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(54) **DISPLAY DEVICE**

ANZEIGEVORRICHTUNG

DISPOSITIF D’AFFICHAGE

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a display device including a self light emitting element.

2. Description of the Related Art

[0002] In recent years, organic EL displays have been actively developed, and have achieved a significant advancement. In a display device including a self light emitting element such as an organic EL element, light emission may be controlled pixel by pixel, and hence there are advantages in contrast and viewing angle characteristics. When used in video display or the like, there is also a merit that reduction in power consumption may be achieved because an average display gradation is low. Meanwhile, when the characteristics of the light emitting element themselves are deteriorated by its use, luminance reduction occurs in accordance with a usage history of each pixel. The luminance reduction occurs at a predetermined pattern depending on displayed images or the usage, and in some cases, the luminance reduction may be visually recognized as "screen burn-in."

[0003] In a case where an organic EL element is used as the light emitting element, light emission intensity is proportional to a current flowing through the element. The ratio between the light emission intensity and the current flowing through the element is called a current luminous efficiency. Normally, the current luminous efficiency is determined based on an organic material forming the light emitting element, an element structure, an interface state, or the like, and the current luminous efficiency is uniform across the entire display region. Therefore, when uniform display characteristics are desired to be obtained, it is only necessary to control, pixel by pixel, the current to be supplied to the light emitting element, so as to obtain uniform display. In an active matrix type organic EL display, the current is controlled by a thin film transistor (TFT) element provided in each pixel, and thus the organic EL element is driven. Generally, a low-temperature polycrystalline silicon TFT or the like is used as the TFT element.

[0004] As characteristics of the low-temperature polycrystalline silicon TFT, there is a problem in that, because of grain boundary scattering of conduction electrons, fluctuation in mobility or in turn-on voltage occurs among the pixels. Therefore, efforts have been made to obtain uniform display characteristics by suppressing the fluctuation in mobility or in turn-on voltage and by correcting the fluctuation, to thereby enable uniform pixel current supply. For example, Japanese Patent Application Laid-open No. 2005-217214 describes a technology in which the crystal-growth direction of the polysilicon is controlled to obtain crystalline grains of uniform shapes. Further,

there have been proposed many technologies for suppressing the fluctuation in mobility or in turn-on voltage and by correcting the fluctuation, to thereby enable uniform pixel current supply. For example, Japanese Patent Application Laid-open No. 2005-217214 describes a technology in which the crystal-growth direction of the polysilicon is controlled to obtain crystalline grains of uniform shapes. Further, there have been proposed many technologies for suppressing fluctuation in display characteristics caused by fluctuation in threshold voltage of the TFT, by adding, to a pixel circuit, a function to offset a threshold voltage of a drive TFT. For example, Japanese patent Application Laid-open No. 2008-203387 is proposed.

[0005] Here, the conventional technologies described above are based on the presupposition that the organic EL element maintains the in-plane uniformity of the current luminous efficiency. However, in actual use, the organic EL element itself is deteriorated by its use, and the current luminous efficiency is accordingly reduced. Reflecting the difference of the usage history among the pixels, the current luminous efficiency is reduced in different speed among the pixels. Depending on the usage of the display device and the displayed images, the difference of the deterioration speed among the organic EL elements may be increased to an extent not negligible. In this case, the difference is visually recognized as display luminance unevenness and screen burn-in. Generally, an organic EL display device life is defined by a luminance half-life. The luminance unevenness and the screen burn-in reach allowable limits thereof with the luminance difference of several percent, and hence the luminous efficiency reduction of the organic EL element is a cause of a significant reduction in device life. Therefore, there is a demand to compensate for the display luminance reduction caused by the current luminous efficiency reduction of the organic EL element.

[0006] Document US 2005/179626 A1 discloses a drive circuit for a light-emitting element that can be used in a display, and an exposing device that uses a light-emitting element as a load.

[0007] Document US 2006/0253755 A1 discloses a display unit comprising a first switch unit, a driving unit, a light-emitting unit, and a control circuit.

[0008] Document EP 1 135 764 A1 discloses an active matrix electroluminescent display device in which the drive current through an EL display element in each pixel in a drive period is controlled by a driving device based on a drive signal applied to the pixel in a preceding address period and stored as a voltage on an associated storage capacitor.

[0009] Document US 7,355,574 B1 discloses an OLED display with aging and efficiency compensation comprising a compensate drive circuit.

SUMMARY OF THE INVENTION

[0010] Some or all of the above problems are over-

come by a display device having the features of claim 1.

[0011] Further, it is preferred that the display device according to the present invention further includes the features of claim 2.

[0012] According to the present invention, the data signal is corrected in accordance with a change of the drive voltage (turn-on voltage) of the light emitting element, and hence it is possible to compensate for the drive current reduction caused by the data signal due to the deterioration of the light emitting element.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] In the accompanying drawings:

FIG. 1 is a diagram illustrating a configuration of a pixel circuit according to a first embodiment of the present invention;

FIG. 2 is a drive waveform diagram of the first embodiment;

FIG. 3 is a diagram illustrating a configuration of a pixel circuit according to a second embodiment of the present invention;

FIG. 4 is a drive waveform diagram of the second embodiment; FIG. 5A is a graph illustrating a relationship between a light emission luminance at a low current of an organic EL element and a voltage of the element;

FIG. 5B is a graph illustrating a relationship between a light emission luminance at a low current of an organic EL element and a voltage of the element;

FIG. 6 is a graph illustrating an example of pixel current simulation of the circuit of the second embodiment;

FIG. 7A is a graph illustrating an example of pixel luminance compensation calculation performed by the circuit of the second embodiment; and

FIG. 7B is a graph illustrating an example of pixel luminance compensation calculation performed by the circuit of the second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Hereinafter, embodiments of the present invention are described with reference to the attached drawings.

(Consideration of Current Luminous Efficiency Reduction)

[0015] Element characteristics of an organic EL element are deteriorated by its use. Generally, because of this deterioration, a current luminous efficiency of the element is reduced and an element drive voltage rise occurs. The cause of the current luminous efficiency reduction has not been completely figured out, but it is understood that generation of a non-radiative recombination

center, which is caused by change in properties of the light emitting material, causes the luminous efficiency reduction and the drive voltage rise (M. E. Kondakova et al., SID 09 DIGEST, p1677). As described in M. E. Kondakova et al., SID 09 DIGEST, p1677, there is a strong correlation between the drive voltage rise and the current luminous efficiency reduction of the organic EL element. Therefore, from the amount of the drive voltage rise, it is possible to predict the deterioration amount of the light emitting characteristics of the organic EL element. That is, the luminous efficiency reduction and the drive voltage (capacitance transition voltage) rise are substantially linear, and further, hardly depend on temperature. Here, the capacitance transition voltage is a voltage at which carriers are excited in an organic layer and a change in capacitance of the organic EL element is observed. As described in M. E. Kondakova et al., SID 09 DIGEST, p1677, the capacitance transition voltage rise can be explained by the generation of the non-radiative recombination center with a deep energy level.

