17**, and reverse bias voltage generator **18**.

[0039] FIG. **5** is a graph illustrating a change of a forward voltage (Vf) to the driving time of the organic EL element (OEL). FIG. **5** illustrates the change in a pattern diagram when a driving current (I) is constant. As illustrated in FIG. **5**, the forward voltage (Vf) of the organic EL element changes (increases) according to the driving time.

[0040] FIG. **6** is a graph illustrating a current shift (drain current: ld) to the driving time of the organic TFT. The vertical axis of the graph shows the drain current (ld) of the organic TFT by standardizing the drain current (ld_0) as 1 (100%) when the driving time is **0**. The horizontal axis shows the driving time t (unit: minute). That is to say, as illustrated in FIG. **6**, in an organic TFT used for a driving transistor or the like, if a forward bias is applied to a gate continuously, a drain current keeps decreasing (Vr=0, shown in a broken line), however, it is possible to compensate the decrease of the drain current by applying a reverse bias voltage. Depending on an amount of the reverse bias voltage to apply, a threshold voltage (Vth) of the organic TFT changes (to be described below), hence the change of the drain current to the driving time of the organic TFT fluctuates even if the voltage of the display signal is constant. That is to say, as the reverse bias voltage increases, the drain current decreases less, and the drain current increases more than at the initial time (driving time is O) depending on the amount of the reverse bias voltage.

[0041] FIG. **7** is a graph exemplifying a drain current (ld) to a gate voltage (Vgs) of an organic TFT in which a reverse bias voltage (Vr) is a parameter. Specifically, it illustrates an ld-Vgs curve after it is driven 60 minutes in which the gate voltage (Vgs) is −5V and the reverse bias voltage (Vr) is +2.5V, +5V, and +10V respectively. That is to say, as illustrated in the drawing, as the reverse bias voltage increases, the threshold voltage (Vth) of the organic TFT shifts in a direction to decrease, consequently the drain current (that is to say, the driving current of the organic EL element) increases. Conversely, if the reverse bias voltage decreases, the threshold voltage (Vth) shifts in a direction to increase, consequently the drain current decreases.

[0042] By using the above characteristic, it is possible to adjust the drain current of the organic TFT (the current driving the organic EL element) without changing the voltage of the display signal, thereby compensating the luminance change (decrease) to the driving time of the organic EL element. Below, the driving method using the characteristic of the organic TFT and the characteristic of the organic EL element as described above will be specifically described.

[0043] FIG. **8** is a drawing illustrating a circuit constitution of Embodiment 1 in a pattern diagram. In Embodiment 1, the above luminance decrease detector **17** is constituted as a forward voltage detector to detect a change of the forward voltage (Vf) of the organic EL element (OEL) **25**. That is to say, the luminance decrease detector (referred to as a forward voltage detector in this embodiment) **17** detects the forward voltage (Vf) of the organic EL element (OEL) **25** of a given display cell $PL_{k1,\ k2}$ (display cell related to the scanning line Yk**1** and the data line Xk**2**) of the display panel **11**, thereby supplying the detected voltage to the reverse bias voltage generator **18**. The reverse bias voltage generator **18** generates a reverse bias voltage having an amount according to the forward voltage of the OEL **25** detected, thereby supplying it to the controller **15**. More specifically, in the description of this embodiment, a reverse bias voltage having an amount in proportion to an increase (difference from the initial value) of the forward voltage of the OEL **25** is generated so as to apply to the organic TFT (driving TFT) **22** as an example.

[0044] The controller **15** supplies to the data driver **13** the reverse bias voltage and a control signal so as to apply the reverse bias voltage to the driving TFT **22**. The data driver **13** supplies the reverse bias voltage or the data voltage (Vdata) to each display cell via the data line Xi (i=1, 2, . . . , m) on the basis of the control of the controller **15**.

[0045] Next, the operation of the forward voltage detector **17** and the reverse bias voltage generator **18** and the application control of the reverse bias voltage of the controller **15** will be described in detail. FIG. **9** is a timing chart in a pattern diagram illustrating a scanning pulse applied to each of scanning lines Y**1**-Yn and timing to apply a voltage to data lines X**1**-Xm of the display panel **11**.

