US 20250265984A1

(19) United States
(12) Patent Application Publication
OHSHITANAI
(10) Pub. No.: US 2025/0265984 A1
(43) Pub. Date: Aug. 21, 2025

(54) **LIGHT EMITTING APPARATUS, IMAGE FORMING APPARATUS, DISPLAY APPARATUS, PHOTOELECTRIC CONVERSION APPARATUS, ELECTRONIC DEVICE, ILLUMINATION APPARATUS, MOVING BODY, AND WEARABLE DEVICE**

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(21) Appl. No.: **19/039,028**

(22) Filed: **Jan. 28, 2025**

(30) **Foreign Application Priority Data**

Feb. 15, 2024 (JP) 2024-021447

Publication Classification

(51) **Int. Cl.**
G09G 3/3225 (2016.01)

(52) **U.S. Cl.**
CPC ... ***G09G 3/3225*** (2013.01); *G09G 2300/0426* (2013.01); *G09G 2300/0828* (2013.01); *G09G 2310/08* (2013.01); *G09G 2330/028* (2013.01)

(57) **ABSTRACT**

A light emitting apparatus includes a pixel array portion including a plurality of pixels, and a plurality of signal lines extending in a column direction. Each of the signal lines is divided into a plurality of sub-signal lines, the apparatus is configured such that, to the pixels of the same column, a signal generated using an output signal from the same reference voltage generation circuit is supplied via a corresponding sub-signal line, the apparatus includes first and second substrates, which are stacked on each other, the first substrate includes the pixel array portion, and the second substrate includes a signal output circuit configured to output the signal, and a signal line switching circuit configured to switch a connection destination of an output of the signal output circuit between the sub-signal lines.

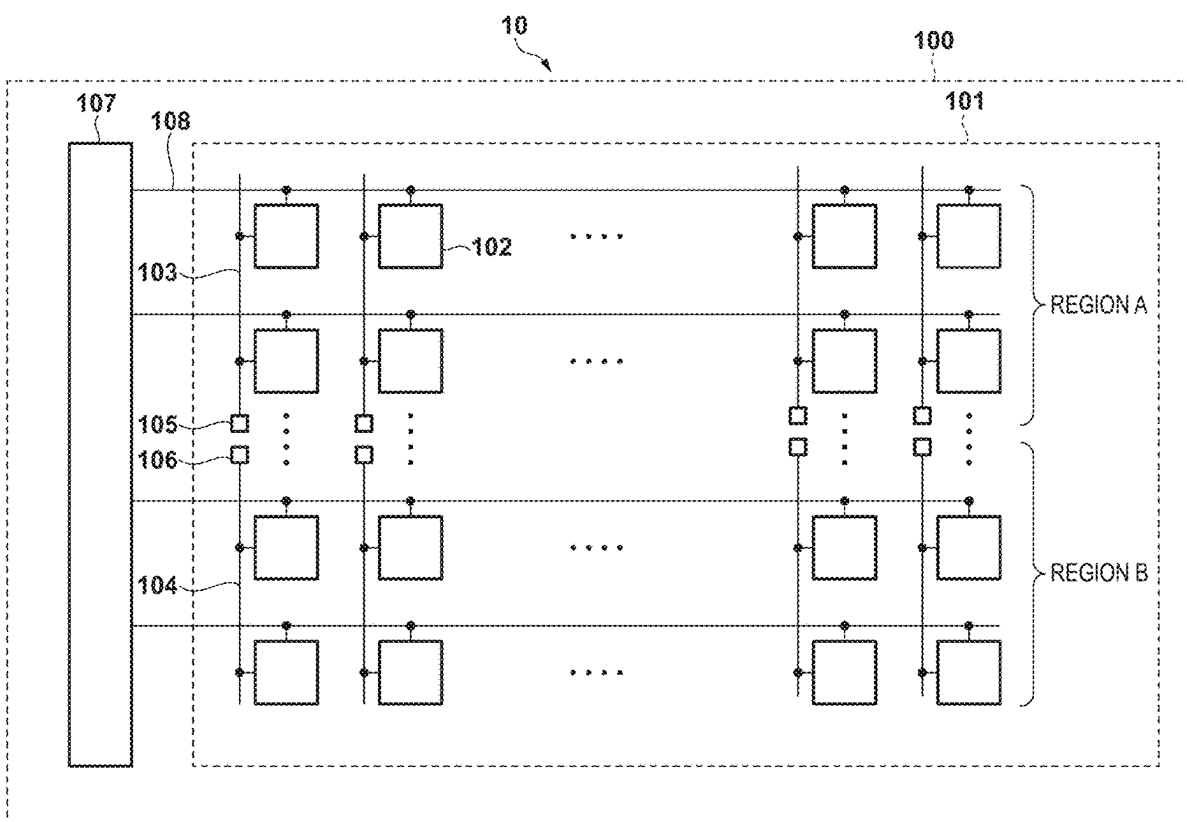


FIG. 1

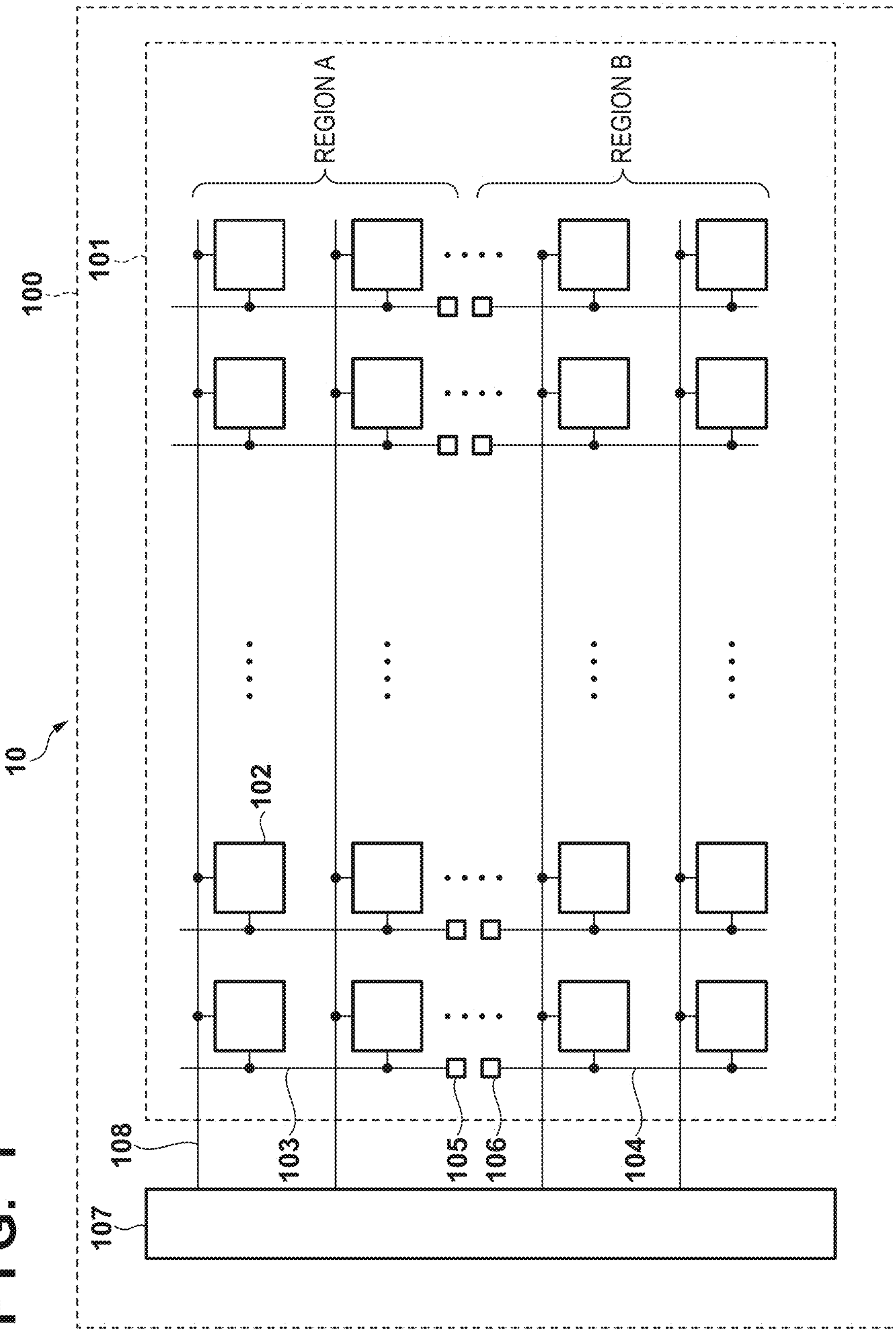


FIG. 2

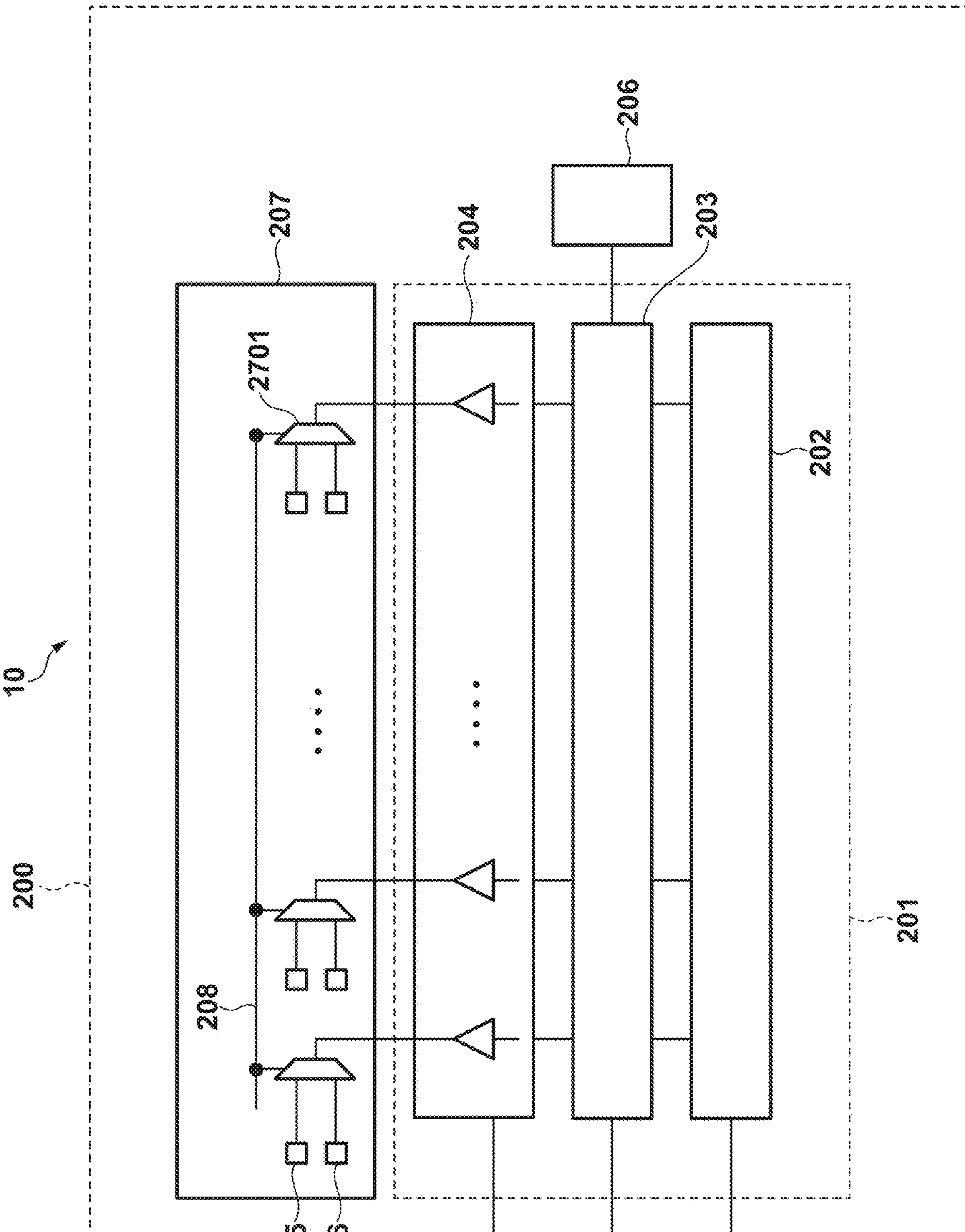


FIG. 3

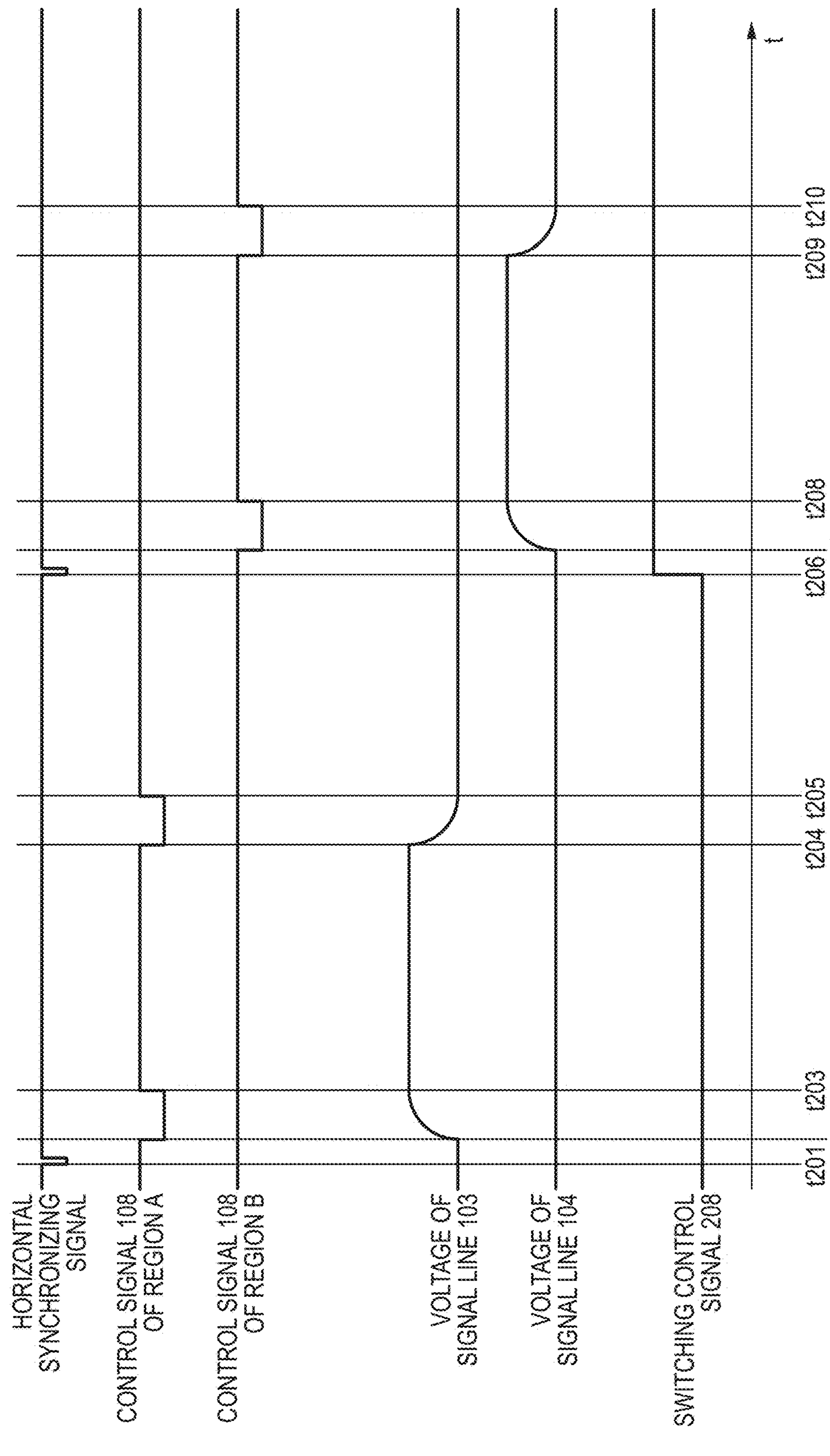
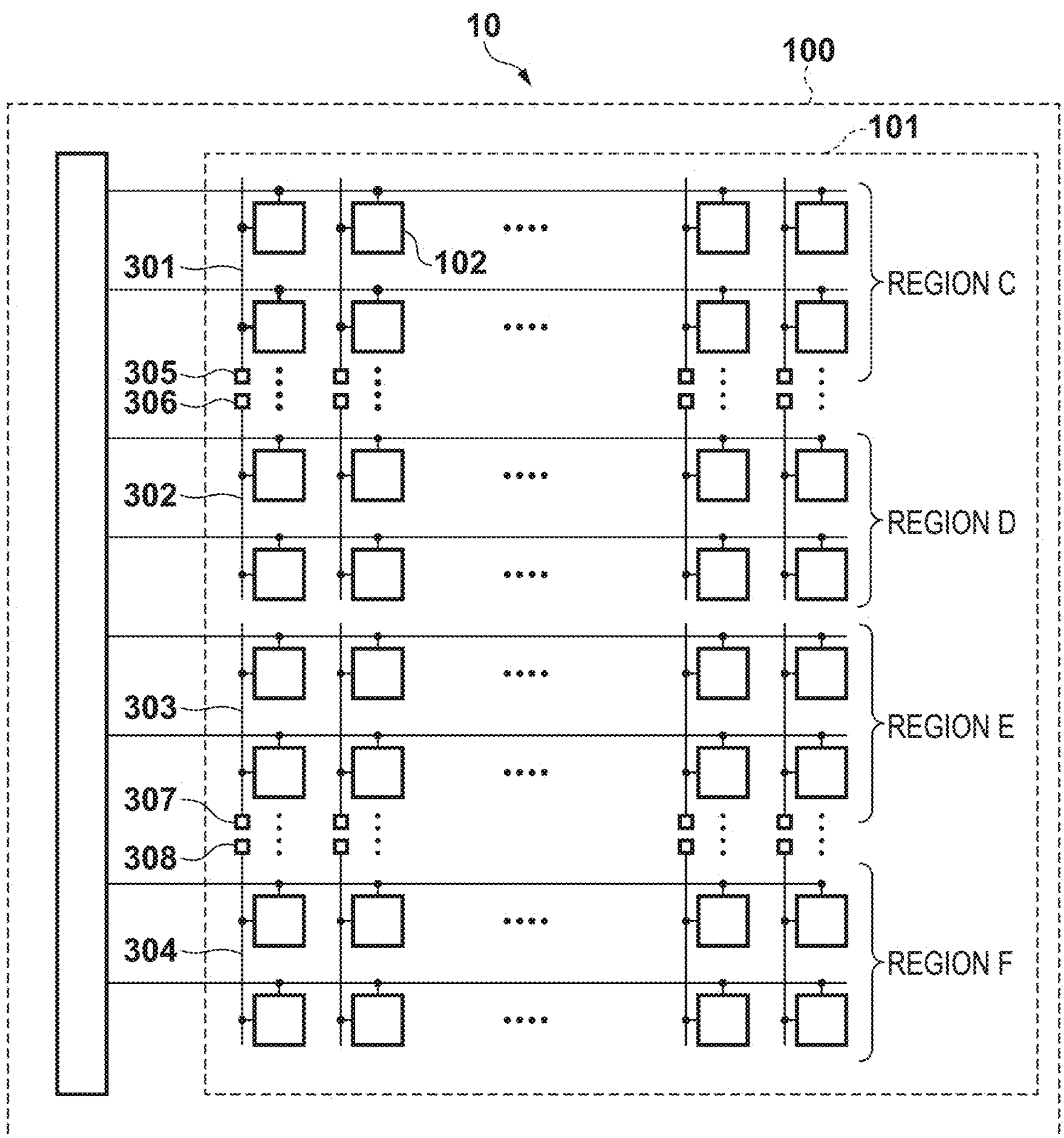