[0016] Therefore, the recombination center acts as a trap, and I-V characteristics of the organic EL element are shifted simply to a positive direction of the voltage. With usage of this, the deterioration of the organic EL element may be compensated for with a method which is relatively simple. The capacitance transition voltage is a voltage at which the carriers start to increase in the element in accordance with voltage application, and hence, owing to the I-V characteristics, the capacitance transition voltage corresponds to a turn-on voltage of the element in broad perspective. The capacitance transition voltage rise is observed as a turn-on voltage rise of the element, and the entire drive voltage of the element increases in accordance with the turn-on voltage rise.

(Compensation for Current Luminous Efficiency Reduction)

[0017] Light emission intensity L from the organic EL element is proportional to a drive current I_d of the element. When the current luminous efficiency is represented by η , the following expression is satisfied.

$$L = \eta \cdot I_d \quad (1)$$

[0018] When a drive voltage rise of the organic EL element is represented by ΔV_{oled} , and it is assumed that ΔV_{oled} is proportional to a current luminous efficiency reduction $\Delta \eta$ of the element, the following expression is satisfied.

$$\Delta \eta = \kappa \Delta V_{oled} \quad (2)$$

where κ represents a constant that does not depend on temperature.

[0019] Meanwhile, the drive current I_d supplied from a TFT element may be expressed as follows.

$$I_d = (\beta/2) (V_g - V_{th})^2 \quad (3)$$

where β represents a transconductance, and V_g and V_{th} represent a gate-source voltage and a threshold voltage, respectively, of the drive TFT.

[0020] When a voltage proportional to a display data signal voltage V_{dat} and a drive voltage V_0 of the organic EL element is applied as the gate-source voltage V_g of the drive TFT, the following expression is satisfied.

$$V_g = V_{dat} (aV_0 + b) \quad (4)$$

[0021] Here, the drive voltage V_0 corresponds to the turn-on voltage of the organic EL element as described above. Hereinafter, the drive voltage V_0 is described as the turn-on voltage V_0 .

[0022] This may be realized by, in the circuit, adding V_{dat} and the multiplier output of V_{dat} and V_0 . Note that, "a" and "b" are constants determined based on designs of a multiplier circuit and an adder circuit.

[0023] Here, when it is assumed that the drive voltage of the organic EL element is changed by Δv by the deterioration of the element, V_g may be expressed as follows.

$$V_g = V_{dat} \{ aV_0^0 (1 + \Delta v) + b \} \quad (5)$$

where V_0^0 represents a drive voltage value of the organic EL element before the deterioration thereof.

[0024] Δv is considered to be sufficiently smaller than 1, and hence, from Expressions (1), (3), and (5), the light emission intensity L may be expressed as follows.

$$L \approx (\beta/2) V_{dat}^2 \cdot \xi^2 (1 - \Delta \eta) (1 + \lambda \Delta V_0)$$

[0025] Note that, the following expressions are satisfied.

$$\xi = aV_0^0 + b$$

$$\lambda = (2aV_0^0) / (aV_0^0 + b)$$

[0026] Here, when V_0 is determined so as to satisfy $\kappa = \lambda$, Expression (5) satisfies

$$L \approx (\beta/2) V_{dat}^2 \cdot \xi^2,$$

and hence the light emission intensity L from the organic EL element becomes substantially constant regardless of the luminous efficiency reduction of the element.

[0027] Therefore, it is found that, by applying the voltage proportional to the display data signal voltage V_{dat} and the turn-on voltage V_0 of the organic EL element, which is represented in Expression (4), as the gate-source voltage V_g of the drive TFT, and by appropriately setting the constant "b", it is possible to prevent the light emission intensity L from receiving influence from the current luminous efficiency η .

(First Embodiment)

[0028] FIG. 1 is a circuit diagram for one pixel according to a first embodiment of the present invention. The pixel includes a drive transistor T1, a write transistor T2, a transistor T3 which serves as a multiplier, a transistor T4 for controlling a multiplier input of the transistor T3, a storage capacitor Cs, and an organic EL element EL.

[0029] The drive transistor T1 has a drain connected to a power source 1 for supplying a high voltage V_{dd} , and a source connected to an anode of the organic EL element EL. A cathode of the organic EL element EL is connected to a power source 2 for supplying a low voltage V_{ss} . With this, a drive current flowing through the drive transistor T1 is supplied to the organic EL element EL. The storage capacitor Cs is connected between a gate and the source of the drive transistor T1.

[0030] The transistor T2 has a source connected to a data line dat, and a drain connected to a source of the transistor T3. Further, the transistor T3 has a drain connected to the gate of the drive transistor T1 and a gate connected to the anode of the organic EL element EL via the transistor T4.

[0031] A gate of the transistor T2 is connected to a selection control line sel, and a gate of the transistor T4 is connected to a merge control line mrg. The transistor T2 and the transistor T4 are controlled by voltages applied to those lines. A display data signal voltage V_{dat} and a constant voltage V_{blk} are alternately loaded to the data line dat. Here, the voltage V_{blk} is a constant voltage which turns OFF the drive transistor T1.

[0032] FIG. 2 illustrates signal waveforms at respective portions in the circuit of the first embodiment. With reference to FIG. 2, a method of driving the circuit is described. In FIG. 2, "dat" indicates a state of a signal of the data line dat, and the display data signal voltage V_{dat} , which is indicated by outlined periods, and a predetermined low voltage V_{blk} , which is indicated by black colored periods, are alternately applied to the data line dat. Hereinafter, description is made of an operation from a timing at which the selection control line sel is caused to rise up in FIG. 2. Note that, before the rising up of the selection control line sel, in the pixel, the organic EL element EL is driven by a current flowing through the drive transistor T1 in accordance with a voltage V_{gs1} stored in the storage capacitor Cs.

[0033] Under a state in which the voltage of the data line dat is set to the voltage V_{dat} , which is a predetermined high voltage, the selection control line sel is set to have a H level voltage and the merge control line mrg is also set to have a H level voltage. With this, the transistors T2 and T4 are turned ON. At this time, the gate of the transistor T3 is connected to the anode of the organic EL element EL. The anode of the organic EL element EL is set to have a voltage higher by V_{oled} , which corresponds to the voltage drop in the organic EL element EL, with respect to Vss (for example, 0 V) of a cathode potential. Therefore, the transistor T3 is also in an ON state.

