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(54) **Organic electroluminescent display device**

Organische elektrolumineszierende Anzeigevorrichtung

Dispositif d'affichage électroluminescent organique

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(73) Proprietor: **SEIKO EPSON CORPORATION**
Tokyo 163 (JP)

(72) Inventor: **Kimura, Mutsumi**
Suwa-shi, Nagano-ken 392-8502 (JP)

(74) Representative: **Sturt, Clifford Mark et al**
Miller Sturt Kenyon
9 John Street
London WC1N 2ES (GB)

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- **SARMA K R ET AL: "ACTIVE-MATRIX LCDS USING GRAY SCALE IN HALFTONE METHODS" PROCEEDINGS OF THE SID,US,SOCIETY FOR INFORMATION DISPLAY. PLAYA DEL REY, CA, vol. 31, no. 1, 1990, pages 7-11, XP000115902**

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Description

[0001] This invention relates to a display device, particularly a thin film transistor driven organic electro-luminescent display device (hereafter referred to as TFT-OELD) which is driven by a thin film transistor (hereafter referred to as TFT) and provided with an organic electro-luminescent element (hereafter referred to as OELD) preferably of a high polymer system formed in a liquid phase process and to a method of forming such a display device.

[0002] TFT-OELD is promising because it is a display device which realizes light-weightness, thinness, smallness, higher accuracy, wider view angle, lower electric consumption, and the like. Fig.1 shows a conventional TFT-OELD. Fig. 2 shows a cross-sectional view of a conventional TFT-OELD. Here, there is only one pixel 11 depicted, but there are actually many pixels 11 in plural rows and lines. Here, OELD 18 is a high polymer system, formed by a liquid phase process, such as spin coating, blade coating, ink jet, or the like.

[0003] In order to implement gradation, in the case of the structure shown in Fig. 1, a gate voltage of a driving TFT 17 is made to change and conductance is changed, so electric current which flows in the OELD 18 needs to be controlled. However, according to this method, particularly in halftone, irregularity of transistor characteristics of the driving TFT 17 appears as brightness irregularity of the OELD 18, and there is a problem such that the screen becomes non-uniform.

[0004] Therefore, as shown in Fig. 3, a method is considered which implements gradation by changing a light emitting area of the OELD 18 (Japanese Patent Application 9-233107). Fig. 4 shows a driving method of this display. A scanning electric potential 31 is applied to a scanning line 12, and a signal line 13 is formed of a signal line (lower bit) 131 and a signal line (upper bit) 132. A signal electric potential (lower bit) 321 and signal electric potential (upper bit) 322 are respectively applied as a signal electric potential 32. A driving TFT 17 is formed of a driving TFT (lower bit) 171 and a driving TFT (upper bit) 172, and the OELD 18 is formed of an OELD (lower bit) 181 and an OELD (upper bit) 182. In this example, 2-bit 4 gradation is considered, so an area ratio between OELD (lower bit) 181 and OELD (upper bit) 182 is 1:2.

[0005] In this method, the driving TFT 17 takes either a substantially completely on state or a substantially completely off state. In the on state, the resistance of the driving TFT 17 is small enough to be ignored, compared to the resistance of OELD 18, and the electric current amount which flows in the driving TFT 17 and OELD 18 is substantially determined by only the resistance of the OELD 18.

[0006] Therefore, irregularity of transistor characteristics of the driving TFT 17 does not appear as brightness irregularity of the OELD 18. Furthermore, in the off state, voltage applied to the OELD 18 becomes less than a threshold voltage, so the OELD 18 does not emit light at all, and, needless to say, irregularity of transistor characteristics of the driving TFT 17 does not appear as brightness irregularity of the OELD 18.

[0007] Fig. 5 is a cross-sectional view of TFT-OELD which implements gradation display by changing a light emitting area of the OELD 18 shown in Figs. 3 and 4. Fig. 5(a) is a cross-sectional view of the OELD (lower bit) 181, and Fig. 5(b) is a cross-sectional view of the OELD (upper bit) 182. The ratio between the light emitting part 25 of the OELD (lower bit) 181 and the light emitting part 25 of the OELD (upper bit) 182 is preferably 1:2.

[0008] A light emitting layer 22 is an OELD of a high polymer system and formed in a liquid phase process. A surface of a bank 24 is lyophobic and the light emitting layer 22 does not remain. Therefore, the area of the OELD 18 is determined by patterning. With respect to a side surface of the bank 24, the materials and processing determine whether the side surface of the bank 24 becomes lyophobic or lyophilic.

[0009] Fig. 5 shows the case of a lyophilic side surface of the bank 24. As a phenomenon that is characteristic of a liquid phase process, the light emitting layer 22 has a cross-sectional shape which is pulled toward the side surface of the bank 24. In this case, electric current flows into a thinner part of the light emitting layer 22, and this part becomes a light emitting part 25. The cross-sectional shape of the light emitting layer 22 described here is sensitive to liquid amount, liquid material, an initial position of the liquid, and a state, temperature, atmosphere, or the like of a substrate, and which are difficult to control. That is, it is difficult to obtain an absolute value of a desired light emitting area. Because of this, it is difficult to obtain an accurate ratio of 1:2, between the light emitting part 25 of the OELD (lower bit) 181 and the light emitting part 25 of the OELD (upper bit) 182, and ultimately, it is difficult to obtain accurate gradation.