[0046] In each image frame of an input image data signal, a scanning pulse SP is applied to the first to the nth scanning lines (Y**1**-Yn) in sequence so as to perform the line sequential scanning (addressing period: Tadr). First, when the scanning pulse SP is applied to the scanning line Y**1** so as to select the scanning line Y**1** (scanning line Y**1** is on, selective period Ts), the selective TFT **21** becomes conductive so that the reverse bias voltage (Vr) is supplied from the data driver **13** to the data line Xi (i=1, 2, . . . , m). Hence, during the supplying period of the reverse bias voltage, the reverse bias voltage is applied to the gate of the driving TFT **22** of the display cell $PL_{1,i}$ (i=1, 2, . . . , m) connected to the scanning line Y**1** (the applying period is constant and Tr<Ts). After the applying period Tr of the reverse bias voltage elapses, an image data signal (data voltage Vdata) is supplied to the electrode E**1** of the capacitor **24** from the data driver **13** through the data line Xi (i=1, 2, . . . , m). A load corresponding to the data voltage Vdata is accumulated in the'capacitor **24** so as to hold the voltage. Then a drain current flows in the driving TFT **22** according to the gate voltage Vgs (=Vdata−Va). Therefore, the organic light emitting element (OEL) **25** is driven with luminance according to the image data signal so as to emit light.

[0047] After the data of the scanning line **Y1** is written (after an elapse of the selective period Ts), a scanning pulse SP is applied to a scanning line Y**2** so as to select the scanning line Y**2** (selective period Ts). Similarly to the above case of the scanning line **Y1**, during the applying period Tr of the reverse bias voltage, a reverse bias voltage pulse is applied to the gate of the driving TFT **22** of the display cell $PL_{2,i}$ (i=1, 2, . . . , m) which is connected to the scanning line Y**2**. After an elapse of the reverse bias applying period Tr, the image data signal (data voltage Vdata) is supplied to the data line Xi (i=1, 2, . . . , m) from the data driver **13** so that the OEL **25** of the display cell $PL_{2,i}$ (i=1, 2, . . . , m) is driven with luminance according to the image data signal so as to emit light.

[0048] Similarly, the sequential line scanning is performed up to the scanning line Yn (addressing period: Tadr), and the reverse bias voltage is applied in all the display cells of the display panel **11**, and the display control is performed according to the image data signal. In the following image frame also, the reverse bias voltage is applied and the display control is performed similarly. However, it is acceptable to apply the reverse bias voltage in every several frames instead of applying it in all the frames.

[0049] Hence, by increasing the reverse bias voltage (that is to say, a voltage value of a rectangle pulse) to apply to the driving TFT **22** in proportion to the increase of the forward voltage of the organic EL element (OEL), it is possible to increase the driving current of the OEL without changing the voltage of a display signal. Accordingly, it is possible to compensate and reduce the chronological luminance decrease of the OEL.

[0050] In the above description, the reverse bias voltage was applied during the addressing period (writing period). However, the applying period of the reverse bias voltage is not limited to the writing period. That is to say, since the organic EL element does not emit light because of the reverse bias voltage applied, it is possible to apply the reverse bias voltage over a time period in which the organic EL element does not emit light. For example, a blanking period, a time period between frames or the like may be used.

[0051] In the above description, the forward voltage detector **17** detected the forward voltage of the organic EL element (OEL) **25** of a given display cell $PL_{k1,\ k2}$ of the display panel **11** as an example, however, the forward voltage detector **17** may be constituted to detect the forward voltage of a plurality of OELs **25** of the display panel **11**. Furthermore, in this case, by using a given statistical method such as an average value of the forward voltage of the OELs **25** or the like, it is possible to comprise it so as to compensate the luminance decrease of the whole display panel **11**.

EXAMPLE 2

[0052] In the description of the above Embodiment 1, the forward voltage of the organic EL element (OEL) **25** of a given display cell $PL_{k1,k2}$ of the display panel **11** was detected as an example. However, in this embodiment, the monitoring OEL **32** is provided separately from the OEL **25** of the display panel **11** so as to detect the forward voltage of the monitoring OEL **32**. FIG. **10** is a drawing illustrating a circuit constitution of Embodiment 2 in a pattern diagram.