[0034] Next, the voltage of the data line is set to V_{blk} , which is a predetermined low voltage, and V_{blk} is supplied from the data line dat to the gate (node na) of the drive transistor T1. V_{blk} is a low voltage, and hence the drive transistor T1 is turned OFF, and the potential of the anode (node nb) of the organic EL element EL is dropped to approach asymptotically to the turn-on voltage V_0 of the organic EL element EL. With this, V_0 is held at the gate of the transistor T3 via the transistor T4. At this stage, $V_0 - V_{blk}$ is stored in the storage capacitor Cs. Further, V_0 is a voltage higher than V_{blk} , and hence the transistor T3 is held in an ON state.

[0035] Next, the merge control line mrg is set to have a L level voltage, and the transistor T4 is turned OFF. Then, the data line dat is set to have the signal voltage V_{dat} . At this time, the turn-on voltage V_0 of the organic EL element EL is applied to the gate of the transistor T3, and the signal voltage V_{dat} is applied to the drain of the transistor T3.

[0036] When the transistor T3 is operated in a linear region, a current I_3 flowing through the transistor T3 is substantially proportional to V_{gs3} (which is proportional to V_0) and V_{ds3} of the transistor T3. That is, a current is caused to flow through the transistor T3 in accordance with a value obtained by multiplying V_0 and V_{dat} . With this current, the gate voltage rise of the drive transistor T1 occurs, and a current is caused to flow through the drive transistor T1, to thereby cause the organic EL element EL to emit light.

[0037] The current amount at this time is determined in accordance with the gate-source voltage V_{gs1} of the drive transistor T1. As described above, the gate voltage of the drive transistor T1 is proportional to V_0 at that time.

[0038] That is, the gate-source voltage V_{gs} is set as follows.

$$V_{gs} = V_{dat} * (aV_0 + b)$$

[0039] Note that, in FIG. 2, the data voltage V_{dat} is assumed to be a constant voltage. Therefore, before and after the writing of the data voltage V_{dat} is performed as described above, the data voltage V_{dat} is always recovered to the same voltage. In actual, the data voltage V_{dat} may have an arbitrary value, but description thereof is

similar to that of this embodiment, and hence the description is omitted.

[0040] As described above, according to the circuit of this embodiment, the gate-source voltage of the drive transistor T1 (=charged voltage of the storage capacitor Cs) when the transistor T2 is turned OFF is a voltage corresponding to a value obtained by multiplying V_0 , which is the gate voltage of the transistor T3, and V_{dat} , which is the drain voltage of the transistor T3. Note that, the transistor T4 is in the OFF state, and hence the voltage of the gate ng of the transistor T3 increases as the source voltage changes from V_{blk} to V_{dat} . Thus, the ON state of the transistor T3 is maintained.

[0041] That is, a voltage which is proportional to V_0 and V_{dat} (which corresponds to the voltage obtained by multiplying V_0 and V_{dat}) is applied as V_{gs1} of the drive transistor T1. Therefore, when V_0 increases with the deterioration of the organic EL element EL, a current supplied to the organic EL element EL with respect to the same signal voltage input V_{dat} increases, to thereby compensate for the deterioration amount of the luminous efficiency of the organic EL element EL.

[0042] In this embodiment, the pixel circuit compensates for only the luminous efficiency reduction of the organic EL element and the drive voltage rise. That is, it is preferred that the characteristic fluctuation of the drive TFT and the TFT deterioration by its use occur to a negligible extent. For example, this embodiment is preferred to be applied to a polycrystalline silicon TFT substrate, which has sufficient in-plane uniformity due to process optimization, or a microcrystalline silicon TFT substrate and an oxide TFT substrate, which have excellent in-plane uniformity and small drive TFT deterioration.

(Second Embodiment)

[0043] FIG. 3 is a circuit diagram according to a second embodiment of the present invention. The second embodiment exemplifies, in consideration of general application thereof, a circuit in which a function of compensating for a threshold voltage of the drive TFT is added besides compensating for luminous efficiency deterioration of the organic EL element. The circuit according to the second embodiment includes, in addition to the components of the circuit according to the first embodiment, a light emission control transistor T5 and a reset transistor T6. Therefore, the circuit of the second embodiment includes six transistors and one capacitor.

[0044] The transistor T5 is inserted in series between the power source 1 and the drive transistor T1. The transistor T5 turns ON/OFF the drive current and controls the light emission period. In order to reset the anode voltage of the organic EL element EL, the transistor T6 is disposed between the anode of the organic EL element EL and a power source 3 for supplying a voltage Vss2.

[0045] FIG. 4 illustrates drive voltage waveforms of the circuit according to the second embodiment. First, the merge control line mrg is set to have a H level voltage

so as to turn ON the transistor T4. At this time, the transistors T5 and T6 are turned OFF, and the transistor T2 is turned ON, and then a constant voltage V_{blk} is written from the data line. V_{blk} is a low voltage, and hence the potential of the anode (nb) of the organic EL element EL is set to be near the turn-on voltage V_0 of the organic EL element EL. At this time, the transistor T4 is in an ON state, and hence V_0 is held at the gate of the transistor T3.

[0046] Then, the transistor T4 is turned OFF and the transistor T6 is turned ON so that the anode of the organic EL element EL is connected to the power source 3, which has the predetermined low voltage V_{ss2} , to thereby reset the anode of the organic EL element EL to the voltage V_{ss2} . With this, the voltage of the organic EL element EL becomes equal to or lower than V_0 . Then, the transistor T6 is turned OFF to write the constant voltage V_{blk} to the gate of the drive transistor T1. Then, the transistor T5 is turned ON, to thereby cause a current to flow through the organic EL element EL. As a result, the anode potential of the organic EL element EL increases, and at a timing when the anode potential reaches $V_{\text{blk}} - V_{\text{th}}$ (at a timing when the gate-source voltage of the drive transistor T1 matches the threshold voltage V_{th} thereof), the drive transistor T1 is turned OFF.

[0047] Next, a desired signal voltage V_{dat} is written from the data line dat. At this time, a turn-on voltage V_0 of the organic EL element EL is applied to the gate of the transistor T3, and the signal voltage V_{dat} is applied to the drain of the transistor T3.

[0048] When the transistor T3 is operated in a linear region, the current I_3 flowing through the transistor T3 is substantially proportional to $V_{\text{gs}} (V_{\text{gs2}})$ and V_{ds} of the transistor T3. When the transistor T2 is turned OFF after a predetermined time period, at one terminal of the storage capacitor C_s on the gate side of the drive transistor T1, a potential obtained by adding V_{blk} to the voltage proportional to the gate voltage V_{gs2} and the drain voltage V_{dat} of the transistor T3 is held.