HORIZONTAL SYNCHRONIZING SIGNAL
CONTROL SIGNAL 108 OF REGION A
CONTROL SIGNAL 108 OF REGION B
VOLTAGE OF SIGNAL LINE 103
VOLTAGE OF SIGNAL LINE 104
SWITCHING CONTROL SIGNAL 208
t201
t202
t203
t204
t205
t206
t207
t208
t209
t210
t

FIG. 4


10
100
101
301
102
305
306
302
303
307
308
304
REGION C
REGION D
REGION E
REGION F

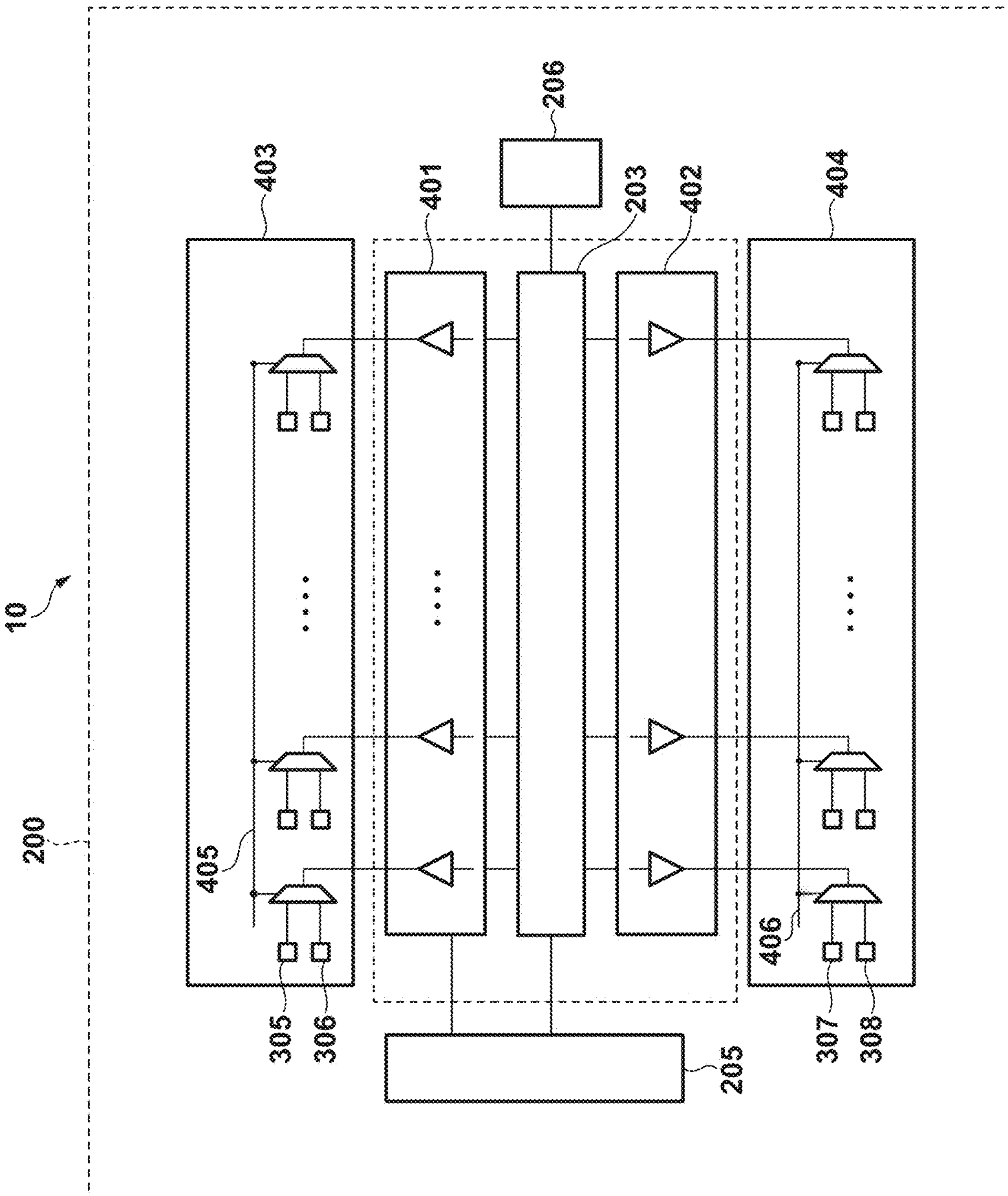


FIG. 5

FIG. 6

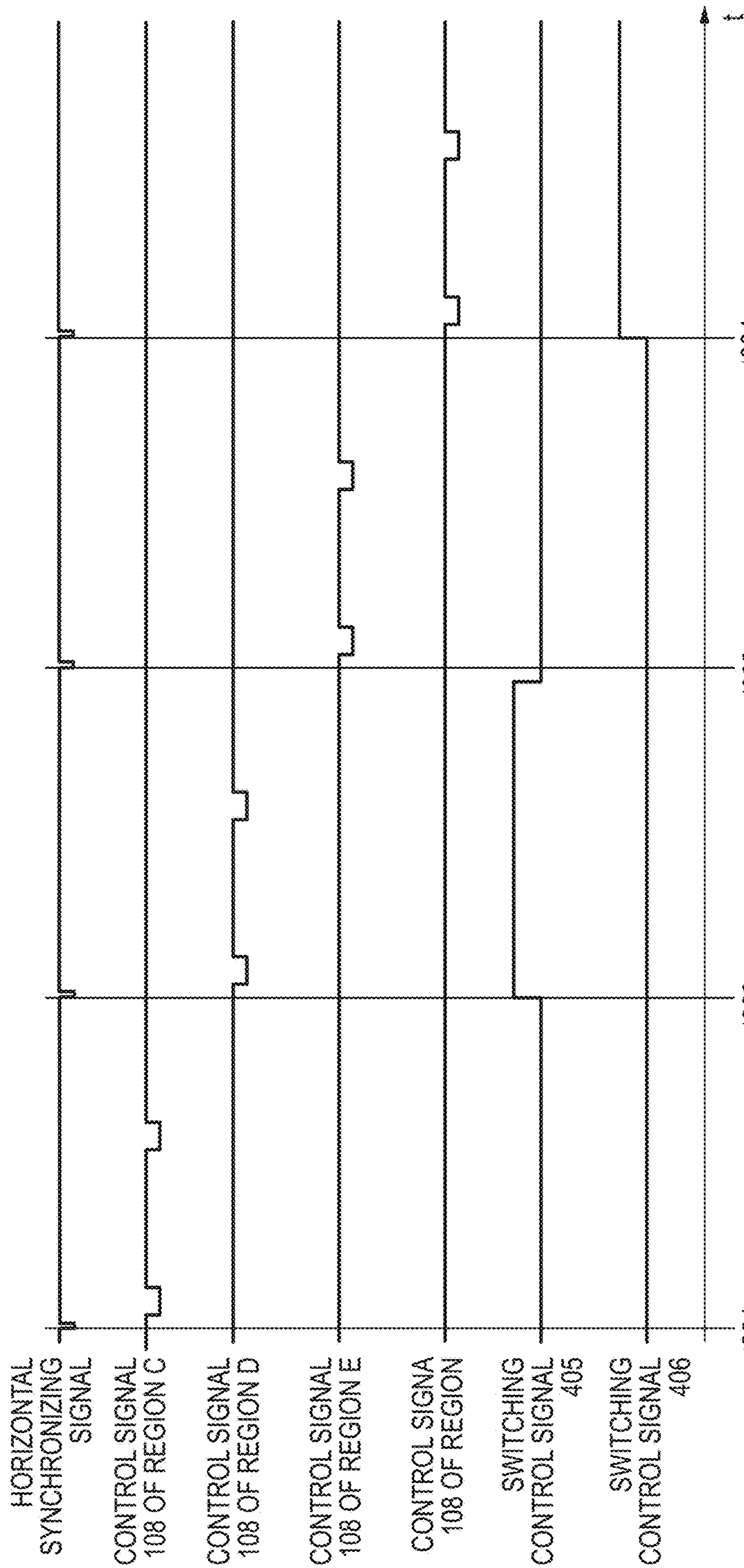

HORIZONTAL SYNCHRONIZING SIGNAL
CONTROL SIGNAL 108 OF REGION C
CONTROL SIGNAL 108 OF REGION D
CONTROL SIGNAL 108 OF REGION E
CONTROL SIGNA 108 OF REGION
SWITCHING CONTROL SIGNAL 405
SWITCHING CONTROL SIGNAL 406
t301
t302
t303
t304
t