[0053] More specifically, as illustrated in FIG. **10**, the monitoring OEL **32** is driven by a given driving current from a constant current circuit **31**. The forward voltage detector **17** that is a luminance decrease detector detects the forward voltage (Vf) of the OEL **32**, thereby supplying the detected voltage to the reverse bias voltage generator **18**. The reverse bias voltage generator **18** generates a reverse bias voltage according to the forward voltage of the OEL **32** detected, thereby supplying it to the controller **15**. The controller **15** supplies to the data driver **13** the reverse bias voltage and a control signal so as to apply the reverse bias voltage to the OEL **25** of the display panel **11**. The data driver **13** supplies the reverse bias voltage or the data voltage (Vdata) to the driving TFT **22** of each display cell via the data line Xi (i=1, 2, . . . , m) on the basis of the control of the controller **15**. It is possible to apply the reverse bias voltage and to apply the data voltage signal to the OEL **25** of the display panel **11** similarly to Embodiment 1 described above.

[0054] This embodiment has a constitution in which the monitoring OEL **32** is provided so that it serves as a detection criterion of the forward voltage so as to detect the forward voltage when driven by a constant driving current. That is to say, the monitoring OEL **32** is driven by a constant current from the constant current circuit **31** so as to detect the forward voltage. Accordingly, it is possible to have a more precise forward voltage as a criterion, wherein it is possible to precisely compensate the luminance decrease, more reflecting the luminance decrease of display cells of the whole display panel **11**. The driving current of the OEL **32** may be a set constant current, or a current according to a display signal.

EXAMPLE 3

[0055] In the above description of Embodiment 1 and 2, the applying period (Tr) of the reverse bias was constant, wherein an amount of the reverse bias voltage was applied according to the forward voltage (Vf) of the organic EL element (OEL). However, the amount of the reverse bias voltage may be constant and the applying period of the reverse bias voltage (or the width of the reverse bias voltage pulse) may be adjusted according to the forward voltage (Vf) of the organic EL element.

[0056] Similarly to FIG. **9**, FIG. **11** is a timing chart in a pattern diagram illustrating a scanning pulse to apply to a scanning line and voltage timing to apply to a data line Xj (j=1-m), however, for the sake of an easy description and understanding, it illustrates only the kth scanning line Yk (k=1-n).

[0057] In this embodiment, the reverse bias voltage generator **18** is constituted so that the reverse bias voltage (Vr**1**) is applied to the driving TFT **22** during the applying period (Tr**1**, the width of the reverse bias voltage pulse) according to the forward voltage of the organic EL element (OEL) detected. Specifically, for example, in order to obtain an effect of applying the reverse bias similar to Embodiment 1, in this embodiment, the reverse bias voltage (Vr**1**) is constant, and the amount of the reverse bias voltage (Vr**1**) is adjusted to become smaller than that of Embodiment 1 (Vr), whereas the applying period of the reverse bias (Tr**1**) is adjusted to become longer than that of Embodiment 1 (Tr). Conversely, the amount of the reverse bias voltage (Vr**1**) of this embodiment is adjusted to become larger than that of Embodiment 1 (Vr), while the applying period of the reverse bias (Tr**1**) is adjusted to become shorter than that of Embodiment 1 (Tr).

EXAMPLE 4

[0058] The present invention can be applied to color display devices. FIG. **12** illustrates the constitution of the color display device **10** of this embodiment in a pattern diagram. That is to say, pixels consisting of three display cells of red (R), green (G), blue (B) are disposed on a scanning line Yk in sequence. Specifically, pixels ($PL_{k,1R}$, $PL_{k,1G}$, $PL_{k,1B}$), ($PL_{k,2R}$, $PL_{k,2G}$, $PL_{k,2B}$), . . . , ($PL_{k,mB}$, $PL_{k,mB}$, $PL_{k,mB}$) are disposed in sequence.