[0049] Meanwhile, the other terminal of the storage capacitor C_s is connected to the source of the drive transistor T1 and the anode of the organic EL element EL, and $V_{\text{gblk}} - V_{\text{th}}$ is held. That is, a voltage obtained by adding V_{th} to the voltage $(V_{\text{dat}} \cdot (aV_0 + b) + V_{\text{blk}})$ proportional to V_0 and V_{dat} is applied as $V_{\text{gs}} (V_{\text{gs1}})$ of the drive transistor T1.

[0050] As described above, in the second embodiment, the gate-source voltage V_{gs1} of the drive transistor T1 is offset by V_{th} , and hence the pixel current does not depend on the change of the threshold voltage V_{th} of the drive transistor T1. Further, the gate-source voltage V_{gs1} of the drive transistor T1 is proportional to V_0 and V_{dat} , and hence, when V_0 increases with the deterioration of the organic EL element EL, the pixel current increases, to thereby compensate for the luminous efficiency reduction of the organic EL element EL, which has a linear relation with the V_0 rise.

[0051] Hereinafter, effects are described with reference to the pixel circuit according to the second embodiment as an example. The deterioration characteristics

of the organic EL element are cited from the data of M. E. Kondakova et al., SID 09 DIGEST, p1677 as an example, and the pixel current is obtained by calculation by a circuit simulator.

[0052] FIGS. 5A and 5B are graphs illustrating a relationship between a luminance of the organic EL element, which is cited from the data of M. E. Kondakova et al., SID 09 DIGEST, p1677, and the capacitance transition voltage. After the organic EL element is driven under various temperatures to be deteriorated, the organic EL element is driven at a constant current under room temperature. The relative value of the luminance and the capacitance transition voltage rise at this time are measured, and the results are plotted. A relative change of the luminance when the organic EL element is driven at a constant current is the same as a relative change of the current luminous efficiency at that current density.

[0053] Further, as described above, the change of the capacitance transition voltage of the element is the same as the change of the element drive voltage (voltage corresponding to the turn-on potential of the element). FIG. 5A illustrates measurement results in a case where there is used an organic EL element in which NPB, C545T-doped Alq, and Alq are laminated and the element is driven under various temperatures to be deteriorated. FIG. 5B illustrates measurement results in a case where a red dopant RD3 or DCJTB is doped in a light emission layer, and the element is deteriorated under 65° C.

[0054] FIG. 6 illustrates simulation results of the pixel current when, in the circuit according to the second embodiment, the threshold voltage V_{th} of the drive transistor T1 is changed in the range of from 0 V to 2 V, and the turn-on voltage V_0 of the organic EL element is changed in the range of from 0 V to 1 V. It is found that the pixel current hardly depends on the change of V_{th} of the drive transistor T1, whereas the pixel current substantially linearly increases in accordance with the drive voltage (turn-on voltage) rise of the organic EL element.

[0055] Assuming that the organic EL element is each of the elements represented in FIGS. 5A and 5B, the change of the pixel luminance with respect to the deterioration of the organic EL element is calculated with the use of the results of FIG. 6. FIGS. 7A and 7B illustrate the relative change of the pixel luminance when the turn-on voltage of the organic EL element is changed by 0 V, 0.5 V, and 1 V, with V_{th} of the drive transistor T1 as a parameter.

[0056] In FIG. 7A, the deterioration characteristics of the organic EL element are assumed as those of the element represented in FIG. 5A. From FIG. 7A, it is found that, when the turn-on voltage of the organic EL element is changed in a range of from 0 V to 0.5 V, there is only a small difference in the relative value of the pixel luminance with respect to the change of V_{th} , and the change of V_{th} is sufficiently compensated for in the range of from 0 V to 2 V.

[0057] Meanwhile, it is found that the relative value of the pixel luminance with respect to the turn-on voltage

of the organic EL element hardly changes in the range of from 0 V to 0.5 V, and although there is a slight reduction when the turn-on voltage is 1 V, the reduction is noticeably compensated for compared with the case of about 75% (FIG. 5A) of the constant current light emission luminance relative value when the turn-on voltage change of the original organic EL element is 1 V.

[0058] In FIG. 7B, in which calculation is performed with respect to the organic EL element of FIG. 5B, further satisfactory effects are obtained, and although the organic EL element is deteriorated by about 25% (even when the turn-on voltage change of the organic EL element is 1 V in FIG. 5B), the relative value of the pixel luminance is substantially maintained to its initial value.

[0059] From the results described above, it is found that, by appropriately designing the compensation circuit of the second embodiment, it is possible to compensate for not only the V_{th} shift of the drive transistor (TFT) but also the drive voltage (turn-on voltage) change of the organic EL element and the luminous efficiency deterioration.

Claims

1. A display device, comprising a plurality of pixels arranged in matrix, wherein:

the each of the plurality of pixels comprises:

a light emitting element (EL) configured to emit light in accordance with a current flowing through the light emitting element (EL);
a drive transistor (T1) having a first current terminal connected to the light emitting element (EL) at a node (nb) and adapted to supply a drive current to the light emitting element (EL) and to control the drive current in accordance with a data signal representing a target luminance of the light emitting element (EL); and
a correction unit for correcting the data signal to be supplied to the drive transistor (T1) in accordance with a light emitting element voltage applied at both terminals of the light emitting element (EL), wherein

the correction unit is configured to apply to the gate of the drive transistor (T1) a corrected data voltage which is one of proportional to and has a positive correlation with the data signal and the light emitting element voltage such that the drive current to be supplied to the light emitting element (EL) increases with an increase in an amount of a voltage drop of the light emitting element (EL), the correction unit comprising:

a storage capacitor (Cs) having a first ter-

minal connected to the gate of the drive transistor (T1) and a second terminal, and a transistor (T4) for controlling a multiplier circuit having a first current terminal connected to the node (nb) and a second current terminal connected to the multiplier circuit,

characterized in that

the second terminal of the storage capacitor (Cs) is connected to the node (nb),
the correction unit further comprises a multiplier circuit having the data signal and the light emitting element voltage as inputs, the multiplier circuit included in the correction unit being formed of a single transistor element (T3) which has a source electrode and a gate electrode as inputs and a drain electrode as an output, the drain of the single transistor element (T3) being connected to the gate of the drive transistor (T1), the source of the single transistor element (T3) being adapted to receive the data signal and the gate of the single transistor element (T3) being connected to the second current terminal of the transistor (T4) for controlling a multiplier circuit.

2. The display device according to claim 1, further comprising in the each of the plurality of pixels a unit for offsetting the corrected data voltage applied to the gate of the drive transistor (T1) by an amount of fluctuation of the light emitting element voltage comprising a first power source (Vdd), a second power source (Vss2), a first additional transistor (T5) having a first current terminal connected to the first power source (Vdd) and a second current terminal connected to the second current terminal of the drive transistor (T1) and a second additional transistor (T6) having a first current terminal connected to the node (nb) and a second current terminal connected to the second power source (Vss2).