FIG. 7

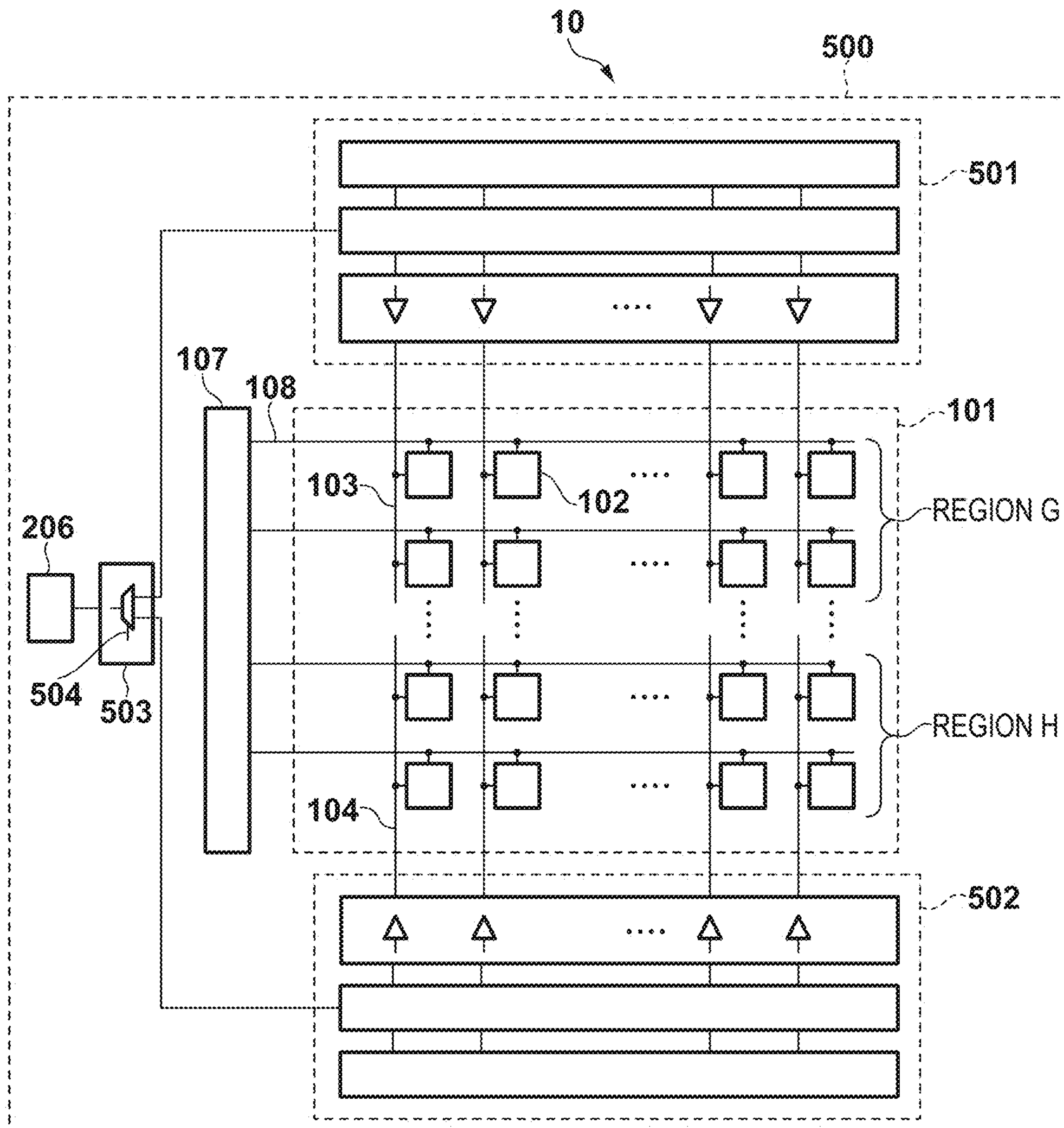

10
500
501
107
108
101
103
102
REGION G
206
504
503
REGION H
104
502

FIG. 8

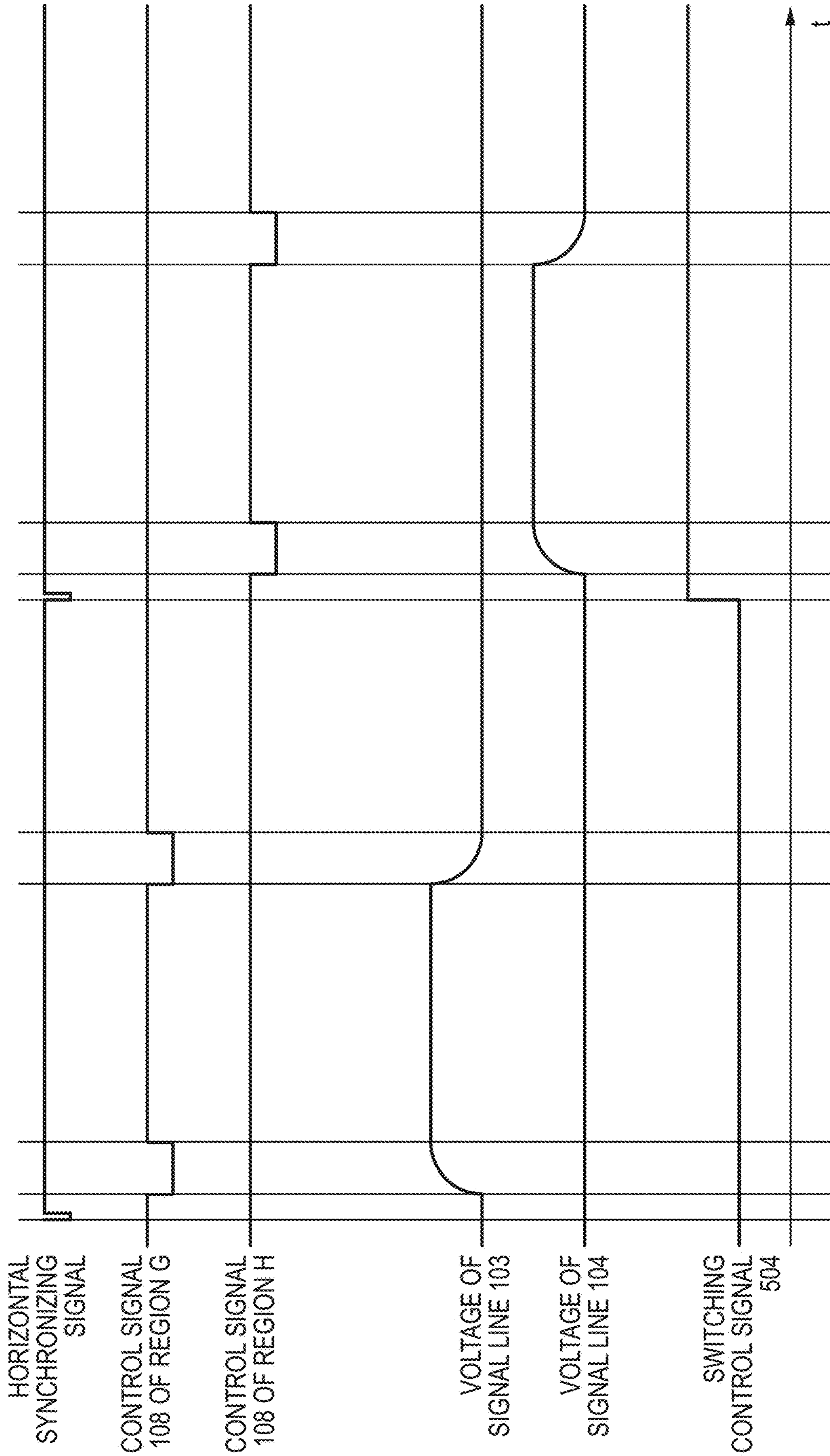
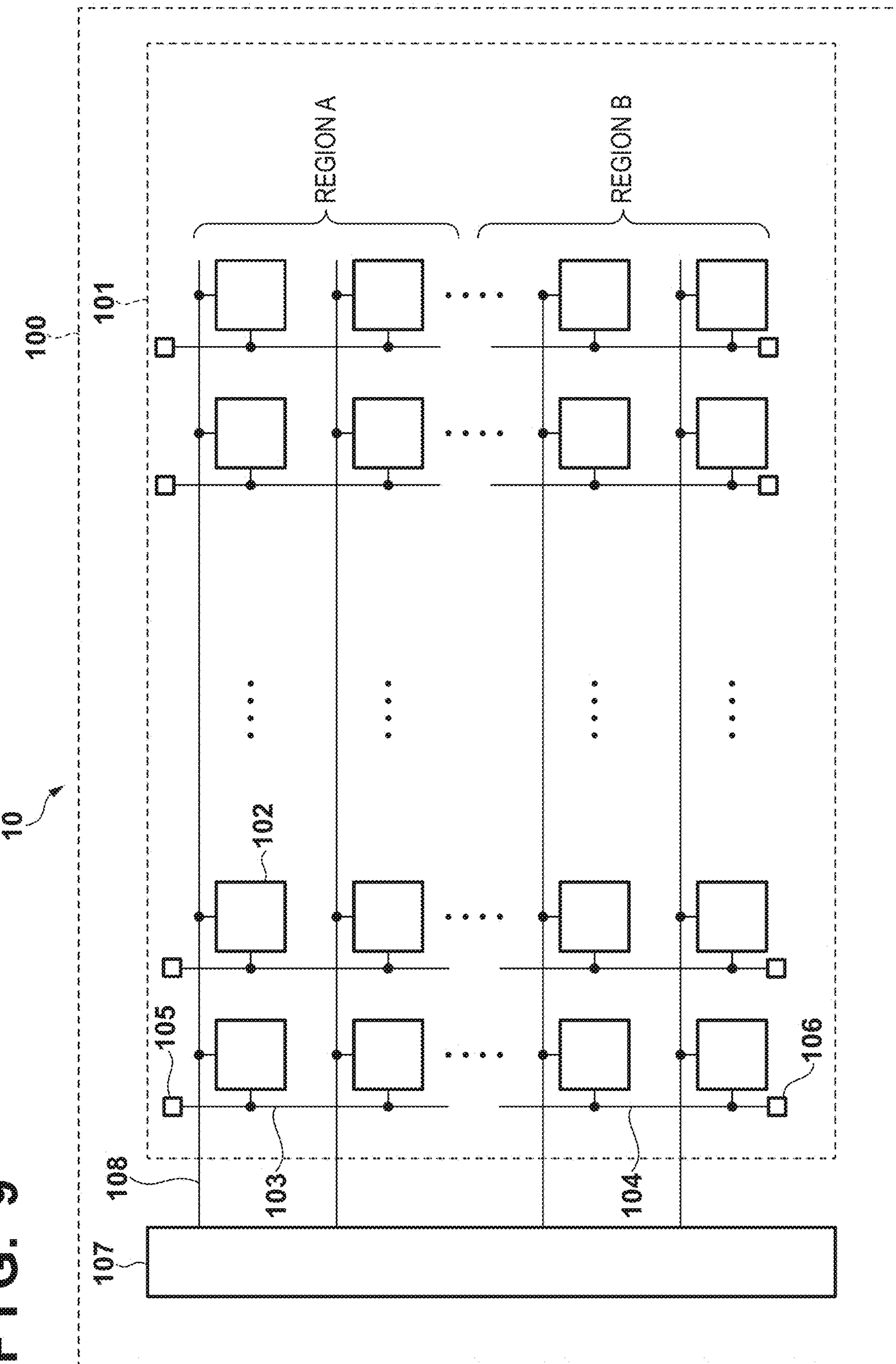

HORIZONTAL SYNCHRONIZING SIGNAL
CONTROL SIGNAL 108 OF REGION G
CONTROL SIGNAL 108 OF REGION H
VOLTAGE OF SIGNAL LINE 103
VOLTAGE OF SIGNAL LINE 104
SWITCHING CONTROL SIGNAL 504
t201
t202
t203
t204
t205
t206
t207
t208
t209
t210
t