[0010] Fig. 6 is a cross-sectional view of OELD (lower bit) 181 (Fig. 6(a)) and a cross-sectional view of OELD (upper bit) 182 (Fig. 6 (b)) in the same manner as in Fig. 5. In Fig. 6, the side surface of the bank 24 is lyophobic. As a phenomenon that is characteristic of a liquid phase process, the light emitting layer 22 has a cross-sectional shape which is distant from the side surface of the bank 24. In this case as well, electric current flows into the thinner part of the light emitting layer 22, and this part becomes the light emitting part 25. In this case as well, in the same manner as in the case of Fig. 5, it is difficult to obtain an accurate ratio of 1:2 between the light emitting part 25 of the OELD (lower bit) 181 and the light emitting part 25 of the OELD (upper bit) 182, so it is difficult to obtain accurate gradation.

[0011] Therefore, one aspect of this invention is to obtain an accurate ratio of the light emitting parts, and accurate gradation. Therefore, the invention may provide a display device in which gradation is implemented by forming a plurality of TFTs and a plurality of OELDs in each pixel, directly connecting the TFTs and OELDs,

switching an on and off state of the TFTs, and controlling an area of the OELDs, that emits light, wherein the plurality of OELDs have the same shape, and gradation is implemented by controlling the number of OELDs that are created to emit light.

[0012] According to this structure, as a characteristic phenomenon of a liquid phase process, even if an OELD becomes a cross-sectional shape which is pulled in to a side surface of a bank or is distant from the side surface of the bank, the light emitting part of each OELD is the same area, and accurate gradation can be obtained. In this structure as well, it is difficult to obtain an absolute value of a desired light emitting area, but the light emitting area of a plurality of OELDs becomes equal, so the ratio of the light emitting areas can be accurate by controlling the number OELDs.

[0013] The display device may also include a plurality of OELDs that have a round shape. According to this structure, the light emitting part of each OELD can reliably be the same area, and accurate gradation can be obtained. The reasons are as follows. When an OELD has a shape with a rectangular vertex (or vertices), there is a possibility that a phenomenon may occur, for example, that the vertex becomes pulled in or the vertex cannot be filled. This phenomenon prevents a user from obtaining accurate gradation for the same reason as in the problems of a cross-sectional shape as described above. This phenomenon is more sensitive to the liquid amount, liquid material, initial position of liquid, and the state, temperature, and atmosphere of a substrate, more so than the problems in a cross-sectional shape described above, and it is difficult to control this phenomenon between adjacent OELDs. By making the OELD round shaped, this phenomenon can be avoided.

[0014] The display device may also include a plurality of OELDs arranged at the same interval in a horizontal and/or vertical direction. According to this structure, the light emitting part of each OELD is made to be more reliably the same area, and accurate gradation can be obtained. The reasons are as follows. When an OELD is formed by spin coating or blade coating, the light emitting layer which is coated over all the pixels, due to the lyophobicity of a surface of the bank, the light emitting layer naturally flows into a convex part of the bank. In the case of ink jet as well, this may sometimes happen. At this time, when a concave area surrounded by a bank convex part is large, the light emitting layer coated over this part flows into a convex bank portion, so the light emitting layer becomes thick. When the convex area surrounded by the bank concave part is small, the light emitting layer becomes thin. Ultimately, irregularity of film thickness of the light emitting layer is generated. This irregularity can be avoided by arranging a plurality of OELDs at the same interval in a horizontal or vertical direction.

[0015] Additionally, according to this structure, when the OELDs are formed by an ink jet process, ink jetting can be performed at the same interval, so fabrication can be simplified.

[0016] Embodiments of the present invention will now be described, by way of further example only and with reference to the accompanying drawings, in which:-

Fig. 1 is a diagram showing a pixel of a conventional TFT-OELD which implements a gradation display by changing a TFT conductance;
Fig. 2 is a cross-sectional view of a TFT-OELD;
Fig. 3 is a diagram showing one pixel of a TFT-OELD which implements a gradation display by changing a conventional OELD light emitting area;
Fig. 4 is a diagram showing a TFT-OELD driving method which implements a gradation display by changing a conventional OELD light emitting area;
Figs. 5(a) and 5(b) are cross-sectional views of an OELD in a TFT-OELD which implements a gradation display by changing a conventional OELD light emitting area (when the side surface of the bank is lyophilic), where Fig. 5(a) is a diagram of an OELD (lower bit) and Fig. 5(b) is a diagram of an OELD (upper bit);
Figs. 6(a) and 6(b) are cross-sectional views of an OELD in a TFT-OELD which implements a gradation display by changing a conventional OELD light emitting area (when the side surface of the bank is lyophobic), where Fig. 6(a) is a diagram of an OELD (lower bit), and Fig. 6(b) is a diagram of an OELD (upper bit);
Fig. 7 is a diagram showing one pixel of a TFT-OELD related to embodiment 1 of this invention;
Fig. 8 is a diagram showing one pixel of a TFT-OELD related to embodiment 2 of this invention; and
Fig. 9 is a diagram showing one pixel of a TFT-OELD related to embodiment 3 of this invention.

[0017] The following explains preferred embodiments of this invention, based upon the drawings.

[0018] Fig. 7 is a diagram showing a pixel of a TFT-OELD related to a first embodiment of this invention. Here, only one pixel 11 is depicted, but many pixels 11 actually exist in a plurality of rows and a plurality of lines.