[0059] In this embodiment, the forward voltage detector **17** detects the forward voltages (VfR, VfG, VBf) of the organic

[0060] EL element (OEL) **25** of display cells ($PL_{k1,\ k2R}$, $PL_{k1,\ k2G}$, $PL_{k1,\ k2G}$) of given pixels of the display panel **11**, thereby supplying the detected voltage to the reverse bias voltage generator **18**. The reverse bias voltage generator **18** generates reverse bias voltages (VrR, VrG, Vrf) having an amount according to the forward voltages (VfR, VfG, VBf) of the OEL **25** detected, thereby supplying them to the controller **15**. The data driver **13** supplies the reverse bias voltages (VrR, VrG, Vrf) to each display cell via the data lines (X1R, X1G, X1B)-(XmR, XmG, XmB) corresponding to R, G, B on the basis of the control of the controller **15** according to the scanning of each of scanning lines Y**1**-Yn.

[0061] That is to say, in this embodiment, the color display device is constituted in which the reverse bias voltage having an amount in proportion to an increase of the forward voltage of the OEL **25** of each color R, G, B is generated so as to apply to the organic TFT (driving TFT) **22** corresponding to the OEL **25** of each color R, G, B.

[0062] According to this embodiment, it is possible to increase the driving current of the OEL **25** of each color R, G, B without changing the voltage of a display signal. Accordingly, even if the luminance deterioration of each color of the OEL is different, it is possible to compensate and reduce the luminance decrease by each color. That is to say, since the luminance decrease can be compensated by each color, it is possible to provide a color display device without luminance deterioration yet with an excellent color rendering property.

[0063] In the description of the above Embodiment, in order to detect the luminance decrease of the organic EL element (OEL), the forward voltage of the organic EL element was detected as an example, however, it is not limited to this. For example, modification examples may be cited as below.

[0064] (A1) As described above, since the luminance of the organic EL element decreases with the driving time, it is acceptable to constitute it in which the amount of the reverse bias voltage, the applying period or the like is changed on the basis of the cumulative driving time of the display panel **11**, that is to say, the organic EL element. In this case, the luminance decrease detector **17** may be constituted to be a circuit to calculate the cumulative driving time of the organic EL element of the display panel **11**.

[0065] (A2) As a direct method used against the luminance decrease of the organic EL element, it is acceptable to constitute it in which a light receiving element is provided so as to detect the emission luminance of the organic EL element so as to change the amount of the reverse bias voltage, the applying period or the like on the basis of the luminance decrease detected.

[0066] (A3) In the description of the above embodiment, the amount of the reverse bias voltage to be applied, the applying period or the like is determined in proportion to an increase of the forward voltage of the organic EL element, however, it is not limited to this. For example, the amount of the reverse bias voltage to the amount of the forward voltage of the organic EL element may be non-linear (super-linear or sub-linear). The point is that a decrease portion of the luminance of the organic EL element (change of a forward voltage) is compensated by an increase of the drain current of the driving TFT caused by applying the reverse bias voltage.

[0067] Furthermore, needless to say, the above embodiments and modification examples may be combined or modified to be used for the application. For example, it is possible to apply Embodiment 2 to a color display device (Embodiment 4), and constitute the monitoring OEL of each color R, G, B to be provided individually. In this case, since a dedicated monitoring OEL is used, it is possible to precisely detect the luminance decrease (change of a forward voltage) and to realize a color display device having an excellent color rendering property.

[0068] Furthermore, according to the luminance decrease of the organic EL element, both the amount and the applying period of the reverse bias voltage (or the voltage value and the width of the reverse bias voltage pulse) may be adjusted. In this case, it is possible to compensate the luminance decrease precisely in a dynamic range.

[0069] As described above in detail, according to the present invention, the chronological luminance decrease of the organic EL element is detected so that the reverse bias voltage is adjusted to apply to the driving TFT, which drives the organic EL element according to the amount of the luminance decrease. That is to say, the reverse bias voltage is adjusted and the driving current to drive the organic EL element is increased according to the luminance decrease, thereby compensating and reducing the chronological luminance decrease of the organic EL element.

[0070] Therefore, it is possible to precisely compensate the chronological luminance decrease of the organic EL element in the organic EL display and to provide a reliable organic EL display. Furthermore, it is possible to provide a reliable color display device having an excellent color rendering property.