Patentansprüche

1. Anzeigeeinrichtung, die eine Mehrzahl von in einer Matrix angeordneten Pixeln umfasst, wobei:

jeder der Mehrzahl von Pixeln umfasst:

ein Licht emittierendes Element (EL), das dazu eingerichtet ist, Licht gemäß einem Strom zu emittieren, der durch das Licht emittierende Element (EL) fließt;
einen Antriebstransistor (T1) mit einem ersten Stromanschluss, der an einer Node (nb) mit dem Licht emittierenden Element (EL) verbunden und dazu eingerichtet ist, dem

Licht emittierenden Element (EL) einen Antriebsstrom zuzuführen und den Antriebsstrom gemäß einem Datensignal zu steuern, das eine Zielluminanz des Licht emittierenden Elements (EL) repräsentiert; und eine Korrekturereinheit zum Korrigieren des dem Antriebstransistor (T1) zuzuführenden Datensignals gemäß einer Spannung des Licht emittierenden Elements, die an beide Anschlüsse des Licht emittierenden Elements (EL) angelegt ist, wobei

die Korrekturereinheit dazu eingerichtet ist, an das Gate des Antriebstransistors (T1) eine korrigierte Datenspannung anzulegen, die proportional zu dem Datensignal und der Spannung des Licht emittierenden Elements ist oder eine positive Korrelation mit dem Datensignal und der Spannung des Licht emittierenden Elements hat, so dass der dem Licht emittierenden Element (EL) zuzuführende Antriebsstrom mit einer Zunahme eines Spannungsabfalls des Licht emittierenden Elements (EL) zunimmt, wobei die Korrekturereinheit umfasst:

einen Speicherkondensator (Cs) mit einem ersten Anschluss, der mit dem Gate des Antriebstransistor (T1) verbunden ist, und einem zweiten Anschluss, und einen Transistor (T4) zum Steuern einer Multiplizierschaltung mit einem ersten Stromanschluss, der mit der Node (nb) verbunden ist, und einem zweiten Stromanschluss, der mit der Multiplizierschaltung verbunden ist,

dadurch gekennzeichnet, dass

der zweite Anschluss des Speicherkondensators (Cs) mit der Node (nb) verbunden ist, die Korrekturereinheit ferner eine Multiplizierschaltung umfasst, die das Datensignal und die Spannung des Licht emittierenden Elements als Eingänge hat, wobei die in der Korrekturereinheit enthaltene Multiplizierschaltung aus einem einzigen Transistorelement (T3) gebildet ist, das eine Sourceelektrode und eine Gateelektrode als Eingänge und eine Drainelektrode als Ausgang hat, wobei das Drain des einzigen Transistorelements (T3) mit dem Gate des Antriebstransistor (T1) verbunden ist, die Source des einzigen Transistorelements (T3) dazu eingerichtet ist, das Datensignal zu empfangen und das Gate des einzigen Transistorelements (T3) mit dem zweiten Stromanschluss des Transistors (T4) zum Steuern einer Multiplizierschaltung verbunden ist.

2. Anzeigeeinrichtung nach Anspruch 1, die ferner in jedem der Mehrzahl von Pixeln eine Einheit zum Versetzen der an das Gate des Antriebstransistors (T1) angelegten Datenspannung um einen Fluktuationsbetrag der Spannung des Licht emittierenden Elements umfasst, die eine erste Energiequelle (Vdd), eine zweite Energiequelle (Vss2), einen ersten zusätzlichen Transistor (T5) mit einem ersten Stromanschluss, der mit der ersten Energiequelle (Vdd) verbunden ist, und einem zweiten Stromanschluss, der mit dem zweiten Stromanschluss des Antriebstransistors (T1) verbunden ist, und einen zweiten zusätzlichen Transistor (T6) mit einem ersten Stromanschluss, der mit der Node (nb) verbunden ist, und einem zweiten Stromanschluss, der mit der zweiten Energiequelle (Vss2) verbunden ist, umfasst.

Revendications

1. Dispositif d'affichage, comprenant une pluralité de pixels agencés en matrice, dans lequel :

chacun de la pluralité de pixels comprend :

un élément électroluminescent (EL) configuré pour émettre une lumière en fonction d'un courant traversant l'élément électroluminescent (EL) ;
un transistor d'attaque (T1) ayant une première borne de courant connectée à l'élément électroluminescent (EL) au niveau d'un noeud (nb) et adapté à délivrer un courant d'attaque à l'élément électroluminescent (EL) et à commander le courant d'attaque en fonction d'un signal de données représentant une luminance cible de l'élément électroluminescent (EL) ; et
une unité de correction pour corriger le signal de données devant être délivré au transistor d'attaque (T1) en fonction d'une tension d'élément électroluminescent appliquée aux deux bornes de l'élément électroluminescent (EL), dans lequel

l'unité de correction est configurée pour appliquer à la grille du transistor d'attaque (T1) une tension de données corrigée qui est un parmi proportionnelle à et a une corrélation positive avec le signal de données et la tension d'élément électroluminescent de telle sorte que le courant d'attaque devant être délivré à l'élément électroluminescent (EL) augmente avec une augmentation d'une quantité de chute de tension de l'élément électroluminescent (EL), l'unité de correction comprenant :

un condensateur de stockage (Cs) ayant une première borne connectée à la grille du transistor d'attaque (T1) et une deuxième borne, et
 un transistor (T4) pour commander un circuit multiplicateur ayant une première borne de courant connectée au noeud (nb) et une deuxième borne de courant connectée au circuit multiplicateur,

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caractérisé en ce que

la deuxième borne du condensateur de stockage (Cs) est connectée au noeud (nb),
 l'unité de correction comprend en outre un circuit multiplicateur ayant le signal de données et la tension d'élément électroluminescent comme entrées, le circuit multiplicateur inclus dans l'unité de correction étant constitué d'un unique élément de transistor (T3) qui a une électrode de source et une électrode de grille comme entrées et une électrode de drain comme une sortie, le drain de l'unique élément de transistor (T3) étant connecté à la grille du transistor d'attaque (T1),
 la source de l'unique élément de transistor (T3) étant adaptée à recevoir le signal de données et la grille de l'unique élément de transistor (T3) étant connectée à la deuxième borne de courant du transistor (T4) pour commander un circuit multiplicateur.