[0019] An OELD (lower bit) 181 is formed of OELD (lower bit·rectangular) 1811, and an OELD (upper bit) 182 is formed of OELD (upper bit·first·rectangular) 18211 and an OELD (upper bit·second·rectangular) 18221. The OELD (lower bit·rectangular) 1811, the OELD (upper bit·first·rectangular) 18221, and the OELD (upper bit·second·rectangular) 18221 have the same shape, so the same light emitting area can be obtained, and accurate gradation can be obtained by changing the number of OELDs that are caused to emit light.

[0020] Fig. 8 is a diagram showing a pixel of a TFT-OELD related to another embodiment of this invention. Here, only one pixel 11 is depicted, but many pixels 11 actually exist in a plurality of lines and a plurality of rows.

[0021] An OELD (lower bit) 181 is formed of an OELD (lower bit·round shape) 1812, and an OELD (upper bit)

182 is formed of OELD (upper bit·first·round shape) 18212 and OELD (upper bit·second·round shape) 18222. The OELD (lower bit·round shape) 1812, the OELD (upper bit·first·round shape) 18212, and the OELD (upper bit·second·round shape) 18222 have the same round shape, so the same light emitting area can be reliably obtained, and accurate gradation can be obtained.

[0022] Fig. 9 is a diagram showing a pixel of a TFT-OELD related to another embodiment of this invention. Here, only one pixel 11 is depicted, but many pixels 11 actually exist in a plurality of lines and a plurality of rows.

[0023] An OELD (lower bit) 181 is formed of an OELD (lower bit·round shape) 1812, and an OELD (upper bit) 182 is formed of an OELD (upper bit·first·round shape) 18212 and an OELD (upper bit·second·round shape) 18222. The OELD (lower bit·round shape) 1812, the OELD (upper bit·first·round shape) 18212, and the OELD (upper bit·second·round shape) 18222 are arranged at the same interval in horizontal and vertical directions within the pixel 11, and also with respect to the adjacent pixel 11. Because of this, the light emitting part of each OELD can more reliably have the same area, and accurate gradation can be obtained.

[0024] Furthermore, as an EL element formed in each pixel, in the first embodiment (Fig. 7), a rectangular element is shown as an example, and in the second and third embodiments (Figs. 8 and 9, respectively), a round-shaped element is shown, but this invention is not limited to these. Accurate gradation can also be obtained in a polygonal-or elliptic-shaped element. In particular, an elliptic element, as in the case of a round shape, does not have a vertex such as is present in the case of a rectangular shape, so there is no problem such that the vertex cannot be filled by the light emitting layer.

[0025] As described above, according to this invention, by controlling the area of an electro-luminescent element that emits light, accurate gradation can be realized.

Claims

1. A display device, comprising:

a plurality of thin film transistors formed in each pixel; and

a plurality of organic electro-luminescent elements formed in each pixel, the thin film transistors being connected to the organic electro-luminescent elements, the display device being adapted to switch an on and off state of the thin film transistors and to control the area which emits electro-luminescent light, **characterized in that**, each of the plurality of organic electro-luminescent elements has the same shape, and **in that** the display device implements gradation by controlling the number of organic electro-luminescent elements that emit light at any given time.

2. The display device as set forth in claim 1, wherein the plurality of organic electro-luminescent elements are round in shape.

3. The display device as set forth in claim 1, wherein the plurality of organic electro-luminescent elements are arranged in horizontal and vertical directions at equal intervals.

4. The display device as set forth in claim 1, wherein the plurality of organic electro-luminescent elements are arranged in a horizontal direction at equal intervals.

5. The display device as set forth in claim 1, wherein the plurality of organic electro-luminescent elements are arranged in a vertical direction at equal intervals.

6. A method of forming a display device, comprising:

forming a plurality of thin film transistors and a plurality of organic electro-luminescent elements in each pixel;

inter-connecting the thin film transistors and the organic electro-luminescent elements;

adapting the display device to switch an on and off state of the thin film transistors;

and to control the area which emits electro-luminescent light,

characterized by

controlling the number of organic electro-luminescent elements that emit light to implement gradation;

each of the plurality of organic electro-luminescent elements being formed to have the same shape.

7. The method as set forth in claim 6, comprising the step of forming the plurality of organic electro-luminescent elements to be round in shape.

8. The method as set forth in claim 6, comprising the step of forming the plurality of organic electro-luminescent elements in horizontal and vertical directions at equal intervals.

9. The method as set forth in claim 6, comprising the step of forming the plurality of organic electro-luminescent elements in a horizontal direction at equal intervals.

10. The method as set forth in claim 6, comprising the

step of forming the plurality of organic electro-luminescent elements in a vertical direction at equal intervals.

Patentansprüche

1. Anzeigevorrichtung, umfassend:

mehrere Dünnschichttransistoren, die in jedem Pixel ausgebildet sind; und
mehrere organische Elektrolumineszenz-Elemente, die in jedem Pixel ausgebildet sind, wobei die Dünnschichttransistoren mit den organischen Elektrolumineszenz-Elementen verbunden sind, und wobei die Anzeigevorrichtung dafür ausgelegt ist, den Zustand der Dünnschichttransistoren ein- und auszuschalten und die Fläche, die Elektrolumineszenz-Licht emittiert, zu steuern,

dadurch gekennzeichnet, daß
jedes der mehreren organischen Elektrolumineszenz-Elemente die gleiche Form aufweist, und
die Anzeigevorrichtung eine Abstufung implementiert durch Steuern der Anzahl der organischen Elektrolumineszenz-Elemente, die zu irgendeinem gegebenen Zeitpunkt Licht emittieren.