REFERENCE SIGNS LIST

[0071] **10** . . . DISPLAY DEVICE

[0072] **11** . . . DISPLAY PANEL

[0073] **12** . . . SCANNING DRIVER

[0074] **13** . . . DATA DRIVER

[0075] **15** . . . CONTROLLER

[0076] **16** . . . POWER SOURCE DRIVING A LIGHT EMITTING ELEMENT

[0077] **17** . . . LUMINANCE DECREASE DETECTOR

[0078] **18** . . . REVERSE BIAS VOLTAGE GENERATOR

[0079] **21** . . . SELECTIVE TFT

[0080] **22** . . . DRIVING TFT

[0081] **24** . . . HOLDING CAPACITOR

[0082] **25** . . . ORGANIC EL ELEMENT

1. A display device having an active matrix type display panel consisting of a plurality of display cells, each of which has an organic EL (Electroluminescent) element and a driving transistor which drives the organic EL element on the basis of a data signal wherein each scanning line of the display panel is scanned in sequence, and the data signal is supplied to the display cell according to the scanning, to perform displays, the display device comprising:

a luminance decrease detector to detect a luminance decrease of the organic EL element;

a reverse bias voltage generator to generate a reverse bias voltage pulse according to an amount of the luminance decrease; and

a controller to control applying the reverse bias voltage pulse to the driving transistor in a time period in which the organic EL element emits no light.

2. The display device according to claim **1**, wherein the luminance decrease detector detects a luminance decrease of the organic EL element on the basis of an amount of a forward voltage of the organic EL element.

3. The display device according to claim **1**, further comprising a monitoring organic EL element different from the organic EL element of the plurality of display cells, wherein the luminance decrease detector detects a luminance decrease of the organic EL element on the basis of an amount of a forward voltage of the monitoring organic EL element.

4. The display device according to claim **1**, wherein the reverse bias voltage pulse has a voltage value according to an amount of the luminance decrease.

5. The display device according to **3** claim **1**, wherein the reverse bias voltage pulse has a pulse width according to an amount of the luminance decrease.

6. The display device according to claim **1**, wherein the driving transistor is an organic TFT (Thin Film Transistor).

7. The display device according to claim **1**, wherein the display cell includes an organic EL element of three colors; the luminance decrease detector detects a luminance decrease of each organic EL element of the three colors; the reverse bias voltage generator generates a reverse bias voltage pulse according to an amount of the luminance decrease of each organic EL element of the three colors; and the controller controls to apply the reverse bias voltage pulse to each organic EL element of the three colors in accordance with each organic EL element of the three colors in the display cell.

8. A driving method of a display device comprising an active matrix type display panel consisting of a plurality of display cells each having an organic EL (Electroluminescent) element and a driving transistor which drives the organic EL element on the basis of a data signal wherein each scanning line of the display panel is scanned in sequence, and the data signal is supplied to the display cell according to the scanning, to perform displays, the driving method comprising:

a step to detect a luminance decrease of the organic EL element;

a step to generate a reverse bias voltage pulse according to an amount of the luminance decrease; and

a step to control applying the reverse bias voltage pulse to the driving transistor in a time period in which the organic EL element emits no light.

9. The driving method according to claim **8**, wherein the step to detect the luminance decrease detects the luminance decrease on the basis of an amount of a forward voltage of the organic EL element.

10. The driving method according to claim **8**, wherein the display panel includes a monitoring organic EL element different from the organic EL element of the plurality of display cells,

so that the step to detect the luminance decrease detects a luminance decrease of the organic EL element on the basis of an amount of a forward voltage of the monitoring organic EL element.

11. The driving method according to claim **8**, wherein the reverse bias voltage pulse has a voltage value according to an amount of the luminance decrease.

12. The driving method according to claim **8**, wherein the reverse bias voltage pulse has a pulse width according to an amount of the luminance decrease.

13. The driving method according to claim **8**, wherein the driving transistor is an organic TFT (Thin Film Transistor).

* * * * *

专利名称(译)	有源矩阵型有机EL显示器件及其驱动方法		
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摘要(译)

为了控制有源矩阵驱动型有机EL显示器中的有机EL元件的时间亮度降低，并提供可靠的有机EL显示器。一种有机EL显示器，包括亮度降低检测器，用于检测有机EL元件的亮度降低;反向偏置电压发生器，用于根据亮度减少量产生反向偏置电压脉冲;控制器控制在有机EL元件不发光的时间段内将上述反向偏压信号施加到驱动晶体管。