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2. Dispositif d'affichage selon la revendication 1, comprenant en outre dans chacun de la pluralité de pixels une unité pour décaler la tension de données corrigée appliquée à la grille du transistor d'attaque (T1) d'une quantité de fluctuation de la tension d'élément électroluminescent comprenant une première source d'énergie (Vdd), une deuxième source d'énergie (Vss2), un premier transistor additionnel (T5) ayant une première borne de courant connectée à la première source d'énergie (Vdd) et une deuxième borne de courant connectée à deuxième borne de courant du transistor d'attaque (T1) et un deuxième transistor additionnel (T6) ayant une première borne de courant connectée au noeud (nb) et une deuxième borne de courant connectée à la deuxième source d'énergie (Vss2).

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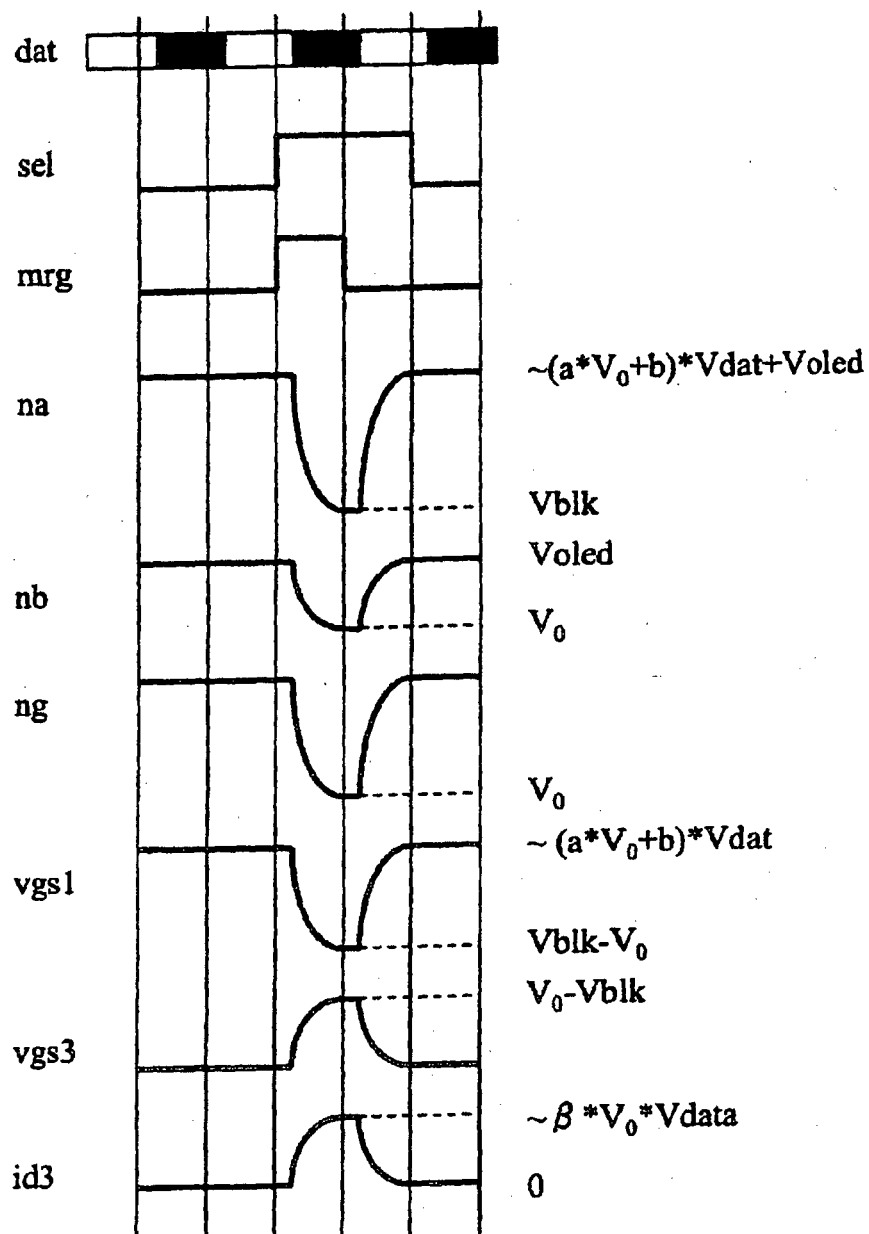
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FIG. 2