2. Anzeigevorrichtung nach Anspruch 1, bei der die mehreren organischen Elektrolumineszenz-Elemente eine runde Form aufweisen.

3. Anzeigevorrichtung nach Anspruch 1, bei der die mehreren organischen Elektrolumineszenz-Elemente in horizontalen und vertikalen Richtungen in gleichen Intervallen angeordnet sind.

4. Anzeigevorrichtung nach Anspruch 1, bei der die mehreren organischen Elektrolumineszenz-Elemente in einer horizontalen Richtung in gleichen Intervallen angeordnet sind.

5. Anzeigevorrichtung nach Anspruch 1, bei der die mehreren organischen Elektrolumineszenz-Elemente einer vertikalen Richtung in gleichen Intervallen angeordnet sind.

6. Verfahren zur Ausbildung einer Anzeigevorrichtung, umfassend:

Ausbilden mehrerer Dünnschichttransistoren und mehrerer organischer Elektrolumineszenz-Elemente in jedem Pixel;
Verbinden der Dünnschichttransistoren und der organischen Elektrolumineszenz-Elemente;
Auslegen der Anzeigevorrichtung zum Ein- und Ausschalten des Zustands der Dünnschichttransistoren und zum Steuern der Fläche, die Elektrolumineszenz-Licht emittiert,

dadurch gekennzeichnet, daß
die Anzahl der organischen Elektrolumineszenz-Elemente, die Licht emittieren, gesteuert wird, um eine Abstufung zu implementieren; und
jedes der mehreren organischen Elektrolumineszenz-Elemente so geformt ist, daß es die gleiche Form aufweist.

7. Verfahren nach Anspruch 6, das den Schritt des Ausbildens der mehreren organischen Elektrolumineszenz-Elemente in einer runden Form umfaßt.

8. Verfahren nach Anspruch 6, das den Schritt des Ausbildens der mehreren organischen Elektrolumineszenz-Elemente in horizontalen und vertikalen Richtungen in gleichen Intervallen umfaßt.

9. Verfahren nach Anspruch 6, das den Schritt des Ausbildens der mehreren organischen Elektrolumineszenz-Elemente in einer horizontalen Richtung in gleichen Intervallen umfaßt.

10. Verfahren nach Anspruch 6, das den Schritt des Ausbildens der mehreren organischen Elektrolumineszenz-Elemente in einer vertikalen Richtung in gleichen Intervallen umfaßt.

Revendications

1. Dispositif d'affichage comprenant :

une pluralité de transistors à couches minces formée dans chaque pixel ; et
une pluralité d'éléments organiques électroluminescents formée dans chaque pixel, les transistors à couches minces étant reliés aux éléments organiques électroluminescents, le dispositif d'affichage étant adapté pour faire passer les transistors à couches minces d'un état non bloqué à un état bloqué et pour contrôler la zone qui émet une lumière électroluminescente, **caractérisé en ce que** chaque élément parmi la pluralité d'éléments organiques électroluminescents a la même forme, et **en ce que** le dispositif d'affichage met en oeuvre une gradation en contrôlant le nombre d'éléments organiques électroluminescents qui émettent de la lumière à n'importe quel moment donné.

2. Dispositif d'affichage selon la revendication 1, dans lequel la pluralité d'éléments organiques électroluminescents est de forme ronde.

3. Dispositif d'affichage selon la revendication 1, dans lequel la pluralité d'éléments organiques électroluminescents est agencée dans des sens horizontal et vertical à intervalles égaux.

4. Dispositif d'affichage selon la revendication 1, dans lequel la pluralité d'éléments organiques électroluminescents est agencée dans un sens horizontal à intervalles égaux.

5. Dispositif d'affichage selon la revendication 1, dans lequel la pluralité d'éléments organiques électroluminescents est agencée dans un sens vertical à intervalles égaux.

6. Procédé de formation d'un dispositif d'affichage, comprenant :

la formation d'une pluralité de transistors à couches minces et d'une pluralité d'éléments organiques électroluminescents dans chaque pixel ;
l'interconnexion des transistors à couches minces et des éléments organiques électroluminescents ;
l'adaptation du dispositif d'affichage pour mettre les transistors à couches minces à l'état non bloqué et bloqué ;
et le contrôle de la zone qui émet une lumière électroluminescente, **caractérisé par** le contrôle du nombre d'éléments organiques électroluminescents qui émettent de la lumière pour mettre en oeuvre une gradation ;
chaque élément parmi la pluralité d'éléments organiques électroluminescents étant formé pour avoir la même forme.

7. Procédé selon la revendication 6, comprenant l'étape consistant à former la pluralité d'éléments organiques électroluminescents pour qu'ils soient de forme ronde.

8. Procédé selon la revendication 6, comprenant l'étape consistant à former la pluralité d'éléments organiques électroluminescents dans des sens horizontal et vertical à intervalles égaux.

9. Procédé selon la revendication 6, comprenant l'étape consistant à former la pluralité d'éléments organiques électroluminescents dans un sens horizontal à intervalles égaux.

10. Procédé selon la revendication 6, comprenant l'étape consistant à former la pluralité d'éléments organiques électroluminescents dans un sens vertical à intervalles égaux.