FIG. 9



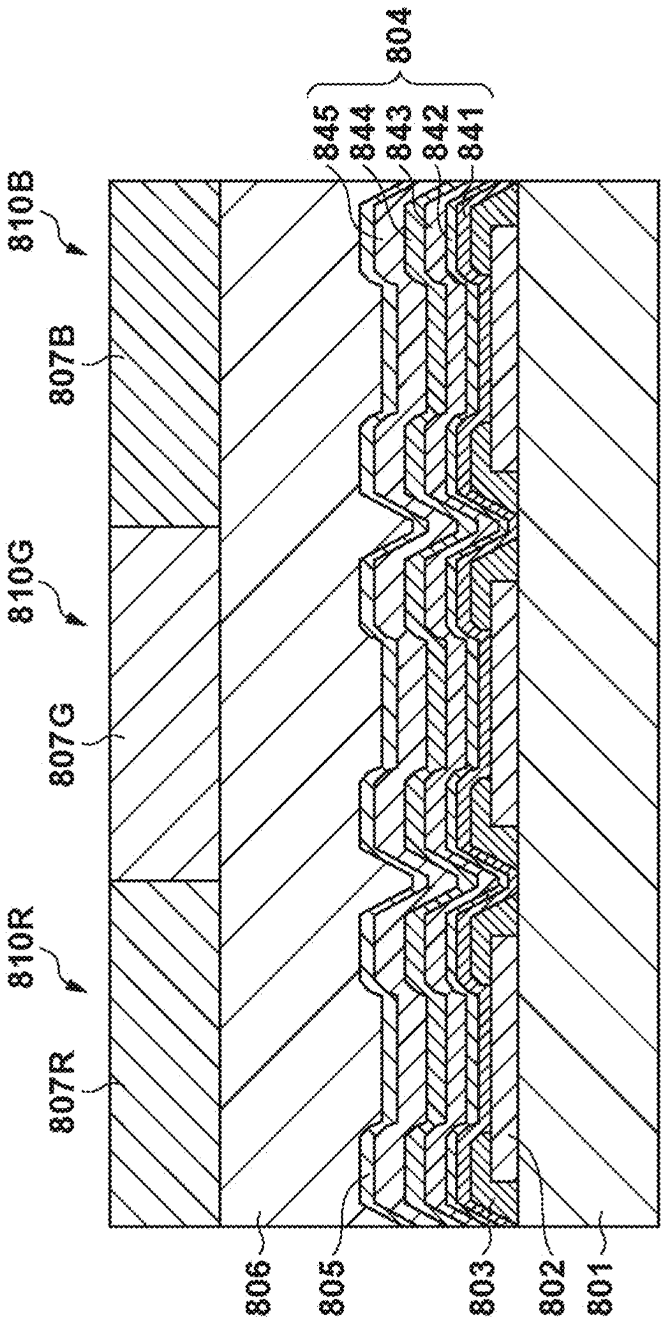


FIG. 10A

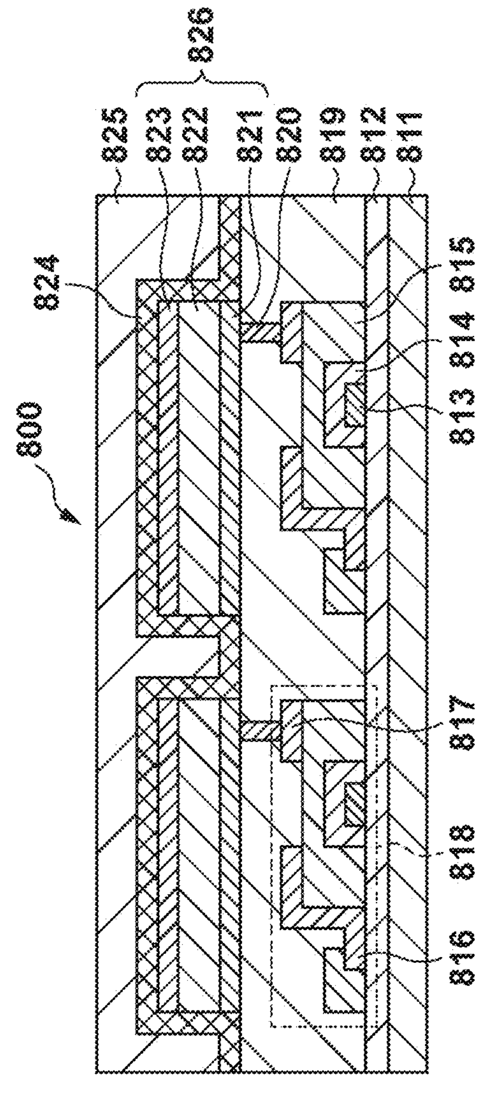


FIG. 10B

FIG. 11A

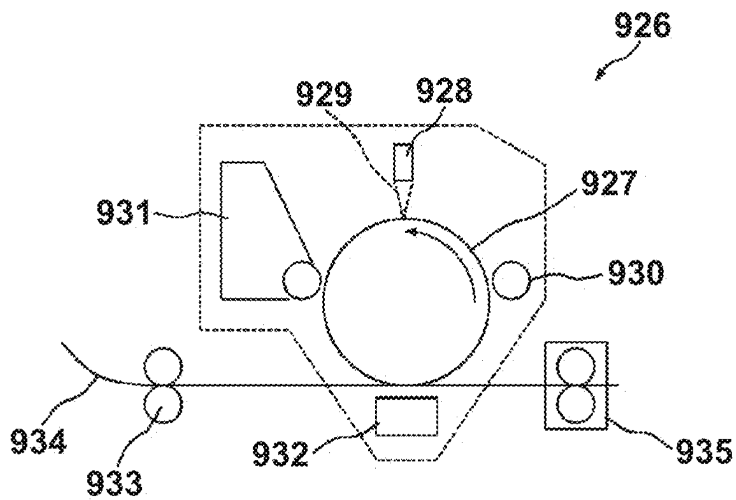


FIG. 11B

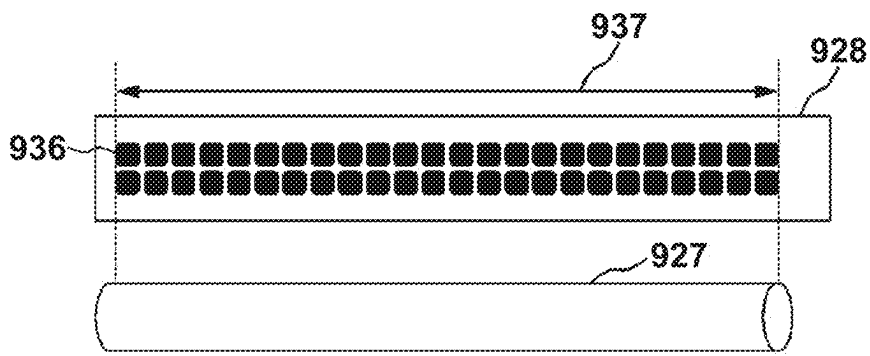


FIG. 11C

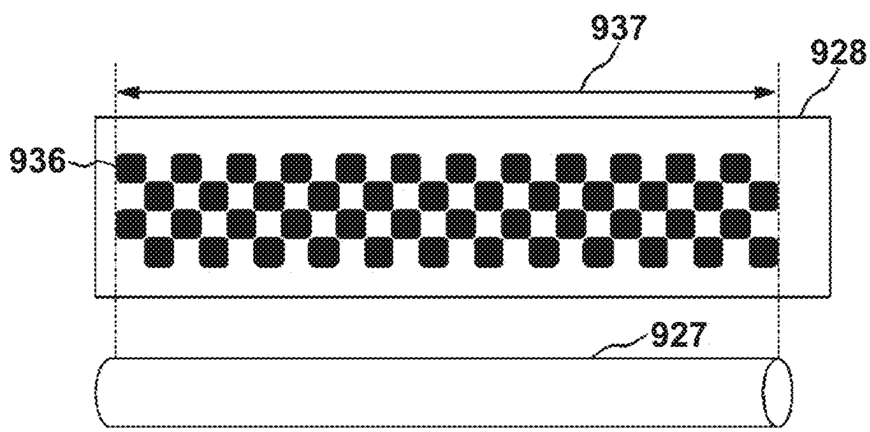


FIG. 12

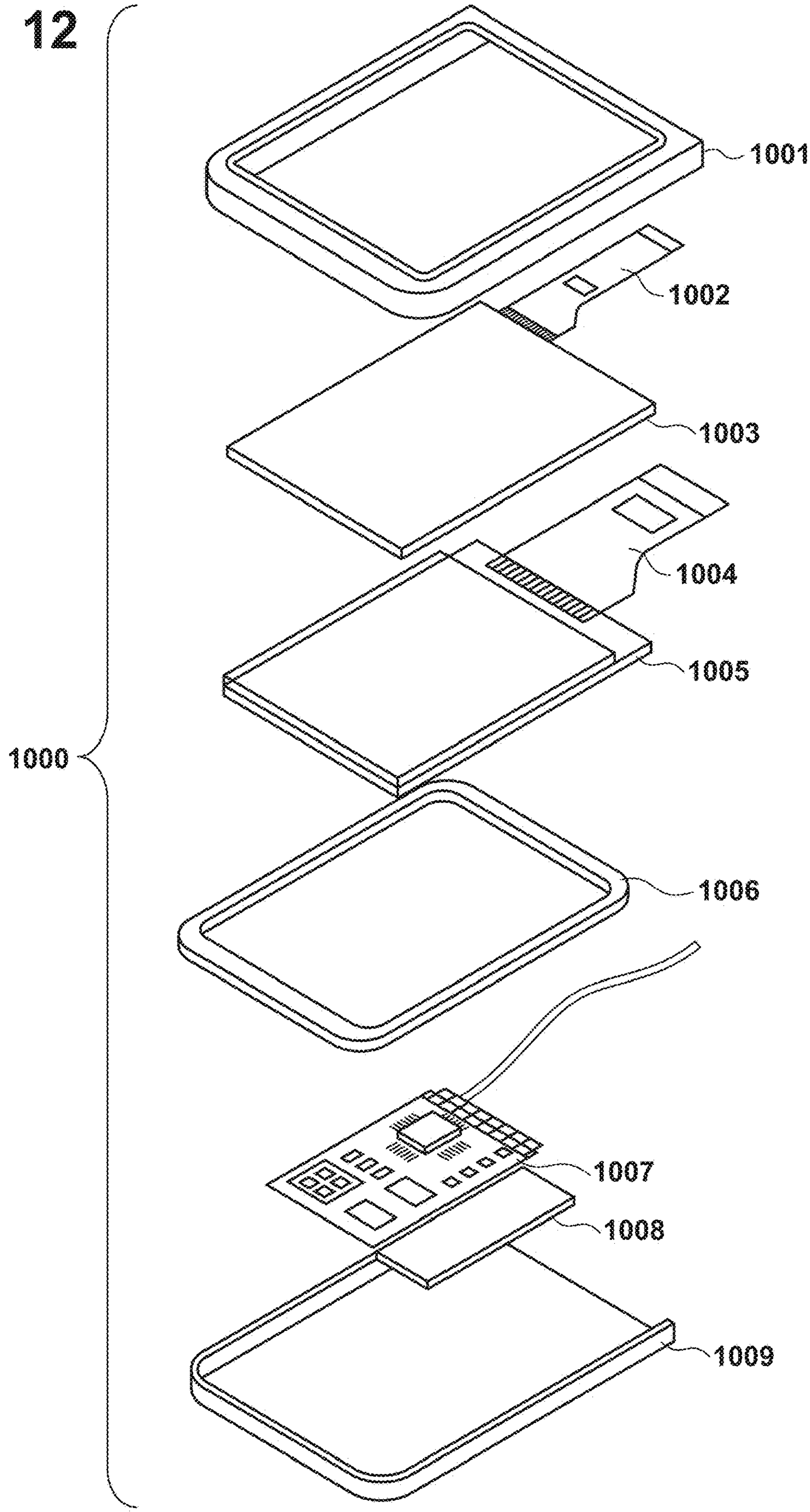


FIG. 13

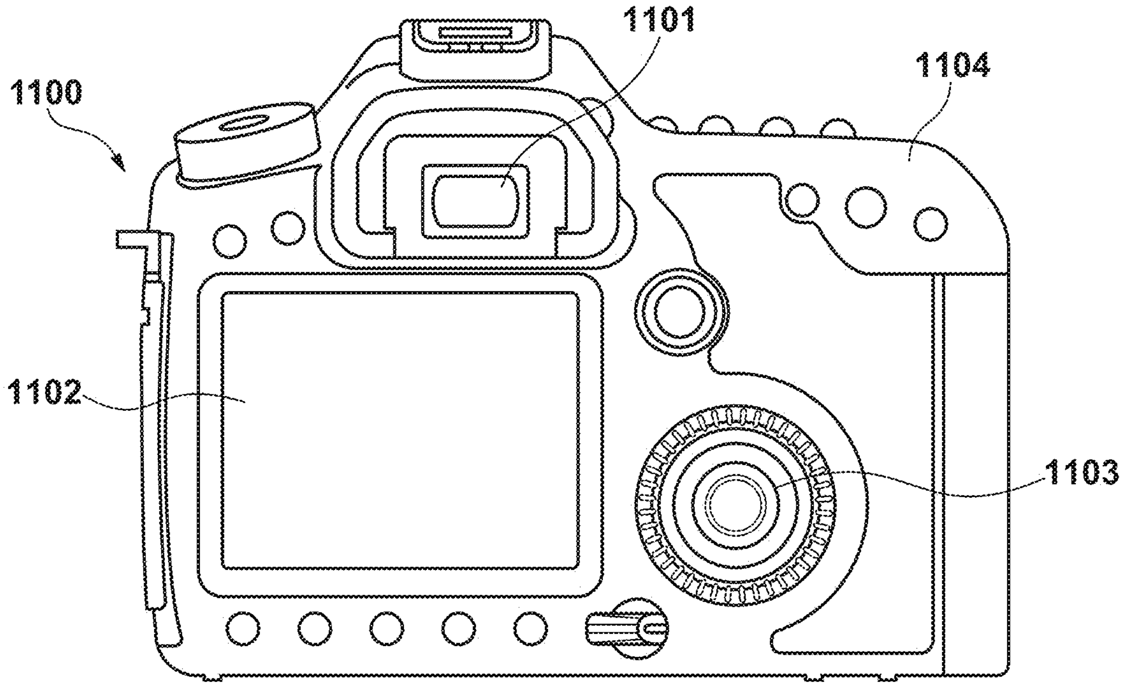


FIG. 14

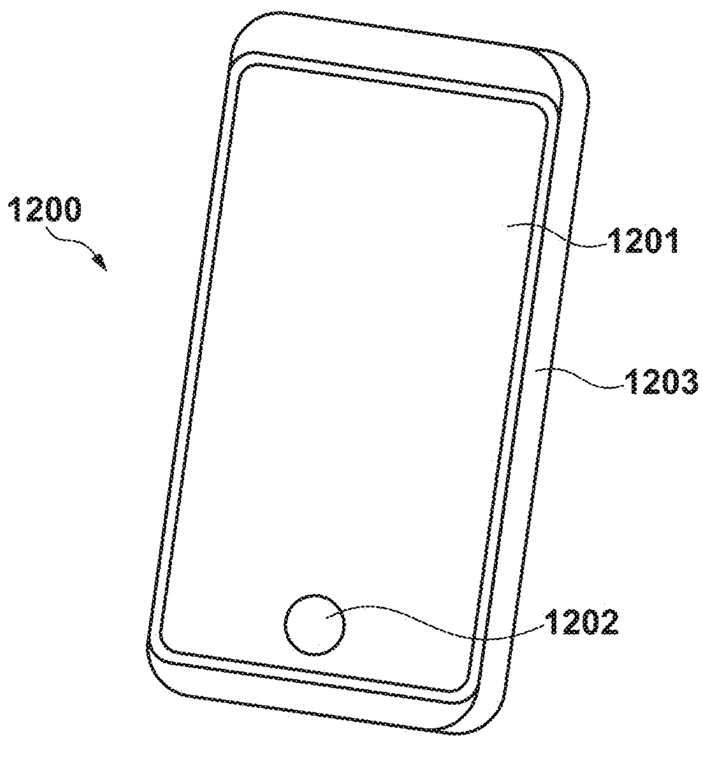


FIG. 15A

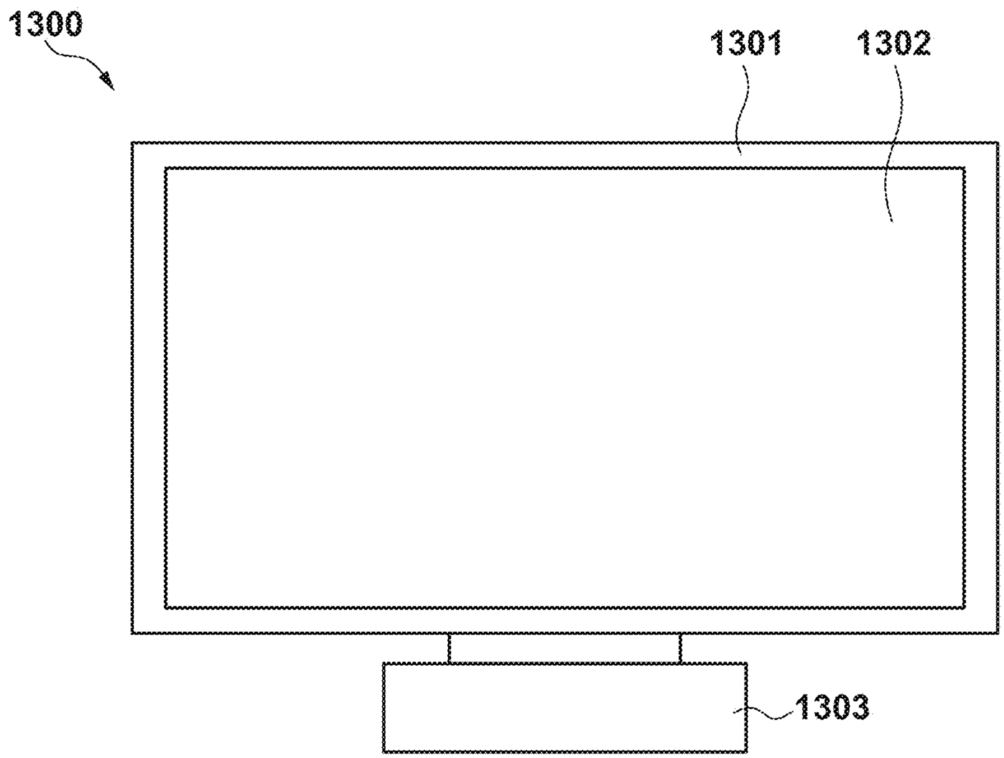


FIG. 15B

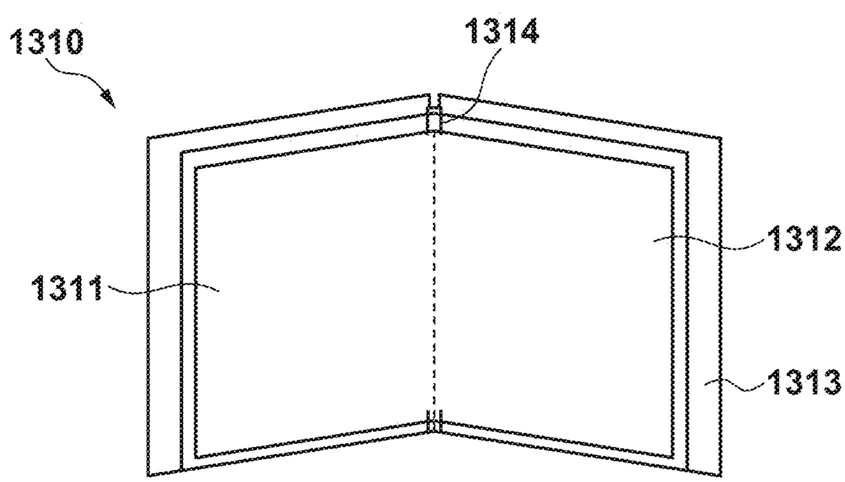


FIG. 16

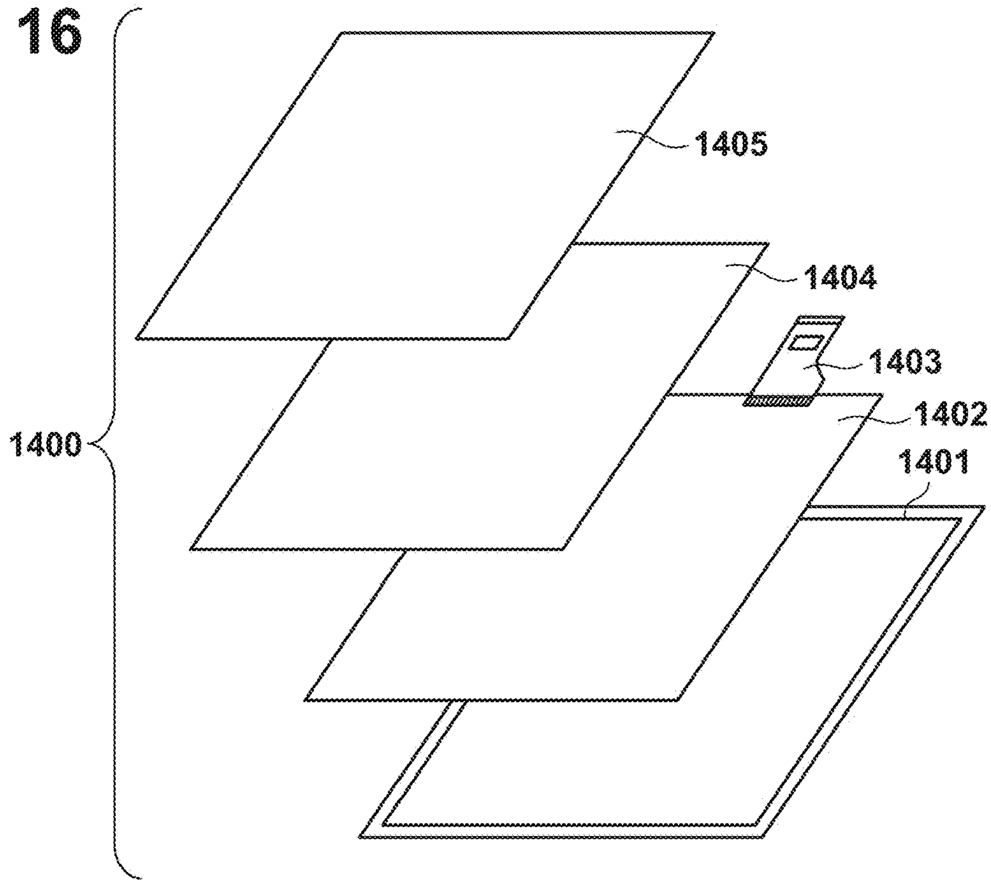


FIG. 17

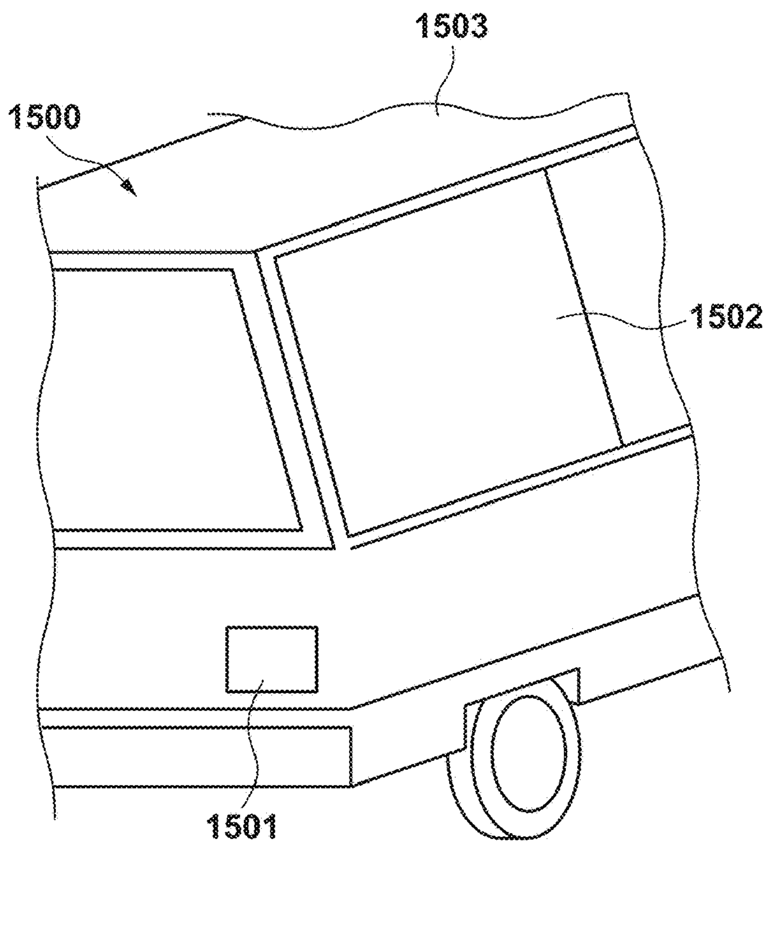


FIG. 18A

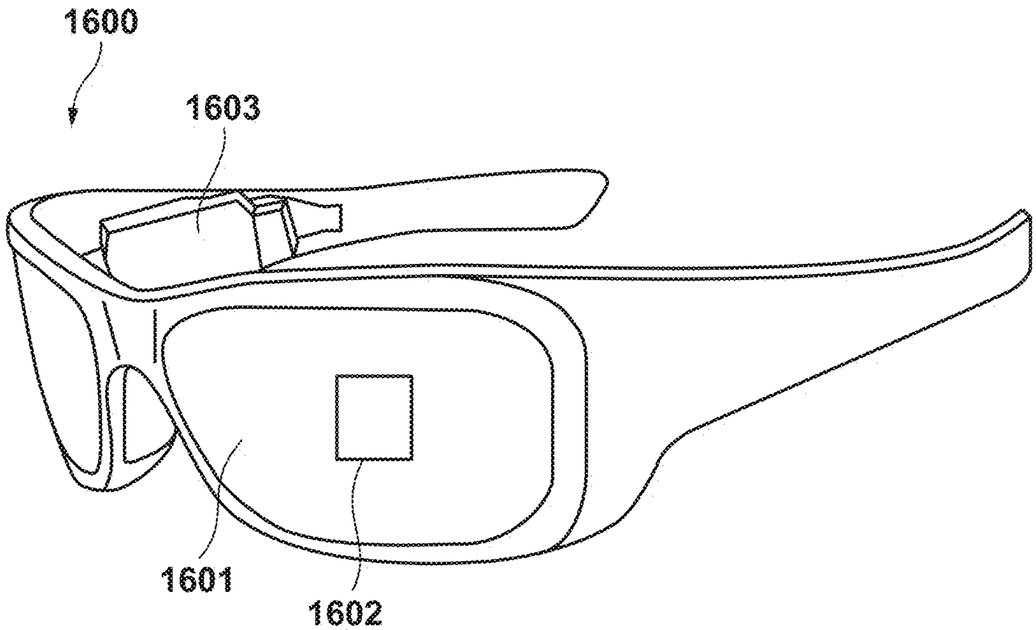
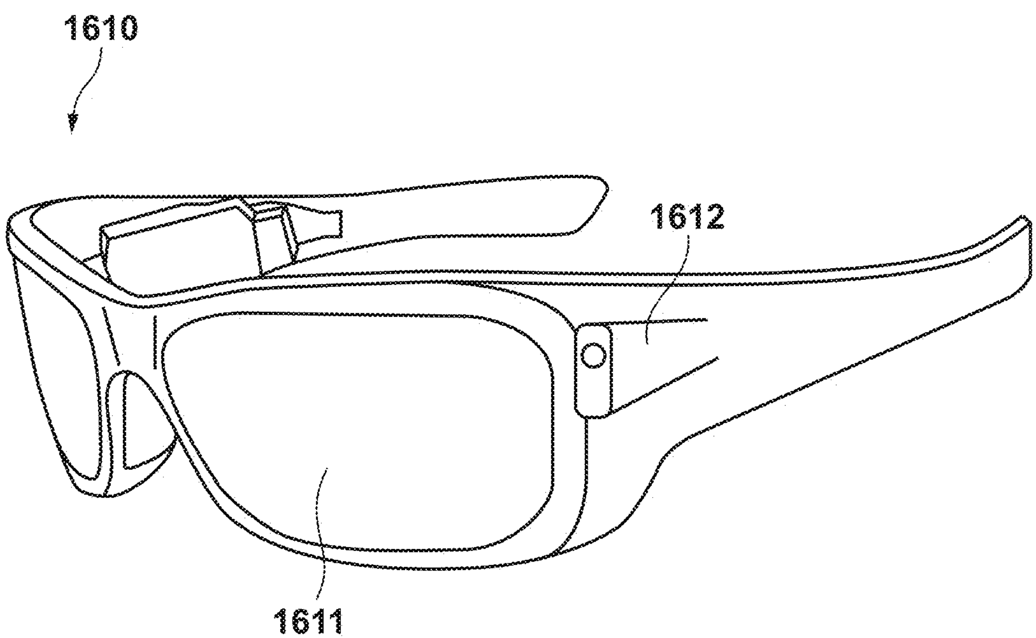


FIG. 18B



LIGHT EMITTING APPARATUS, IMAGE FORMING APPARATUS, DISPLAY APPARATUS, PHOTOELECTRIC CONVERSION APPARATUS, ELECTRONIC DEVICE, ILLUMINATION APPARATUS, MOVING BODY, AND WEARABLE DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present disclosure relates to a light emitting apparatus, an image forming apparatus, a display apparatus, a photoelectric conversion apparatus, an electronic device, an illumination apparatus, a moving body, and a wearable device.

Description of the Related Art

[0002] There is known a light emitting apparatus or display apparatus using a light emitting element such as an organic light emitting diode (OLED). Japanese Patent Laid-Open No. 2004-077567 discloses a configuration that shortens a write time by supplying video signals to the upper half and the lower half of a pixel array portion via different data lines.

[0003] In the configuration described in Japanese Patent Laid-Open No. 2004-077567, however, since signals are supplied from different driving circuits to the signal lines of the upper half and the lower half of pixels in the same column, a characteristic difference is generated between the upper half and the lower half of the pixel array portion.

SUMMARY OF THE INVENTION

[0004] The present disclosure provides a technique advantageous in reducing a characteristic difference between regions of a pixel array portion.

[0005] The present invention in its one aspect provides a light emitting apparatus including a pixel array portion including a plurality of pixels arrayed to form a plurality of rows and a plurality of columns, and a plurality of signal lines extending in a column direction, wherein each of the plurality of signal lines is divided into a plurality of sub-signal lines, the light emitting apparatus is configured such that, to the pixels of the same column, a signal generated using an output signal from the same reference voltage generation circuit is supplied via a corresponding sub-signal line, the light emitting apparatus includes a first substrate and a second substrate, which are stacked on each other, the first substrate includes the pixel array portion, and the second substrate includes a signal output circuit configured to output the signal, and a signal line switching circuit configured to switch a connection destination of an output of the signal output circuit between the plurality of sub-signal lines.

[0006] Further features of the present invention will become apparent from the following description of exemplary embodiments (with reference to the attached drawings).

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** is a view showing the configuration of the pixel substrate of a light emitting apparatus;

[0008] FIG. **2** is a view showing the configuration of the circuit board of the light emitting apparatus;

[0009] FIG. **3** is a timing chart showing an example of the operation of the light emitting apparatus;

[0010] FIG. **4** is a view showing the configuration of the pixel substrate of a light emitting apparatus;

[0011] FIG. **5** is a view showing the configuration of the circuit board of the light emitting apparatus;

[0012] FIG. **6** is a timing chart showing an example of the operation of the light emitting apparatus;

[0013] FIG. **7** is a view showing the configuration of a light emitting apparatus;

[0014] FIG. **8** is a timing chart showing an example of the operation of the light emitting apparatus;

[0015] FIG. **9** is a view showing the configuration of the pixel substrate of the light emitting apparatus;

[0016] FIGS. **10**A and **10**B are sectional views showing an example of the configuration of a pixel of the light emitting apparatus;

[0017] FIGS. **11**A to **11**C are views showing an example of the configuration of an image forming apparatus;

[0018] FIG. **12** is a view showing an example of the configuration of a display apparatus;

[0019] FIG. **13** is a view showing an example of a photoelectric conversion apparatus;

[0020] FIG. **14** is a view showing an example of an electronic device;

[0021] FIGS. **15**A and **15**B are views each showing an example of a display apparatus;

[0022] FIG. **16** is a view showing an example of the configuration of an illumination apparatus;

[0023] FIG. **17** is a view showing an example of a moving body; and

[0024] FIGS. **18**A and **18**B are views each showing an example of a wearable device.

DESCRIPTION OF THE EMBODIMENTS

[0025] Hereinafter, embodiments will be described in detail with reference to the attached drawings. Note, the following embodiments are not intended to limit the scope of the claimed invention. Multiple features are described in the embodiments, but limitation is not made to an invention that requires all such features, and multiple such features may be combined as appropriate.

[0026] Furthermore, in the attached drawings, the same reference numerals are given to the same or similar configurations, and redundant description thereof is omitted.

First Embodiment

[0027] A light emitting apparatus according to the first embodiment will be described with reference to FIGS. **1** to **3**. Note that all the following embodiments show examples of the present invention, and numerical values, shapes, materials, constituent elements, arrangements and connection forms of the constituent elements, and the like are not intended to limit the scope of the present invention.

[0028] FIGS. **1** and **2** are schematic views showing a light emitting apparatus **10** according to this embodiment. The light emitting apparatus **10** includes a pixel substrate **100** (first substrate) and a circuit board **200** (second substrate), which are stacked on each other. FIG. **1** shows the configuration of the pixel substrate **100**, and FIG. **2** shows the configuration of the circuit board **200**. A pixel array portion **101** is formed on the pixel substrate **100**. The pixel array portion **101** includes a plurality of pixels **102** that are arrayed to form a plurality of rows and a plurality of columns. Each of the plurality of pixels **102** includes a light emitting diode (light emitting element) and emits light in a light emitting amount corresponding to an input luminance signal voltage. To each of the plurality of pixels **102**, a luminance signal voltage Vsig that is an image signal is input from a signal output circuit via a signal line.

[0029] The pixel array portion **101** includes a plurality of signal lines extending in the column direction. In this embodiment, as shown in FIG. **1**, each of the plurality of signal lines is divided into a plurality of sub-signal lines. Here, consider two regions obtained by dividing a region including the plurality of pixels **102** into two parts by a line parallel to the row direction. One of the two regions is defined as a region A (first region), and the other is defined as a region B (second region). The region A includes a plurality of first sub-signal lines **103**, and the region B includes a plurality of second sub-signal lines **104**. Conventionally, one signal line extending in the column direction is arranged for one column of pixels in the pixel array portion. "Sub-signal lines" mean signal lines divided for each region. An image signal is input to each pixel in the region A via the sub-signal line **103**, and an image signal is input to each pixel in the region B via the sub-signal line **104**. The "sub-signal line" will simply be referred to as a "signal line" hereinafter. The signal line **103** (first sub-signal line) is connected to a circuit on the circuit board **200** via a first connecting portion **105**, and the signal line **104** (second sub-signal line) is connected to a circuit on the circuit board **200** via a second connecting portion **106**.