β : TRANSCONDUCTANCE OF T3
 a, b: CONSTANT DETERMINED BY DESIGN PARAMETER

FIG. 3

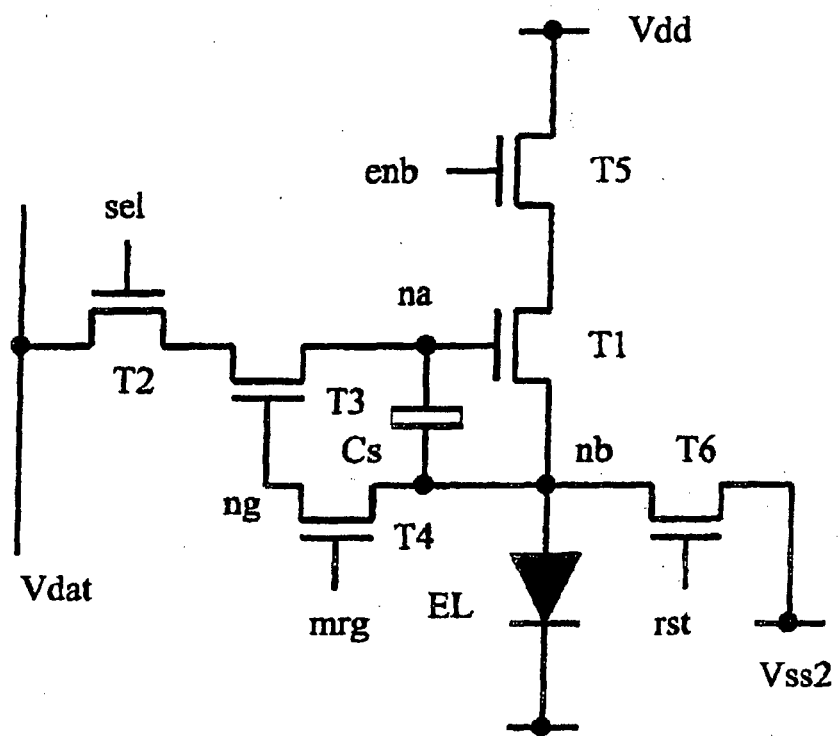


FIG. 4

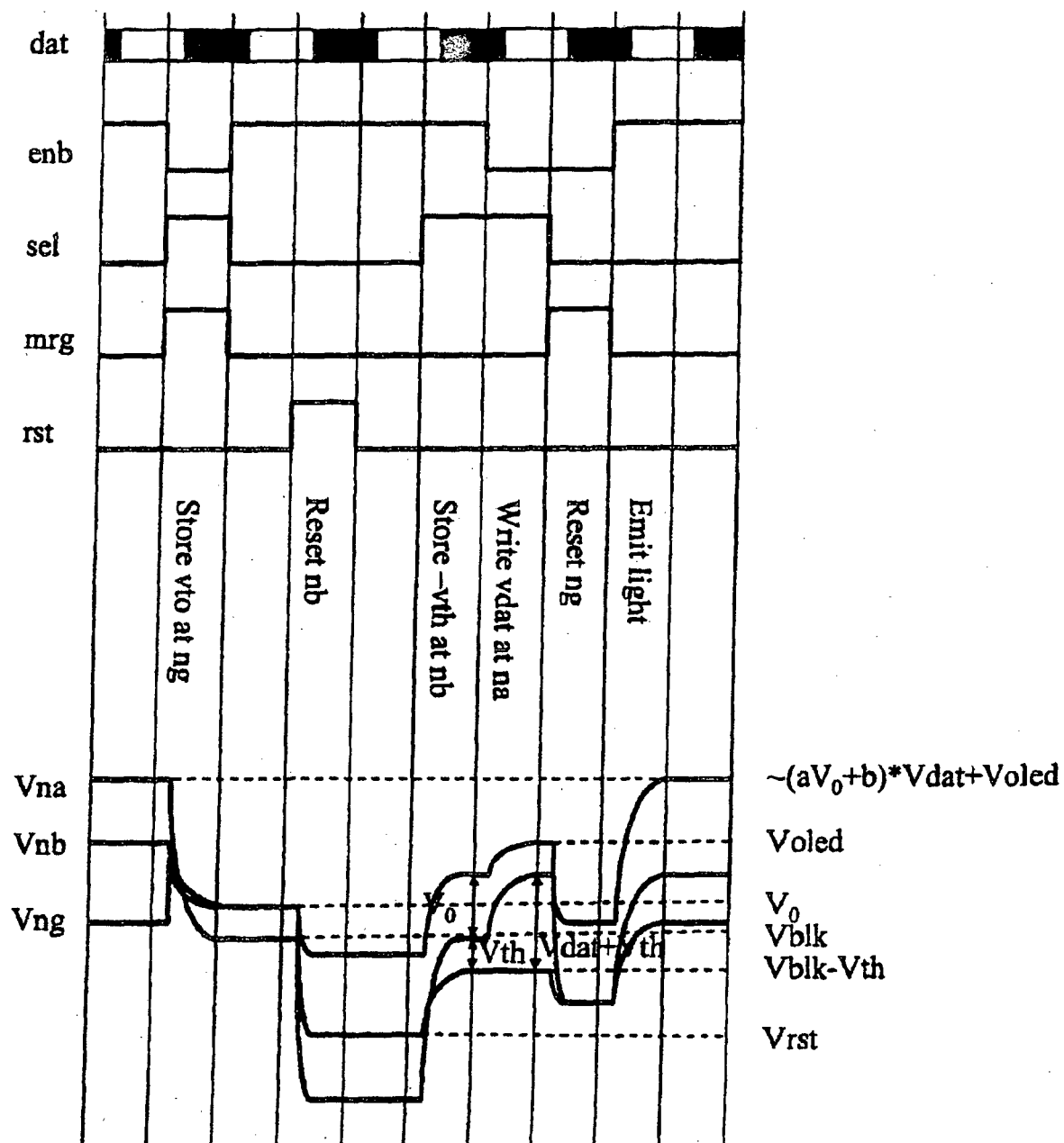


FIG. 5A

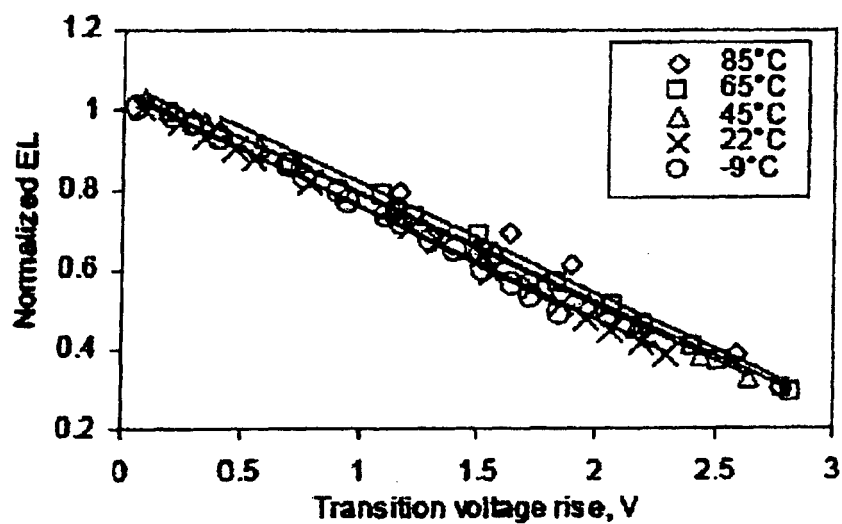


FIG. 5B

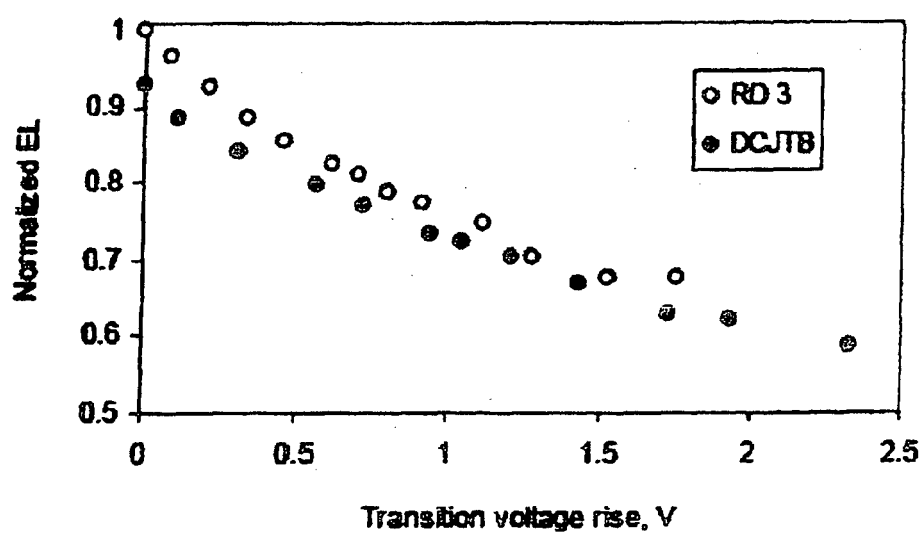
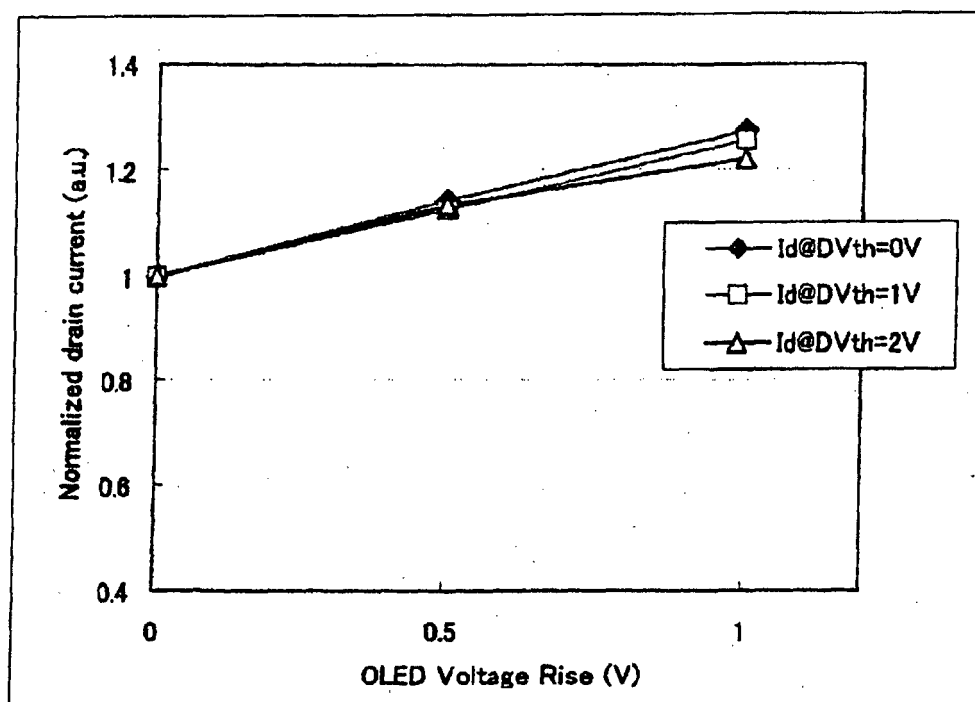
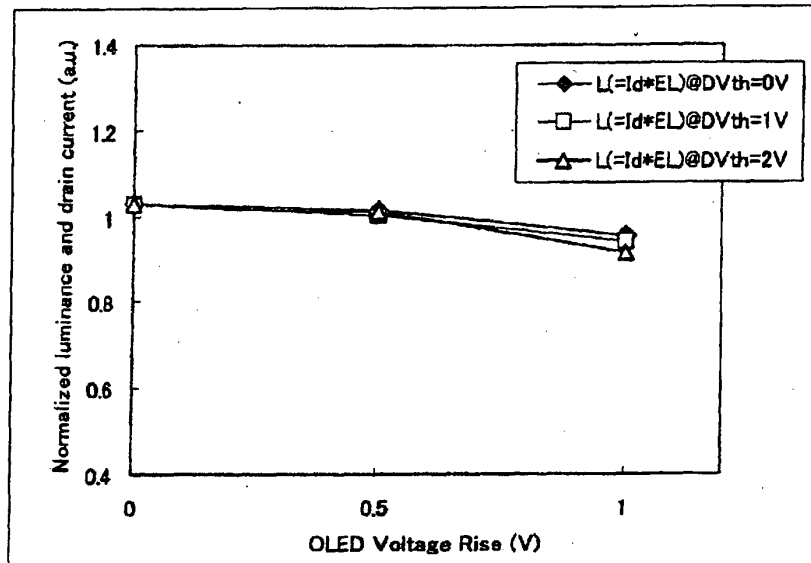


FIG. 6



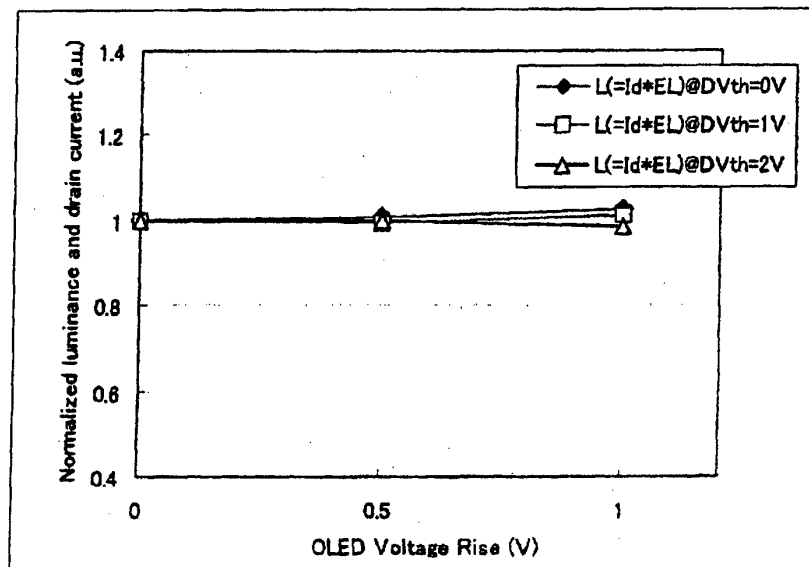
EXAMPLE OF PIXEL CURRENT SIMULATION OF
CIRCUIT OF SECOND EMBODIMENT

FIG. 7A



EXAMPLE OF PIXEL LUMINANCE CALCULATION OF
PIXEL CIRCUIT OF SECOND EMBODIMENT
(EL vs ΔV : C545T @22C [Ref.3])

FIG. 7B



EXAMPLE OF PIXEL LUMINANCE CALCULATION OF
PIXEL CIRCUIT OF SECOND EMBODIMENT
(EL vs ΔV : DCJTB @65C [Ref.3])

REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

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专利名称(译)	显示设备		
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申请(专利权)人(译)	全球OLED科技有限责任公司		
当前申请(专利权)人(译)	全球OLED科技有限责任公司		
[标]发明人	MIWA KOICHI		
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优先权	2010023285 2010-02-04 JP		
其他公开文献	EP2531993A1		
外部链接	Espacenet		

摘要(译)

为了补偿由发光元件的劣化引起的发光强度的变化，提供了一种包括驱动元件（T1）的显示装置，该驱动元件控制根据a提供给发光元件（EL）的驱动电流。表示发光元件（EL）的目标亮度的数据信号。发光元件（EL）根据流过发光元件（EL）的电流发光。根据施加在发光元件（EL）的两个端子处的电压来校正数据信号，使得要提供给发光元件（EL）的驱动电流随着电压降的量的增加而增加。发光元件（EL）。