Fig. 1

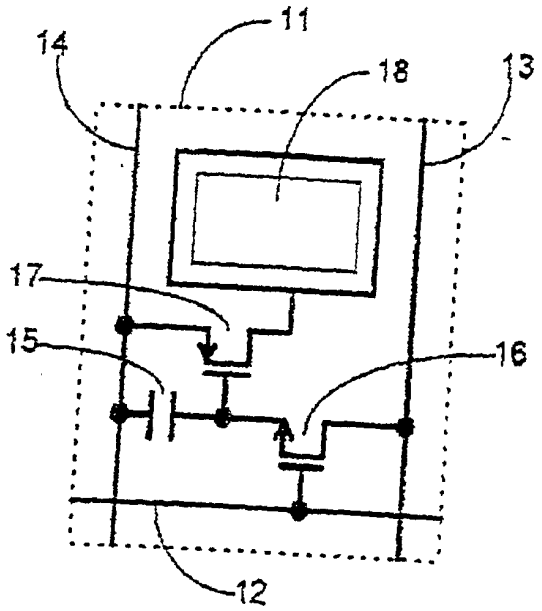


Fig. 2

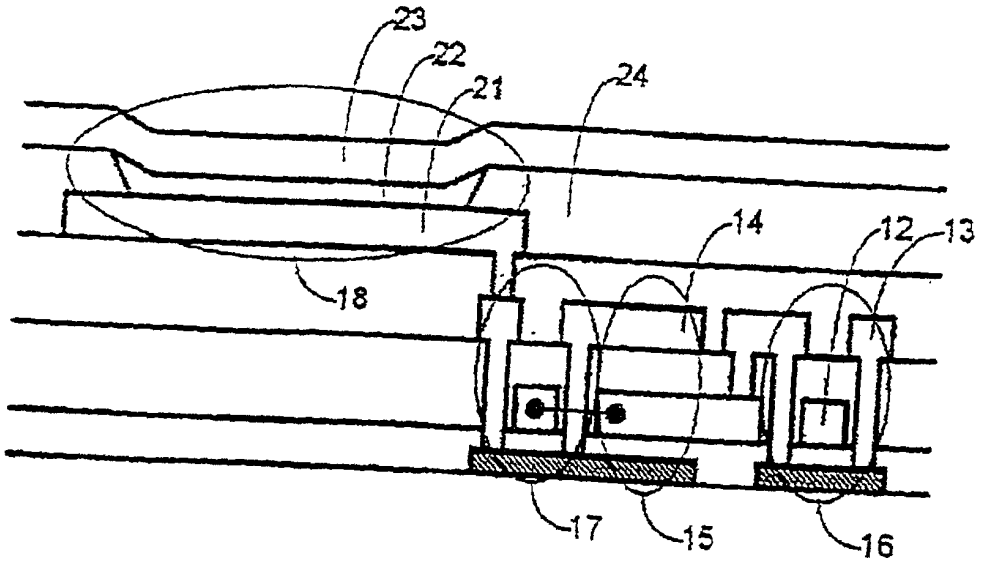


Fig. 3

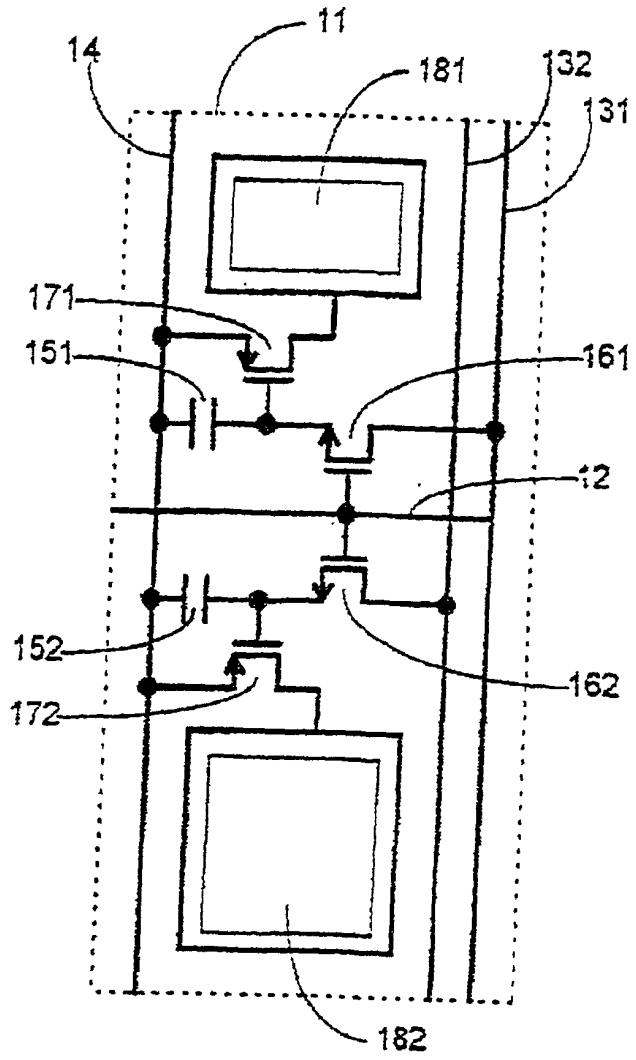


Fig. 4

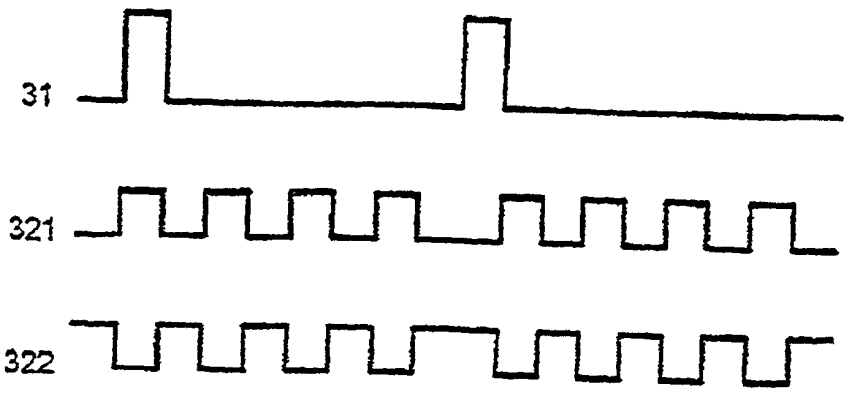


Fig. 5

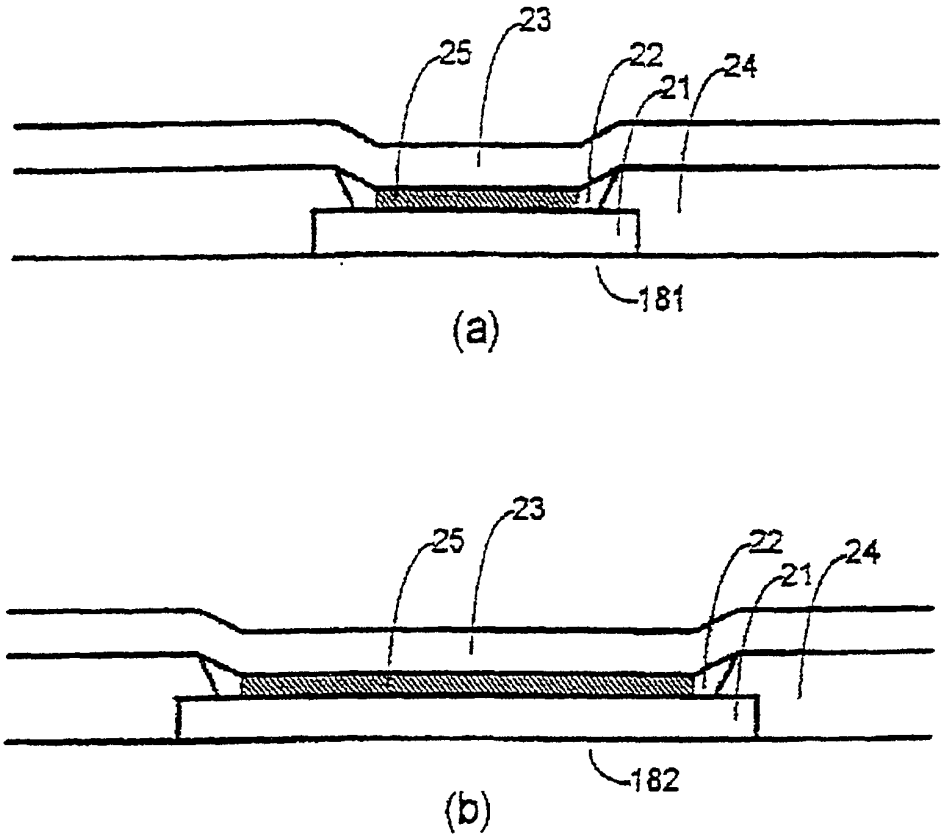