[0030] A control signal **108** is input from a vertical scanning circuit **107** to each pixel via a scanning line. The control signal **108** is active at LOW, and the potential of the signal line **103** is written to the pixel **102**. The control signal **108** is nonactive at HIGH, and the signal line **103** and the pixel **102** are disconnected. The vertical scanning circuit **107** is formed on the pixel substrate **100**, like the example shown in FIG. **1**, but may be formed on the circuit board **200**.

[0031] Note that each of the plurality of pixels **102** may include a plurality of sub-pixels arranged on a color basis. In this case, a signal line is arranged for each column with respect to each sub-pixel as a reference. For example, if one pixel includes three sub-pixels, three signal lines can be arranged for one pixel column.

[0032] A signal output circuit **201** is formed on the circuit board **200**. The signal output circuit **201** can include a horizontal scanning circuit **202**, a column DAC circuit **203** arranged for a plurality of columns, and a column driver circuit **204** arranged for a plurality of columns. The vertical scanning circuit **107** and the signal output circuit **201** are controlled by a control circuit **205**.

[0033] A signal line switching circuit **207** is further formed on the circuit board **200**. The signal line switching circuit **207** switches the connection destination of the output of the signal output circuit **201** between a plurality of sub-signal lines. More specifically, the signal line switching circuit **207** switches whether to output a signal output from the column driver circuit **204** to the signal line **103** in the region A via the first connecting portion **105** or output the signal to the signal line **104** in the region B via the second connecting portion **106**. The signal line switching circuit **207** is controlled by a switching control signal **208**. For example, when the switching control signal **208** is at LOW, the signal line switching circuit **207** is connected to the signal line **103** in the region A. When the switching control signal **208** is at HIGH, the signal line switching circuit **207** is connected to the signal line **104** in the region B. In an example, the signal line switching circuit **207** can include a plurality of selectors **2071** configured to select, for each pixel column, the signal lines **103** in the region A or the signal lines **104** in the region B as the connection destination of the output of the signal output circuit **201**.

[0034] In this embodiment, one column DAC circuit **203** and one column driver circuit **204** correspond to each other. The column DAC circuit **203** converts image data scanned by the horizontal scanning circuit **202** and input to each pixel column into an analog signal and supplies it to the column driver circuit **204**. The column driver circuit **204** outputs a luminance signal (luminance signal voltage Vsig) according to an output signal from the column DAC circuit **203**.

[0035] A reference voltage generation circuit **206** is further formed on the circuit board **200**. The reference voltage generation circuit **206** generates analog voltages Vref in number according to the image data (for example, 256 analog voltages if the image data is 8-bit data), and supplies these to the column DAC circuit **203**. Also, the reference voltage generation circuit **206** may generate a reference voltage Vcal to be used for variation correction of the signal output circuit **201** and the pixels **102**. At this time, the reference voltage Vcal may be supplied to the pixels **102** via the column driver circuit **204** and the signal lines **103** and **104**.

[0036] FIG. **3** is a timing chart showing an example of the operation of the light emitting apparatus **10** according to this embodiment. Referring to FIG. **3**, a horizontal synchronizing signal indicates a horizontal scanning period of the nth row, and a reset period and a signal write period are included in the horizontal scanning period. In the period from time t**201** to time t**206**, the pixels in the region A connected to the signal lines **103** are scanned, and in the period from time t**206**, the pixels in the region B connected to the signal lines **104** are scanned.

[0037] At time t**201**, scanning of the pixels in the region A of the pixel array portion **101** is started by the horizontal synchronizing signal. At this time, the switching control signal **208** is at LOW, and the output of the column driver circuit **204** is connected to the signal line **103** in the region A by the signal line switching circuit **207**.

[0038] At time t**202**, the column driver circuit **204** outputs a reset potential. Writing of a reset voltage to the pixels **102** is thus started. A standby time until the signal line **103** reaches the reset potential is needed, and the settling time at this time is represented by τ=CR, where C is the capacitance of the signal line, and R is the resistance of the signal line. In addition, the control signal **108** changes to LOW, and the reset potential of the signal line **103** is written to the pixels **102**.

[0039] At time t**203**, the control signal **108** changes to HIGH, and the writing of the reset voltage to the pixels **102** is ended. The period from time t**202** to time t**203** is the reset period.

[0040] At time t**204**, the column driver circuit **204** outputs a luminance signal potential. At this time, the switching control signal **208** is at LOW, and the output of the column driver circuit **204** is connected to the signal line **103** in the region A by the signal line switching circuit **207**. Writing of the luminance signal voltage to the pixels **102** is thus started. Like the reset potential, a settling time is needed until the signal line reaches the luminance signal potential. In addition, the control signal **108** changes to LOW, and the luminance signal potential of the signal line **103** is written to the pixels **102**. The light emitting element provided in the pixel **102** emits light in a light emitting amount corresponding to the input luminance signal voltage.

[0041] At time t**205**, the control signal **108** changes to HIGH, and the writing of the luminance signal voltage to the pixels **102** is ended. The period from time t**204** to time t**205** is the signal write period.

[0042] At time t**206**, scanning of the pixels in the region B of the pixel array portion **101** is started by the horizontal synchronizing signal. At this time, the switching control signal **208** changes to HIGH, and the output of the column driver circuit **204** is connected to the signal line **104** in the region B.

[0043] The period from time t**207** to time t**208** is the reset period, like the period from time t**202** to time t**203**, and the reset potential of the signal line **104** is written to the pixels in the region B.

[0044] The period from time t**209** to time t**210** is the signal write period, like the period from time t**204** to time t**205**, and the luminance signal potential of the signal line **104** is written to the pixels in the region B.

[0045] Here, one column DAC circuit **203** and one column driver circuit **204** may correspond to one sub-pixel column or a plurality of sub-pixel columns.

[0046] As described above, according to this embodiment, each of the plurality of signal lines extending in the column direction is divided into a plurality of sub-signal lines. To the pixels of the same column, a signal generated using the output signal from the same reference voltage generation circuit is supplied via a corresponding sub-signal line. The "signal generated using the output signal from the same reference voltage generation circuit" can be, for example, the output signal from the column DAC circuit **203**, which is generated based on the output from the reference voltage generation circuit **206**. Alternatively, the "signal generated using the output signal from the same reference voltage generation circuit" can be a luminance signal output from the column driver circuit **204** in accordance with the output signal from the column DAC circuit **203**.

[0047] According to this embodiment, to the pixels of the same column, a signal generated using the output signal from the same reference voltage generation circuit is supplied via a corresponding sub-signal line. This can reduce the characteristic difference of pixels between the region A and the region B.

[0048] Note that in the example shown in FIG. **1**, the first connecting portion **105** and the second connecting portion **106** are provided at the end portions of the signal line **103** (first sub-signal line) and the signal line **104** (second sub-signal line) on the sides close to each other. However, the positions of the first connecting portion **105** and the second connecting portion **106** are not limited to this. For example, as shown in FIG. **9**, the first connecting portion **105** and the second connecting portion **106** may be provided at the end portions of the signal line **103** and the signal line **104** on the sides far apart from each other.

Second Embodiment

[0049] A light emitting apparatus according to the second embodiment will be described with reference to FIGS. **4** to **6**. Matters that are not mentioned in the second embodiment can comply with the first embodiment as far as they are not incompatible.

[0050] A light emitting apparatus **10** includes a pixel substrate **100** (first substrate) and a circuit board **200** (second substrate), which are stacked on each other, as in the first embodiment. FIG. **4** shows the configuration of the pixel substrate **100**, and FIG. **5** shows the configuration of the circuit board **200**.

[0051] In the second embodiment, as shown in FIG. **4**, a pixel array portion **101** includes four regions obtained by dividing a region including a plurality of pixels **102** into four parts by lines parallel to the row direction. Here, the four regions include a region C (first region), a region D (second region), a region E (third region), and a region F (fourth region). The region C includes a plurality of first sub-signal lines **301**, the region D includes a plurality of second sub-signal lines **302**, the region E includes a plurality of third sub-signal lines **303**, and the region F includes a plurality of fourth sub-signal lines **304**. An image signal is input to each pixel in the region C via the sub-signal line **301**, and an image signal is input to each pixel in the region D via the sub-signal line **302**. Also, an image signal is input to each pixel in the region E via the sub-signal line **303**, and an image signal is input to each pixel in the region F via the sub-signal line **304**. As in the first embodiment, the "sub-signal line" will simply be referred to as a "signal line" hereinafter. The signal line **301** (first sub-signal line) is connected to a circuit on the circuit board **200** via a first connecting portion **305**, and the signal line **302** (second sub-signal line) is connected to a circuit on the circuit board **200** via a second connecting portion **306**. Also, the signal line **303** (third sub-signal line) is connected to a circuit on the circuit board **200** via a third connecting portion **307**, and the signal line **304** (fourth sub-signal line) is connected to a circuit on the circuit board **200** via a fourth connecting portion **308**.

[0052] Unlike the first embodiment, the signal output circuit of the circuit board **200** includes two column driver circuits **401** and **402** and two signal line switching circuits **403** and **404**. The signal line switching circuit **403** switches whether to output a signal output from the column driver circuit **401** to the signal line **301** via the first connecting portion **305** or output the signal to the signal line **302** via the second connecting portion **306**. The signal line switching circuit **403** is controlled by a switching control signal **405**. The signal line switching circuit **404** switches whether to output a signal output from the column driver circuit **402** to the signal line **303** via the third connecting portion **307** or output the signal to the signal line **304** via the fourth connecting portion **308**. The signal line switching circuit **404** is controlled by a switching control signal **406**.

[0053] In this embodiment, one column DAC circuit **203** and two column driver circuits **401** and **402** correspond to each other.

[0054] FIG. **6** is a timing chart showing an example of the operation of the light emitting apparatus **10** according to this embodiment.

[0055] In the period from time t**301** to time t**302**, the region C of the pixel array portion **101** connected to the signal lines **301** is scanned. At time t**301**, scanning of the region C of the pixel array portion **101** is started by the horizontal synchronizing signal. At this time, the switching control signal **405** is at LOW, and the output of the column driver circuit **401** is connected to the signal line **301** in the region C by the signal line switching circuit **403**. The reset period and the signal write period of the pixels of each row of the region C are thus sequentially scanned.

[0056] In the period from time t**302** to time t**303**, the region D of the pixel array portion **101** connected to the signal lines **302** is scanned. At time t**302**, scanning of the region D of the pixel array portion **101** is started by the horizontal synchronizing signal. At this time, the switching control signal **405** is at HIGH, and the output of the column driver circuit **401** is connected to the signal line **302** in the region D by the signal line switching circuit **403**. The reset period and the signal write period of the pixels of each row of the region D are thus sequentially scanned.

[0057] In the period from time t**303** to time t**304**, the region E of the pixel array portion **101** connected to the signal lines **303** is scanned. At time t**303**, scanning of the region E of the pixel array portion **101** is started by the horizontal synchronizing signal. At this time, the switching control signal **406** is at LOW, and the output of the column driver circuit **402** is connected to the signal line **303** in the region E by the signal line switching circuit **404**. The reset period and the signal write period of the pixels of each row of the region E are thus sequentially scanned.

[0058] In the period after time t**304**, the region F of the pixel array portion **101** connected to the signal lines **304** is scanned. At time t**304**, scanning of the region F of the pixel array portion **101** is started by the horizontal synchronizing signal. At this time, the switching control signal **406** is at HIGH, and the output of the column driver circuit **402** is connected to the signal line **304** in the region F by the signal line switching circuit **404**. The reset period and the signal write period of the pixels of each row of the region F are thus sequentially scanned.

[0059] In the above-described example, scanning is sequentially performed for the regions C, D, E, and F. However, after the regions C and E are scanned in parallel, the regions D and F may be scanned in parallel.

[0060] As described above, since the number of divided signal lines is increased as compared to the first embodiment, the time constant of the signal lines becomes short, and the reset period and the signal write period can be shortened.

[0061] Also, in this embodiment, connection between the outputs of the column driver circuits **401** and **402** and the four divided signal lines **301**, **302**, **303**, and **304** is switched by the signal line switching circuits **403** and **404**, thereby supplying signals to the pixels in the regions C, D, E, and F. At this time, the characteristic difference of the pixels can be reduced by supplying signals from the column driver circuit **204** and the reference voltage generation circuit **206** to the regions C, D, E, and F. Since the regions C and D and the regions E and F use different column DAC circuits, a characteristic difference derived from the difference of the column DAC circuit between the region D and the region E may occur. However, the above-described signal write period can be shortened.

Third Embodiment

[0062] A light emitting apparatus according to the third embodiment will be described with reference to FIGS. **7** and **8**. Matters that are not mentioned in the third embodiment can comply with the first and second embodiments as far as they are not incompatible.

[0063] FIG. **7** is a view showing the configuration of a light emitting apparatus **10** according to the third embodiment. In the above-described first and second embodiments, the light emitting apparatus **10** includes the pixel substrate **100** (first substrate) and the circuit board **200** (second substrate), which are stacked on each other. However, the present invention is not limited to the configuration in which a plurality of substrates are stacked. In the third embodiment, a pixel array portion **101** and a signal output circuit **501** are formed on the same substrate **500**, unlike the first embodiment. A plurality of signal lines extending in the column direction are divided into a plurality of first sub-signal lines **103** and a plurality of second sub-signal lines **104**. Here, consider two regions obtained by dividing a region including a plurality of pixels **102** into two parts by a line parallel to the row direction. One of the two regions is defined as a region G (first region), and the other is defined as a region H (second region). The region G includes the plurality of first sub-signal lines **103**, and the region H includes the plurality of second sub-signal lines **104**. An image signal is input to each pixel in the region G via the sub-signal line **103**, and an image signal is input to each pixel in the region H via the sub-signal line **104**. The "sub-signal line" will simply be referred to as a "signal line" hereinafter.

[0064] The signal line **103** is connected to the signal output circuit **501**, and the signal line **104** is connected to a signal output circuit **502**. Each of the signal output circuits **501** and **502** can include a horizontal scanning circuit, a column DAC circuit, and a column driver circuit **204**. The output of a reference voltage generation circuit **206** is input to the column DAC circuit of each of the signal output circuits **501** and **502** via a signal line switching circuit **503**. The signal line switching circuit **503** is controlled by a switching control signal **504**. For example, if the switching control signal **504** is at LOW, the signal line switching circuit **503** is connected to the signal output circuit **501** for the region G. If the switching control signal **504** is at HIGH, the signal line switching circuit **503** is connected to the signal output circuit **502** for the region H.

[0065] FIG. **8** is a timing chart showing an example of the operation of the light emitting apparatus **10** according to this embodiment. In the first embodiment, the switching control signal **208** is used as the switching control signal, but in this embodiment, the switching control signal **504** is used. However, the timing relationship is the same in the timing charts of FIGS. **8** and **3**.

[0066] As described above, in this embodiment, when supplying a signal to the pixels in the region G, the output of the reference voltage generation circuit **206** is input to the signal output circuit **501** via the signal line switching circuit **503**. When supplying a signal to the pixels in the region H, the output of the reference voltage generation circuit **206** is input to the signal output circuit **502** via the signal line switching circuit **503**. At this time, when scanning the pixels in the region G and the pixels in the region H, the signal is supplied from the same reference voltage generation circuit **206**.

[0067] As described above, according to this embodiment, the characteristic difference of pixels can be reduced. Since the configuration of this embodiment is a configuration in which different column DAC circuits and column driver circuits are used for the pixels in the region G and the pixels in the region H, the characteristic difference suppressing effect may be small as compared to the first and second embodiments. However, even if a stacked structure that is generally said to have a cost demerit is not employed, as described above, a configuration in which a signal generated using the output signal from the same reference voltage generation circuit is supplied to the pixels of the same column via a corresponding signal line can be applied. Hence, even by this configuration, the characteristic difference of pixels between the regions can be reduced.

APPLICATION EXAMPLES

[0068] Hereinafter, application examples in which the light emitting apparatus **10** according to the above-described embodiments is applied to an image forming apparatus, a display apparatus, a photoelectric conversion apparatus, an electronic device, an illumination apparatus, a moving body, and a wearable device will be described. The description will be given assuming that, for example, an organic light emitting element such as an organic EL element is arranged as a light emitting element in each of the plurality of pixels **102** arranged in the pixel array portion **101** of the light emitting apparatus **10**. Details of each component arranged in the pixel array portion **101** of the light emitting apparatus **10** described above will be described first, and the application examples will be described after that.

Configuration of Organic Light Emitting Element

[0069] The organic light emitting element is provided by forming an insulating layer, a first electrode, an organic compound layer, and a second electrode on a substrate. A protection layer, a color filter, a microlens, and the like may be provided on a cathode. If a color filter is provided, a planarizing layer may be provided between the protection layer and the color filter. The planarizing layer can be formed using acrylic resin or the like. The same applies to a case where a planarizing layer is provided between the color filter and the microlens.

Substrate

[0070] Quartz, glass, a silicon wafer, a resin, a metal, or the like may be used as a substrate. Furthermore, a switching element such as a transistor, a wiring pattern, and the like may be provided on the substrate, and an insulating layer may be provided thereon. The insulating layer may be made of any material as long as a contact hole can be formed so that the wiring pattern can be formed between the first electrode and the substrate and insulation from the unconnected wiring pattern can be ensured. For example, a resin such as polyimide, silicon oxide, silicon nitride, or the like may be used for the insulating layer.

Electrode

[0071] A pair of electrodes can be used as the electrodes. The pair of electrodes can be an anode and a cathode. If an electric field is applied in the direction in which the organic light emitting element emits light, the electrode having a high potential is the anode, and the other is the cathode. It can also be said that the electrode that supplies holes to the light emitting layer is the anode and the electrode that supplies electrons is the cathode.

[0072] As the constituent material of the anode, a material having a large work function may be selected. For example, a metal such as gold, platinum, silver, copper, nickel, palladium, cobalt, selenium, vanadium, or tungsten, a mixture containing some of them, or an alloy obtained by combining these can be used as the constituent material of the anode. Alternatively, a metal oxide such as tin oxide, zinc oxide, indium oxide, indium tin oxide (ITO), or zinc indium oxide can be used as the constituent material of the anode. Alternatively, a conductive polymer such as polyaniline, polypyrrole, or polythiophene may be used as the constituent material of the anode.

[0073] One of these electrode materials may be used singly, or two or more of them may be used in combination. The anode may be formed by a single layer or a plurality of layers.

[0074] If the electrode is used as a reflective electrode, for example, chromium, aluminum, silver, titanium, tungsten, molybdenum, an alloy thereof, a stacked layer thereof, or the like can be used. The above materials can function as a reflective film having no role as an electrode. If a transparent electrode is used as the electrode, an oxide transparent conductive layer made of indium tin oxide (ITO), indium zinc oxide, or the like can be used, but the present invention is not limited thereto. A photolithography technique can be used to form the electrode.

[0075] On the other hand, as the constituent material of the cathode, a material having a small work function may be selected. Examples of the material include an alkali metal such as lithium, an alkaline earth metal such as calcium, a metal such as aluminum, titanium, manganese, silver, lead, or chromium, and a mixture containing some of them. Alternatively, an alloy obtained by combining these metals can also be used. For example, a magnesium-silver alloy, an aluminum-lithium alloy, an aluminum-magnesium alloy, a silver-copper alloy, a zinc-silver alloy, or the like can be used. A metal oxide such as indium tin oxide (ITO) can also be used. One of these electrode materials may be used singly, or two or more of them may be used in combination. The cathode may have a single-layer structure or a multilayer structure. Silver may be used as the cathode. To suppress aggregation of silver, a silver alloy may be used. The ratio of the alloy is not limited as long as aggregation of silver can be suppressed. For example, the ratio between silver and another metal may be 1:1, 3:1, or the like.

[0076] The cathode may be a top emission element using an oxide conductive layer made of ITO or the like, or may be a bottom emission element using a reflective electrode made of aluminum (Al) or the like, and is not particularly limited. The method of forming the cathode is not particularly limited, but if direct current sputtering or alternating current sputtering is used, the good coverage is achieved for the film to be formed, and the resistance of the cathode can be lowered.

Pixel Isolation Layer

[0077] A pixel isolation layer may be formed by a so-called silicon oxide, such as silicon nitride (SiN), silicon oxynitride (SiON), or silicon oxide (SiO), formed using a Chemical Vapor Deposition (CVD) method. To increase the resistance in the in-plane direction of the organic compound layer, the organic compound layer, especially the hole transport layer may be thinly deposited on the side wall of the pixel isolation layer. More specifically, the organic compound layer can be deposited so as to have a thin film thickness on the side wall by increasing the taper angle of the side wall of the pixel isolation layer or the film thickness of the pixel isolation layer to increase vignetting during vapor deposition.

[0078] On the other hand, the taper angle of the side wall of the pixel isolation layer or the film thickness of the pixel isolation layer can be adjusted to the extent that no space is formed in the protection layer formed on the pixel isolation layer. Since no space is formed in the protection layer, it is possible to reduce generation of defects in the protection layer. Since generation of defects in the protection layer is reduced, a decrease in reliability caused by generation of a dark spot or occurrence of a conductive failure of the second electrode can be reduced.

[0079] According to this embodiment, even if the taper angle of the side wall of the pixel isolation layer is not acute, it is possible to effectively suppress leakage of charges to an adjacent pixel. As a result of this consideration, it has been found that the taper angle of 60° (inclusive) to 90° (inclusive) can sufficiently reduce the occurrence of defects. The film thickness of the pixel isolation layer may be 10 nm (inclusive) to 150 nm (inclusive). A similar effect can be obtained in a configuration including only pixel electrodes without the pixel isolation layer. However, in this case, the film thickness of the pixel electrode is set to be equal to or smaller than half the film thickness of the organic layer or the end portion of the pixel electrode is formed to have a forward tapered shape of less than 60°. With this, short circuit of the organic light emitting element can be reduced.

[0080] Furthermore, in a case where the first electrode is the cathode and the second electrode is the anode, a high color gamut and low-voltage driving can be achieved by forming the electron transport material and charge transport layer and forming the light emitting layer on the charge transport layer.

Organic Compound Layer

[0081] The organic compound layer may be formed by a single layer or a plurality of layers. If the organic compound layer includes a plurality of layers, the layers can be called a hole injection layer, a hole transport layer, an electron blocking layer, a light emitting layer, a hole blocking layer, an electron transport layer, and an electron injection layer in accordance with the functions of the layers. The organic compound layer is mainly formed from an organic compound but may contain inorganic atoms and an inorganic compound. For example, the organic compound layer may contain copper, lithium, magnesium, aluminum, iridium, platinum, molybdenum, zinc, or the like. The organic compound layer may be arranged between the first and second electrodes, and may be arranged in contact with the first and second electrodes.