Fig. 6

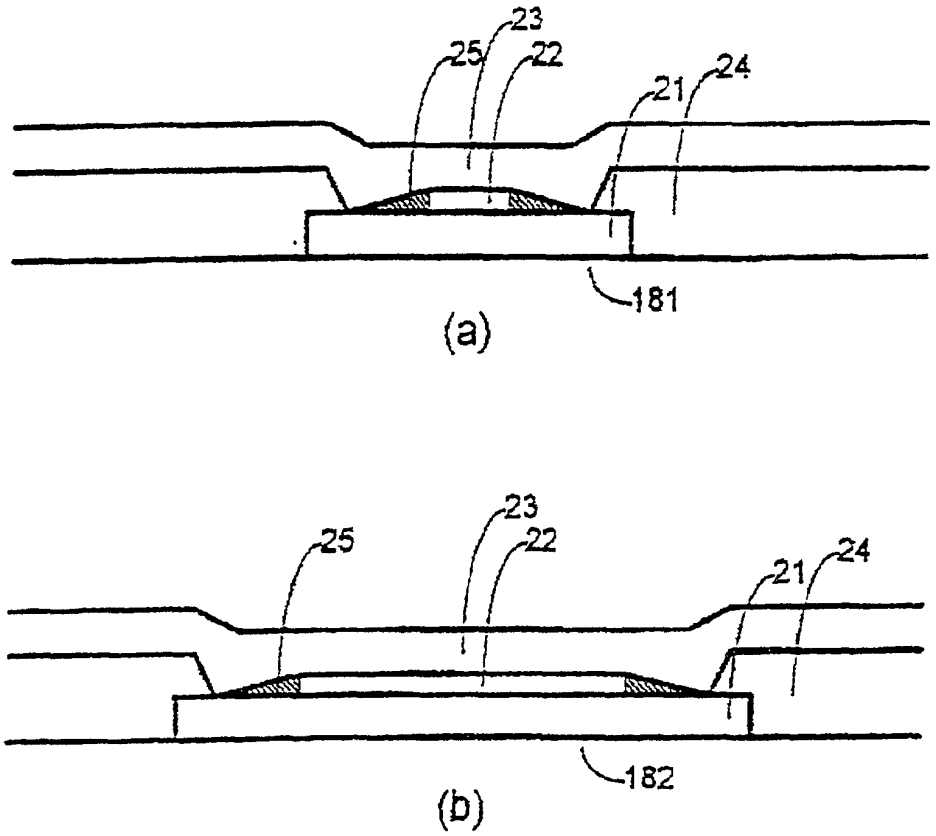


Fig. 7

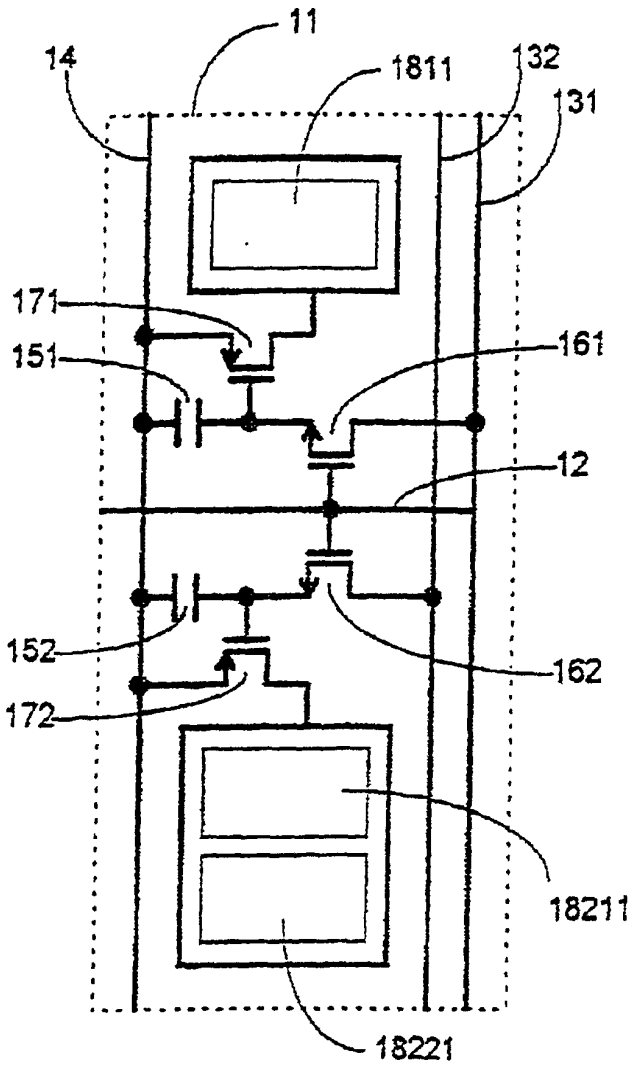


Fig. 8

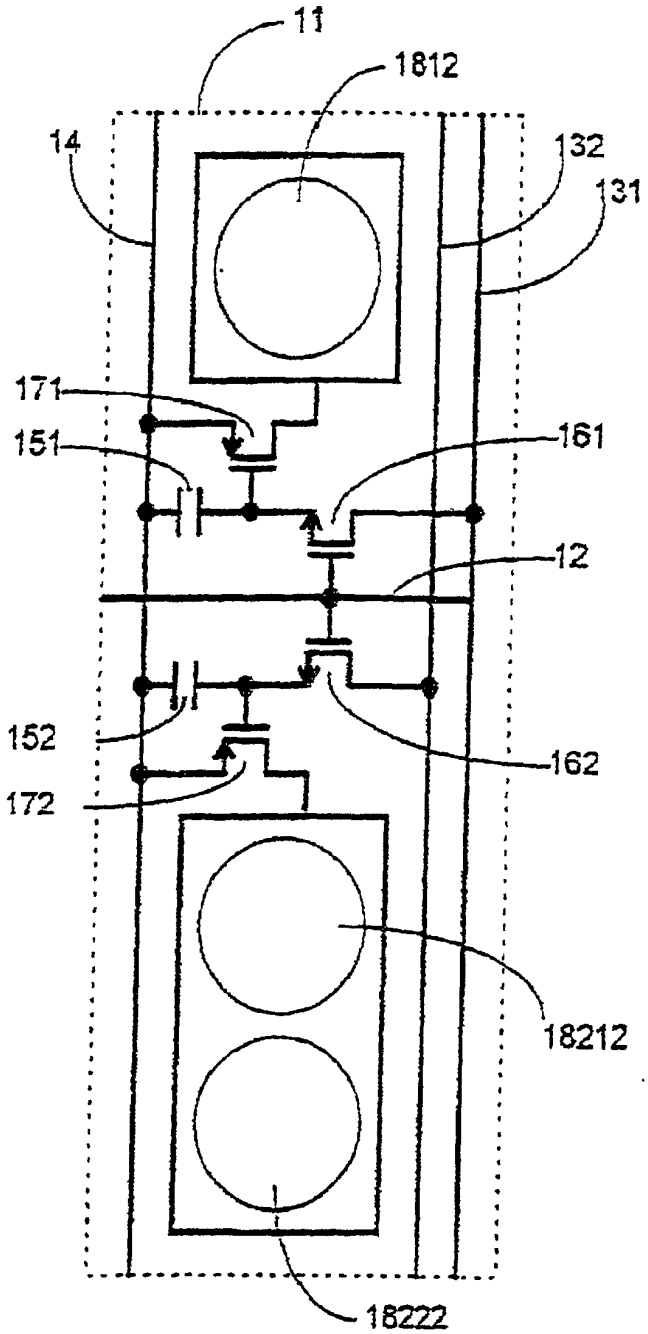
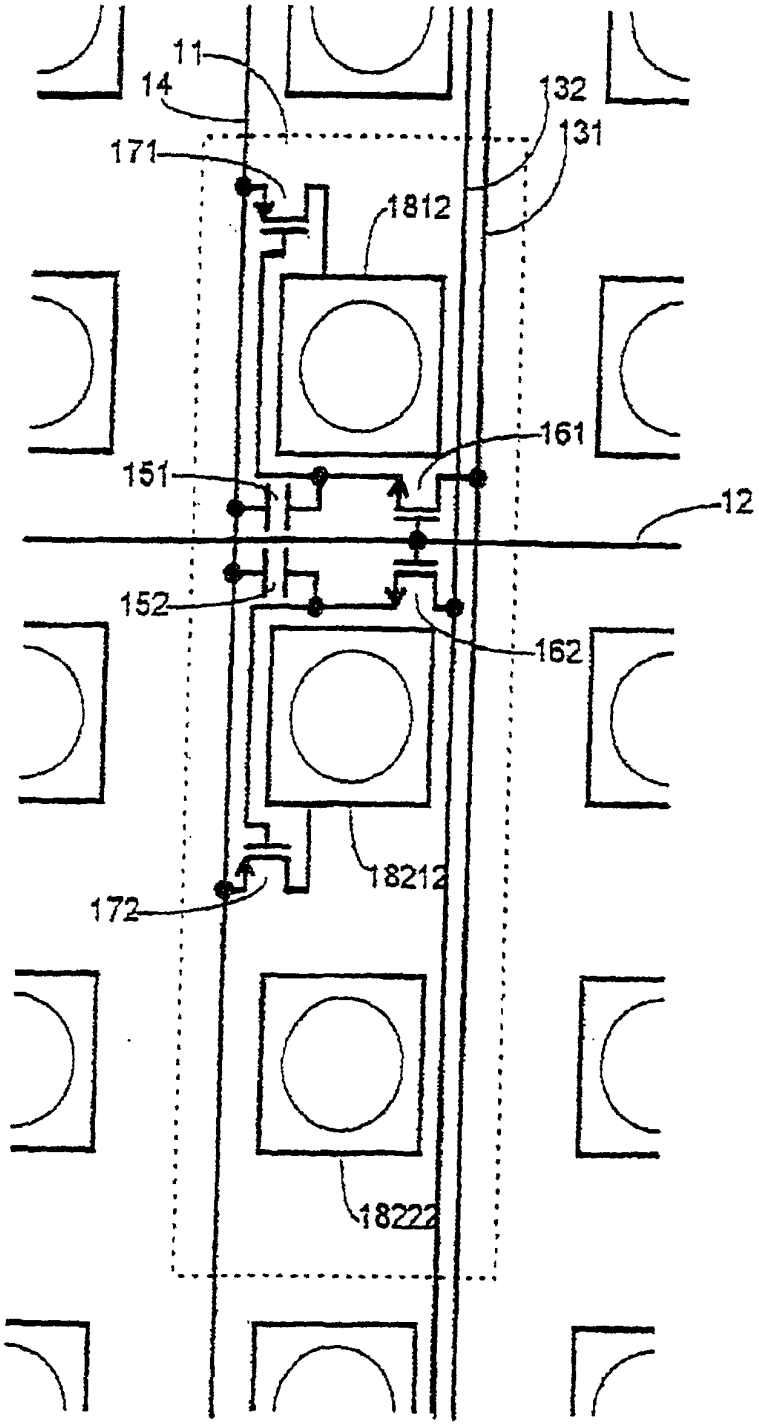


Fig. 9



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当前申请(专利权)人(译)	SEIKO EPSON CORPORATION		
[标]发明人	KIMURA MUTSUMI		
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外部链接	Espacenet		

摘要(译)

本发明提供了一种方法和装置，通过在显示装置中获得精确的发光部分比率来获得精确的灰度，该显示装置通过在每个像素中形成多个TFT和多个OELD来实现灰度，互连TFT和OELD，以及切换TFT的导通和截止状态，以及控制OELD的发光区域。多个OELD具有相同的形状，并且可以通过控制在给定时间发光的OELD的数量来实现灰度。优选地，多个OELD具有圆形形状。同样优选地，多个OELD在垂直和/或水平方向上以相同的间隔排列。根据该结构，因为多个OELD的发光区域彼此相等，所以通过控制OELD的数量，可以精确地获得发光区域的比率。

Fig. 1

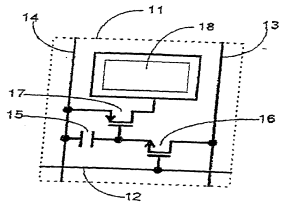

Fig. 2