Protection Layer

[0082] A protection layer may be provided on the cathode. For example, by adhering glass provided with a moisture absorbing agent on the cathode, permeation of water or the like into the organic compound layer can be suppressed and occurrence of display defects can be suppressed. Furthermore, as another embodiment, a passivation layer made of silicon nitride or the like may be provided on the cathode to suppress permeation of water or the like into the organic compound layer. For example, the protection layer can be formed by forming the cathode, transferring it to another chamber without breaking the vacuum, and forming silicon nitride having a thickness of 2 μm by the CVD method. The protection layer may be provided using an atomic layer deposition (ALD) method after deposition of the protection layer using the CVD method. The material of the protection layer by the ALD method is not limited but can be silicon nitride, silicon oxide, aluminum oxide, or the like. Silicon nitride may further be formed by the CVD method on the protection layer formed by the ALD method. The protection layer formed by the ALD method may have a film thickness smaller than that of the protection layer formed by the CVD method. More specifically, the film thickness of the protection layer formed by the ALD method may be 50% or less, or 10% or less of that of the protection layer formed by the CVD method.

Color Filter

[0083] A color filter may be provided on the protection layer. For example, a color filter considering the size of the organic light emitting element may be provided on another substrate, and the substrate with the color filter formed thereon may be bonded to the substrate with the organic light emitting element provided thereon. Alternatively, for example, a color filter may be patterned on the above-described protection layer using a photolithography technique. The color filter may be formed from a polymeric material.

Planarizing Layer

[0084] A planarizing layer may be arranged between the color filter and the protection layer. The planarizing layer is provided to reduce unevenness of the layer below the planarizing layer. The planarizing layer may be called a material resin layer without limiting the purpose of the layer. The planarizing layer may be formed from an organic compound, and may be made of a low-molecular material or a polymeric material. In consideration of reduction of unevenness, a polymeric organic compound may be used for the planarizing layer.

[0085] The planarizing layers may be provided above and below the color filter. In that case, the same or different constituent materials may be used for these planarizing layers. More specifically, examples of the material of the planarizing layer include polyvinyl carbazole resin, polycarbonate resin, polyester resin, ABS resin, acrylic resin, polyimide resin, phenol resin, epoxy resin, silicone resin, and urea resin.

Microlens

[0086] The organic light emitting apparatus may include an optical member such as a microlens on the light emission side. The microlens can be made of acrylic resin, epoxy resin, or the like. The microlens can aim to increase the amount of light extracted from the organic light emitting apparatus and control the direction of light to be extracted. The microlens can have a hemispherical shape. If the microlens has a hemispherical shape, among tangents contacting the hemisphere, there is a tangent parallel to the insulating layer, and the contact between the tangent and the hemisphere is the vertex of the microlens. The vertex of the microlens can be decided in the same manner even in an arbitrary sectional view. That is, among tangents contacting the semicircle of the microlens in a sectional view, there is a tangent parallel to the insulating layer, and the contact between the tangent and the semicircle is the vertex of the microlens.

[0087] Furthermore, the middle point of the microlens can also be defined. In the section of the microlens, a line segment from a point at which an arc shape ends to a point at which another arc shape ends is assumed, and the middle point of the line segment can be called the middle point of the microlens. A section for determining the vertex and the middle point may be a section perpendicular to the insulating layer.

[0088] The microlens includes a first surface including a convex portion and a second surface opposite to the first surface. The second surface can be arranged on the functional layer (light emitting layer) side of the first surface. For this configuration, the microlens needs to be formed on the light emitting apparatus. If the functional layer is an organic layer, a process which produces high temperature in the manufacturing step of the microlens may be avoided. In addition, if it is configured to arrange the second surface on the functional layer side of the first surface, all the glass transition temperatures of an organic compound forming the organic layer may be 100° C. or more. For example, 130° C. or more is suitable.

Counter Substrate

[0089] A counter substrate may be arranged on the planarizing layer. The counter substrate is called a counter substrate because it is provided at a position corresponding to the above-described substrate. The constituent material of the counter substrate can be the same as that of the above-described substrate. If the above-described substrate is the first substrate, the counter substrate can be the second substrate.

Organic Layer

[0090] The organic compound layer (hole injection layer, hole transport layer, electron blocking layer, light emitting layer, hole blocking layer, electron transport layer, electron injection layer, and the like) forming the organic light emitting element according to an embodiment of the present disclosure may be formed by the method to be described below.

[0091] The organic compound layer forming the organic light emitting element according to the embodiment of the present disclosure can be formed by a dry process using a vacuum deposition method, an ionization deposition method, a sputtering method, a plasma method, or the like. Instead of the dry process, a wet process that forms a layer by dissolving a solute in an appropriate solvent and using a well-known coating method (for example, a spin coating method, a dipping method, a casting method, an LB method, an inkjet method, or the like) can be used.

[0092] Here, when the layer is formed by a vacuum deposition method, a solution coating method, or the like, crystallization or the like hardly occurs and excellent temporal stability is obtained. Furthermore, when the layer is formed using a coating method, it is possible to form the film in combination with a suitable binder resin.

[0093] Examples of the binder resin include polyvinyl carbazole resin, polycarbonate resin, polyester resin, ABS resin, acrylic resin, polyimide resin, phenol resin, epoxy resin, silicone resin, and urea resin. However, the binder resin is not limited to them.

[0094] One of these binder resins may be used singly as a homopolymer or a copolymer, or two or more of them may be used in combination. Furthermore, additives such as a well-known plasticizer, antioxidant, and an ultraviolet absorber may also be used as needed.

Pixel Circuit

[0095] The light emitting apparatus can include a pixel circuit connected to the light emitting element. The pixel circuit may be an active matrix circuit that individually controls light emission of the first and second light emitting elements. The active matrix circuit may be a voltage or current programing circuit. A driving circuit includes a pixel circuit for each pixel. The pixel circuit can include a light emitting element, a transistor for controlling light emission luminance of the light emitting element, a transistor for controlling a light emission timing, a capacitor for holding the gate voltage of the transistor for controlling the light emission luminance, and a transistor for connection to GND without intervention of the light emitting element.

[0096] The light emitting apparatus includes a display region and a peripheral region arranged around the display region. The light emitting apparatus includes the pixel circuit in the display region and a display control circuit in the peripheral region. The mobility of the transistor forming the pixel circuit may be smaller than that of a transistor forming the display control circuit.

[0097] The slope of the current-voltage characteristic of the transistor forming the pixel circuit may be smaller than that of the current-voltage characteristic of the transistor forming the display control circuit. The slope of the current-voltage characteristic can be measured by a so-called Vg-Ig characteristic.

[0098] The transistor forming the pixel circuit is a transistor connected to the light emitting element such as the first light emitting element.

Pixel

[0099] The organic light emitting apparatus includes a plurality of pixels. Each pixel includes sub-pixels that emit light components of different colors. The sub-pixels may include, for example, R, G, and B emission colors, respectively.

[0100] In each pixel, a region also called a pixel opening emits light. The pixel opening can have a size of 5 μm (inclusive) to 15 μm (inclusive). More specifically, the pixel opening can have a size of 11 μm, 9.5 μm, 7.4 μm, 6.4 μm, or the like.

[0101] A distance between the sub-pixels can be 10 μm or less, and can be, more specifically, 8 μm, 7.4 μm, or 6.4 μm.

[0102] The pixels can have a known arrangement form in a plan view. For example, the pixels may have a stripe arrangement, a delta arrangement, a pentile arrangement, or a Bayer arrangement. The shape of each sub-pixel in a plan view may be any known shape. For example, a quadrangle such as a rectangle or a rhombus, a hexagon, or the like may be possible. A shape which is not a correct shape but is close to a rectangle is included in a rectangle, as a matter of course. The shape of the sub-pixel and the pixel arrangement can be used in combination.

Application of Organic Light Emitting Element of Embodiment of Present Disclosure

[0103] The organic light emitting element according to an embodiment of the present disclosure can be used as a constituent member of a display apparatus or an illumination apparatus. In addition, the organic light emitting element is applicable to the exposure light source of an electrophotographic image forming apparatus, the backlight of a liquid crystal display apparatus, a light emitting apparatus including a color filter in a white light source, and the like.

[0104] The display apparatus may be an image information processing apparatus that includes an image input unit for inputting image information from an area CCD, a linear CCD, a memory card, or the like, and an information processing unit for processing the input information, and displays the input image on a display unit.

[0105] In addition, a display unit included in an image capturing apparatus or an inkjet printer can have a touch panel function. The driving type of the touch panel function may be an infrared type, a capacitance type, a resistive film type, or an electromagnetic induction type, and is not particularly limited. The display apparatus may be used for the display unit of a multifunction printer.

[0106] More details will be described next with reference to the accompanying drawings. FIG. **10**A shows an example of a pixel that is a constituent element of the above-described pixel array portion **101**. The pixel includes sub-pixels **810**. The sub-pixels are divided into sub-pixels **810**R, **810**G, and **810**B by emitted light components. The light emission colors may be discriminated by the wavelengths of light components emitted from the light emitting layers, or light emitted from each sub-pixel may be selectively transmitted or undergo color conversion by a color filter or the like. Each sub-pixel includes a reflective electrode **802** as the first electrode on an interlayer insulating layer **801**, an insulating layer **803** covering the end of the reflective electrode **802**, an organic compound layer **804** covering the first electrode and the insulating layer, a transparent electrode **805** as the second electrode, a protection layer **806**, and a color filter **807**.

[0107] The interlayer insulating layer **801** can include a transistor and a capacitive element arranged in the interlayer insulating layer **801** or a layer below it. The transistor and the first electrode can electrically be connected via a contact hole (not shown) or the like.

[0108] The insulating layer **803** can also be called a bank or a pixel isolation film. The insulating layer **803** covers the end of the first electrode, and is arranged to surround the first electrode. A portion of the first electrode where no insulating layer **803** is arranged is in contact with the organic compound layer **804** to form a light emitting region.

[0109] The organic compound layer **804** includes a hole injection layer **841**, a hole transport layer **842**, a first light emitting layer **843**, a second light emitting layer **844**, and an electron transport layer **845**.

[0110] The second electrode may be a transparent electrode, a reflective electrode, or a semi-transmissive electrode.

[0111] The protection layer **806** suppresses permeation of water into the organic compound layer. The protection layer is shown as a single layer but may include a plurality of layers. Each layer can be an inorganic compound layer or an organic compound layer.

[0112] The color filter **807** is divided into color filters **807**R, **807**G, and **807**B by colors. The color filters can be formed on a planarizing film (not shown). A resin protection layer (not shown) may be arranged on the color filters. The color filters can be formed on the protection layer **806**. Alternatively, the color filters can be provided on the counter substrate such as a glass substrate, and then the substrate may be bonded.

[0113] A display apparatus **800** (corresponding to the above-described light emitting apparatus **10**) shown in FIG. **10**B can include an organic light emitting element **826** and a TFT **818** as an example of a transistor. An insulating layer **812** is provided on a substrate **811** of glass, silicon, or the like. The active element such as the TFT **818** is arranged on the insulating layer **812**, and a gate electrode **813**, a gate insulating film **814**, and a semiconductor layer **815** of the active element are arranged. The TFT **818** can further include the semiconductor layer **815**, a drain electrode **816**, and a source electrode **817**. An insulating film **819** is provided on the TFT **818**. The source electrode **817** and an anode **821** forming the organic light emitting element **826** are connected via a contact hole **820** formed in the insulating film **819**.

[0114] A method of electrically connecting the electrodes (anode and cathode) included in the organic light emitting element **826** and the electrodes (source electrode and drain electrode) included in the TFT is not limited to that shown in FIG. **10**B. That is, one of the anode and cathode and one of the source electrode and drain electrode of the TFT are electrically connected. The TFT indicates a thin-film transistor.

[0115] In the display apparatus **800** shown in FIG. **10**B, an organic compound layer is illustrated as one layer. However, an organic compound layer **822** may include a plurality of layers. A first protection layer **824** and a second protection layer **825** are provided on a cathode **823** to suppress deterioration of the organic light emitting element.

[0116] A transistor is used as a switching element in the display apparatus **800** shown in FIG. **10**B but may be used as another switching element.

[0117] The transistor used in the display apparatus **800** shown in FIG. **10**B is not limited to a transistor using a single-crystal silicon wafer, and may be a thin-film transistor including an active layer on an insulating surface of a substrate. Examples of the active layer include single-crystal silicon, amorphous silicon, non-single-crystal silicon such as microcrystalline silicon, and a non-single-crystal oxide semiconductor such as indium zinc oxide and indium gallium zinc oxide. Note that a thin-film transistor is also called a TFT element.

[0118] The transistor included in the display apparatus **800** shown in FIG. **10**B may be formed in the substrate such as a silicon substrate. Forming the transistor in the substrate means forming the transistor by processing the substrate such as a silicon substrate. That is, when the transistor is included in the substrate, it can be considered that the substrate and the transistor are formed integrally.

[0119] The light emission luminance of the organic light emitting element according to this embodiment can be controlled by the TFT which is an example of a switching element, and the plurality of organic light emitting elements can be provided in a plane to display an image with the light emission luminances of the respective elements. Here, the switching element according to this embodiment is not limited to the TFT, and may be a transistor formed from low-temperature polysilicon or an active matrix driver formed on the substrate such as a silicon substrate. The term “on the substrate” may mean “in the substrate”. Whether to provide a transistor in the substrate or use a TFT is selected based on the size of the display unit. For example, if the size is about 0.5 inch, the organic light emitting element is preferably provided on the silicon substrate.

[0120] FIGS. **11**A to **11**C are schematic views showing an example of an image forming apparatus using the above-described light emitting apparatus **10**. An image forming apparatus **926** shown in FIG. **11**A includes a photosensitive member **927**, an exposure light source **928**, a developing unit **931**, a charging unit **930**, a transfer device **932**, a conveyance unit **933** (a conveyance roller in the configuration shown in FIG. **11**A), and a fixing device **935**.

[0121] Light **929** is emitted from the exposure light source **928**, and an electrostatic latent image is formed on the surface of the photosensitive member **927**. The light emitting apparatus **10** can be applied to the exposure light source **928**. The developing unit **931** can function as a developing device that includes a toner or the like as a developing agent and applies the developing agent to the exposed photosensitive member **927**. The charging unit **930** charges the photosensitive member **927**. The transfer device **932** transfers the developed image to a print medium **934**. The conveyance unit **933** conveys the print medium **934**. The print medium **934** can be, for example, paper, a film, or the like. The fixing device **935** fixes the image formed on the print medium.

[0122] Each of FIGS. **11**B and **11**C is a schematic view showing a form in which a plurality of light emitting units **936** are arranged in the exposure light source **928** along the longitudinal direction of a long substrate. The light emitting apparatus **10** can be applied to each of the light emitting units **936**. That is, a plurality of pixels **150** arranged in a pixel array **110** are arranged along the longitudinal direction of the substrate. A direction **937** is a direction parallel to the axis of the photosensitive member **927**. This column direction matches the direction of the axis upon rotating the photosensitive member **927**. This direction **937** can also be referred to as the long-axis direction of the photosensitive member **927**.

[0123] FIG. **11**B shows a form in which the light emitting units **936** are arranged along the long-axis direction of the photosensitive member **927**. FIG. **11**C shows a form, which is a modification of the arrangement of the light emitting units **936** shown in FIG. **11**B. FIG. **11**C shows a form in which the light emitting units **936** are arranged in the column direction alternately between the first column and the second column. The light emitting units **936** are arranged at different positions in the row direction between the first column and the second column. In the first column, the plurality of light emitting units **936** are arranged apart from each other. In the second column, the light emitting unit **936** is arranged at the position corresponding to the space between the light emitting units **936** in the first column. Furthermore, in the row direction, the plurality of light emitting units **936** are arranged apart from each other. The arrangement of the light emitting units **936** shown in FIG. **11**C can be referred to as, for example, an arrangement in a grid pattern, an arrangement in a staggered pattern, or an arrangement in a checkered pattern.

[0124] FIG. **12** is a schematic view showing an example of the display apparatus using the above-described light emitting apparatus **10**. A display apparatus **1000** can include a touch panel **1003**, a display panel **1005**, a frame **1006**, a circuit board **1007**, and a battery **1008** between an upper cover **1001** and a lower cover **1009**. Flexible printed circuits (FPCs) **1002** and **1004** are respectively connected to the touch panel **1003** and the display panel **1005**. Active elements such as transistors are arranged on the circuit board **1007**. The battery **1008** is unnecessary if the display apparatus **1000** is not a portable device. Even when the display apparatus **1000** is a portable device, the battery **1008** need not be provided at this position. The light emitting apparatus **10** can be applied to the display panel **1005**. The pixels **150** arranged in the pixel array portion **101** of the light emitting apparatus **10** functioning as the display panel **1005** operate in a state in which they are connected to the active elements such as transistors arranged on the circuit board **1007**.

[0125] The display apparatus **1000** shown in FIG. **12** can be used for a display unit of a photoelectric conversion apparatus (also referred to as an image capturing apparatus) including an optical unit having a plurality of lenses, and an image sensor for receiving light having passed through the optical unit and photoelectrically converting the light into an electric signal. The photoelectric conversion apparatus can include a display unit for displaying information acquired by the image sensor. In addition, the display unit can be either a display unit exposed outside the photoelectric conversion apparatus, or a display unit arranged in the finder. The photoelectric conversion apparatus can be a digital camera or a digital video camera.

[0126] FIG. **13** is a schematic view showing an example of a photoelectric conversion apparatus **1100** using the above-described light emitting apparatus **10**. The photoelectric conversion apparatus **1100** can include a viewfinder **1101**, a rear display **1102**, an operation unit **1103**, and a housing **1104**. The photoelectric conversion apparatus **1100** can also be called an image capturing apparatus. The light emitting apparatus **10** according to this embodiment can be applied to the viewfinder **1101** or the rear display **1102** as a display unit. In this case, the pixel array portion **101** of the light emitting apparatus **10** can display not only an image to be captured but also environment information, image capturing instructions, and the like. Examples of the environment information are the intensity and direction of external light, the moving velocity of an object, and the possibility that an object is covered with an obstacle.

[0127] The timing suitable for image capturing is a very short time in many cases, so the information is preferably displayed as soon as possible. Therefore, the light emitting apparatus **10** in which the pixels **150** each including the light emitting element using the organic light emitting material such as an organic EL element are arranged in the pixel array portion **101** may be used for the viewfinder **1101** or the rear display **1102**. This is so because the organic light emitting material has a high response speed. The light emitting apparatus **10** using the organic light emitting material can be used for the apparatuses that require a high display speed more preferably than for the liquid crystal display apparatus.

[0128] The photoelectric conversion apparatus **1100** includes an optical unit (not shown). This optical unit has a plurality of lenses, and forms an image on a photoelectric conversion element (not shown) that receives light having passed through the optical unit and is accommodated in the housing **1104**. The focal points of the plurality of lenses can be adjusted by adjusting the relative positions. This operation can also automatically be performed.

[0129] The light emitting apparatus **10** may be applied to a display unit of an electronic device. At this time, the display unit can have both a display function and an operation function. Examples of the portable terminal are a portable phone such as a smartphone, a tablet, and a head mounted display.

[0130] FIG. **14** is a schematic view showing an example of an electronic device **1200** using the above-described light emitting apparatus **10**. The electronic device **1200** includes a display unit **1201**, an operation unit **1202**, and a housing **1203**. The housing **1203** can accommodate a circuit, a printed board having this circuit, a battery, and a communication unit. The operation unit **1202** can be a button or a touch-panel-type reaction unit. The operation unit **1202** can also be a biometric authentication unit that performs unlocking or the like by authenticating the fingerprint. The portable device including the communication unit can also be regarded as a communication device. The light emitting apparatus **10** can be applied to the display unit **1201**.

[0131] FIGS. **15**A and **15**B are schematic views showing examples of a display apparatus **1300** using the above-described light emitting apparatus **10**. FIG. **15**A shows a display apparatus such as a television monitor or a PC monitor. A display apparatus **1300** includes a frame **1301** and a display unit **1302**. The light emitting apparatus **10** can be applied to the display unit **1302**. The display apparatus **1300** can include a base **1303** that supports the frame **1301** and the display unit **1302**. The base **1303** is not limited to the form shown in FIG. **15**A. For example, the lower side of the frame **1301** may also function as the base **1303**. In addition, the frame **1301** and the display unit **1302** can be bent. The radius of curvature in this case can be 5,000 mm (inclusive) to 6,000 mm (inclusive).

[0132] FIG. **15**B is a schematic view showing another example of the display apparatus using the above-described light emitting apparatus **10**. A display apparatus **1310** shown in FIG. **15**B can be folded, and is a so-called foldable display apparatus. The display apparatus **1310** includes a first display unit **1311**, a second display unit **1312**, a housing **1313**, and a bending point **1314**. The light emitting apparatus **10** can be applied to each of the first display unit **1311** and the second display unit **1312**. The first display unit **1311** and the second display unit **1312** can also be one seamless display apparatus. The first display unit **1311** and the second display unit **1312** can be divided by the bending point. The first display unit **1311** and the second display unit **1312** can display different images, and can also display one image together.

[0133] FIG. **16** is a schematic view showing an example of an illumination apparatus **1400** using the above-described light emitting apparatus **10**. The illumination apparatus **1400** can include a housing **1401**, a light source **1402**, a circuit board **1403**, an optical film **1404**, and a light diffusing unit **1405**. The light emitting apparatus **10** can be applied to the light source **1402**. The optical film **1404** can be a filter that improves the color rendering of the light source. When performing lighting-up or the like, the light diffusing unit **1405** can throw the light of the light source over a broad range by effectively diffusing the light. The illumination apparatus can also include a cover on the outermost portion, as needed. The illumination apparatus **1400** can include both or one of the optical film **1404** and the light diffusing unit **1405**.

[0134] The illumination apparatus **1400** is, for example, an apparatus for illuminating the interior of the room. The illumination apparatus **1400** can emit white light, natural white light, or light of any color from blue to red. The illumination apparatus **1400** can also include a light control circuit for controlling these light components. The illumination apparatus **1400** can also include a power supply circuit connected to the light emitting apparatus **10** functioning as the light source **1402**. The power supply circuit is a circuit for converting an AC voltage into a DC voltage. White has a color temperature of 4,200 K, and natural white has a color temperature of 5,000 K. The illumination apparatus **1400** may also include a color filter. In addition, the illumination apparatus **1400** can include a heat radiation unit. The heat radiation unit radiates the internal heat of the apparatus to the outside of the apparatus, and examples are a metal having a high specific heat and liquid silicon.

[0135] FIG. **17** is a schematic view of an automobile **1500** having a taillight as an example of a vehicle lighting appliance using the above-described light emitting apparatus **10**. An automobile **1500** has a taillight **1501**, and can have a form in which the taillight **1501** is turned on when performing a braking operation or the like. The above-described light emitting apparatus **10** can be used as a headlight serving as a vehicle lighting appliance. The automobile is an example of a moving body, and the moving body may be a ship, a drone, an aircraft, a railroad car, an industrial robot, or the like. The moving body may include a main body and a lighting appliance provided in the main body. The lighting appliance may be used to make a notification of the current position of the main body.

[0136] The light emitting apparatus **10** can be applied to the taillight **1501**. The taillight **1501** can include a protection member for protecting the light emitting apparatus **10** functioning as the taillight **1501**. The material of the protection member is not limited as long as the material is a transparent material with a strength that is high to some extent, and an example is polycarbonate. The protection member may be made of a material obtained by mixing a furandicarboxylic acid derivative, an acrylonitrile derivative, or the like in polycarbonate.

[0137] The automobile **1500** can include a vehicle body **1503**, and a window **1502** attached to the vehicle body **1503**. This window can be a window for checking the front and back of the automobile, and can also be a transparent display such as a head-up display. For this transparent display, the light emitting apparatus **10** may be used. In this case, the constituent materials of the electrodes and the like of the light emitting apparatus **10** are formed by transparent members.

[0138] Further application examples of the light emitting apparatus **10** will be described with reference to FIGS. **18**A and **18**B. The light emitting apparatus **10** can be applied to a system that can be worn as a wearable device such as smartglasses, a Head Mounted Display (HMD), or a smart contact lens. An image capturing display apparatus used for such application examples includes an image capturing apparatus capable of photoelectrically converting visible light and a light emitting apparatus capable of emitting visible light.

[0139] FIG. **18**A is a view showing glasses **1600** (smartglasses) according to one application example. An image capturing apparatus **1602** such as a CMOS sensor or an SPAD is provided on the surface side of a lens **1601** of the glasses **1600**. In addition, the light emitting apparatus **10** is provided on the back surface side of the lens **1601**.

[0140] The glasses **1600** further include a control apparatus **1603**. The control apparatus **1603** functions as a power supply that supplies electric power to the image capturing apparatus **1602** and the above-described light emitting apparatus **10**. In addition, the control apparatus **1603** controls the operations of the image capturing apparatus **1602** and the light emitting apparatus **10**. An optical system configured to condense light to the image capturing apparatus **1602** is formed on the lens **1601**.

[0141] FIG. **18**B is a view showing glasses **1610** (smartglasses) according to one application example. The glasses **1610** include a control apparatus **1612**, and an image capturing apparatus corresponding to the image capturing apparatus **1602** and the light emitting apparatus **10** are mounted on the control apparatus **1612**. The image capturing apparatus in the control apparatus **1612** and an optical system configured to project light emitted from the light emitting apparatus **10** are formed in a lens **1611**, and an image is projected to the lens **1611**. The control apparatus **1612** functions as a power supply unit that supplies electric power to the image capturing apparatus and the light emitting apparatus **10**, and controls the operations of the image capturing apparatus and the light emitting apparatus **10**. The control apparatus **1612** may include a line-of-sight detection unit that detects the line of sight of a wearer. The detection of a line of sight may be done using infrared rays. An infrared ray emitting unit emits infrared rays to an eyeball of the user who is gazing at a displayed image. An image capturing unit including a light receiving element detects reflected light of the emitted infrared rays from the eyeball, thereby obtaining a captured image of the eyeball. A reduction unit for reducing light from the infrared ray emitting unit to the display unit in a planar view is provided, thereby reducing deterioration of image quality.

[0142] The line of sight of the user to the displayed image is detected from the captured image of the eyeball obtained by capturing the infrared rays. An arbitrary known method can be applied to the line-of-sight detection using the captured image of the eyeball. As an example, a line-of-sight detection method based on a Purkinje image obtained by reflection of irradiation light by a cornea can be used.

[0143] More specifically, line-of-sight detection processing based on pupil center corneal reflection is performed. Using pupil center corneal reflection, a line-of-sight vector representing the direction (rotation angle) of the eyeball is calculated based on the image of the pupil and the Purkinje image included in the captured image of the eyeball, thereby detecting the line-of-sight of the user.

[0144] The light emitting apparatus **10** according to the embodiment of the present disclosure can include an image capturing apparatus including a light receiving element, and control a displayed image based on the line-of-sight information of the user from the image capturing apparatus.

[0145] More specifically, the light emitting apparatus **10** decides a first visual field region at which the user is gazing and a second visual field region other than the first visual field region based on the line-of-sight information. The first visual field region and the second visual field region may be decided by the control apparatus of the light emitting apparatus **10**, or those decided by an external control apparatus may be received. In the display region of the light emitting apparatus **10**, the display resolution of the first visual field region may be controlled to be higher than the display resolution of the second visual field region. That is, the resolution of the second visual field region may be lower than that of the first visual field region.

[0146] In addition, the display region includes a first display region and a second display region different from the first display region, and a region of higher priority is decided from the first display region and the second display region based on line-of-sight information. The first display region and the second display region may be decided by the control apparatus of the light emitting apparatus **10**, or those decided by an external control apparatus may be received. The resolution of the region of higher priority may be controlled to be higher than the resolution of the region other than the region of higher priority. That is, the resolution of the region of relatively low priority may be low.

[0147] Note that AI may be used to decide the first visual field region or the region of higher priority. The AI may be a model configured to estimate the angle of the line of sight and the distance to a target ahead the line of sight from the image of the eyeball using the image of the eyeball and the direction of actual viewing of the eyeball in the image as supervised data. The AI program may be held by the light emitting apparatus **10**, the image capturing apparatus, or an external apparatus. If the external apparatus holds the AI program, it is transmitted to the light emitting apparatus **10** via communication.

[0148] When performing display control based on line-of-sight detection, smartglasses further including an image capturing apparatus configured to capture the outside can be applied. The smartglasses can display captured outside information in real time.

[0149] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

[0150] This application claims the benefit of Japanese Patent Application No. 2024-021447, filed Feb. 15, 2024, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A light emitting apparatus comprising:

a pixel array portion including a plurality of pixels arrayed to form a plurality of rows and a plurality of columns, and a plurality of signal lines extending in a column direction, wherein

each of the plurality of signal lines is divided into a plurality of sub-signal lines,

the light emitting apparatus is configured such that, to the pixels of the same column, a signal generated using an output signal from the same reference voltage generation circuit is supplied via a corresponding sub-signal line,

the light emitting apparatus includes a first substrate and a second substrate, which are stacked on each other,

the first substrate includes the pixel array portion, and the second substrate includes a signal output circuit configured to output the signal, and a signal line switching circuit configured to switch a connection destination of an output of the signal output circuit between the plurality of sub-signal lines.

2. The apparatus according to claim **1**, wherein the second substrate further includes the reference voltage generation circuit.

3. The apparatus according to claim **1**, wherein the signal line switching circuit includes a plurality of selectors configured to select, for each pixel column, one of the plurality of sub-signal lines as the connection destination of the output of the signal output circuit.

4. The apparatus according to claim **1**, wherein the signal output circuit further includes a column DAC circuit configured to convert data corresponding to each pixel column into an analog signal, and

a signal based on an output signal from the column DAC circuit is supplied to the plurality of sub-signal lines.

5. The apparatus according to claim **4**, wherein the signal output circuit further includes a column driver circuit configured to output a luminance signal according to the output signal from the column DAC circuit, and

a signal based on an output signal from the column driver circuit is supplied to the plurality of sub-signal lines.

6. The apparatus according to claim **1**, further comprising:

a first sub-signal line connected to the second substrate via a first connecting portion provided on the first substrate; and

a second sub-signal line connected to the second substrate via a second connecting portion provided on the first substrate,

wherein the first connecting portion and the second connecting portion are provided at end portions of the first sub-signal line and the second sub-signal line on sides close to each other.

7. The apparatus according to claim **1**, further comprising:

a first sub-signal line connected to the second substrate via a first connecting portion provided on the first substrate; and

a second sub-signal line connected to the second substrate via a second connecting portion provided on the first substrate,

wherein the first connecting portion and the second connecting portion are provided at end portions of the first sub-signal line and the second sub-signal line on sides far apart from each other.

8. The apparatus according to claim **1**, wherein the plurality of signal lines include:

a plurality of first sub-signal lines provided for each pixel column in a first region that is one of two regions obtained by dividing a region including the plurality of pixels into two parts by a line parallel to a row direction; and

a plurality of second sub-signal lines provided for each pixel column in a second region that is the other of the two regions.

9. The apparatus according to claim **1**, wherein the plurality of signal lines include:

a plurality of first sub-signal lines provided for each pixel column in a first region of four regions obtained by dividing a region including the plurality of pixels into four parts by lines parallel to a row direction;

a plurality of second sub-signal lines provided for each pixel column in a second region of the four regions;

a plurality of third sub-signal lines provided for each pixel column in a third region of the four regions; and

a plurality of fourth sub-signal lines provided for each pixel column in a fourth region of the four regions.

10. An image forming apparatus comprising a photosensitive member, an exposure light source configured to expose the photosensitive member, a developing device configured to apply a developing agent to the exposed photosensitive member, and a transfer device configured to transfer an image developed by the developing device to a print medium,

wherein the exposure light source includes a light emitting apparatus defined in claim **1**.

11. A display apparatus comprising a light emitting apparatus defined in claim **1**, and an active element connected to the light emitting apparatus.

12. A photoelectric conversion apparatus comprising an optical unit including a plurality of lenses, an image sensor configured to receive light having passed through the optical unit, and a display unit configured to display an image captured by the image sensor,

wherein the display unit includes a light emitting apparatus defined in claim **1**.

13. An electronic device comprising a display unit including a light emitting apparatus defined in claim **1**, a housing provided with the display unit, and a communication unit provided in the housing and configured to perform external communication.

14. An illumination apparatus comprising a light source including a light emitting apparatus defined in claim **1**, and one of a light diffusing unit and an optical film, through which light emitted by the light source is transmitted.

15. A moving body comprising a lighting appliance including a light emitting apparatus defined in claim **1**, and a main body provided with the lighting appliance.

16. A wearable device comprising a display apparatus configured to display an image,

wherein the display apparatus includes a light emitting apparatus defined in claim **1**.

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