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(54) ORGANIC LIGHT-EMITTING DISPLAY DEVICE

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(52) **U.S. Cl.** **313/504**

(57) **ABSTRACT**

A scanning line, a signal line, a first current supply line, and a second current supply line are formed on a glass substrate, a first electrode is formed on the wiring layer comprising the above members, an organic layer comprising a hole transport layer, a light-emitting layer, an electron transport layer, and an electron injection layer is formed on the first electrode, a second electrode is formed as cathode on the electron injection layer, the first electrode as anode is connected to a plus terminal of a power source through the driving devices and the first current supply line, whereas the second electrode as cathode is connected to a minus terminal of the power source, and is connected to the second current supply line in the display region of each pixel, with a contact hole serving as a feeding point, whereby wiring resistance due to the second electrode is reduced, and variations in the brightness of a panel is reduced.

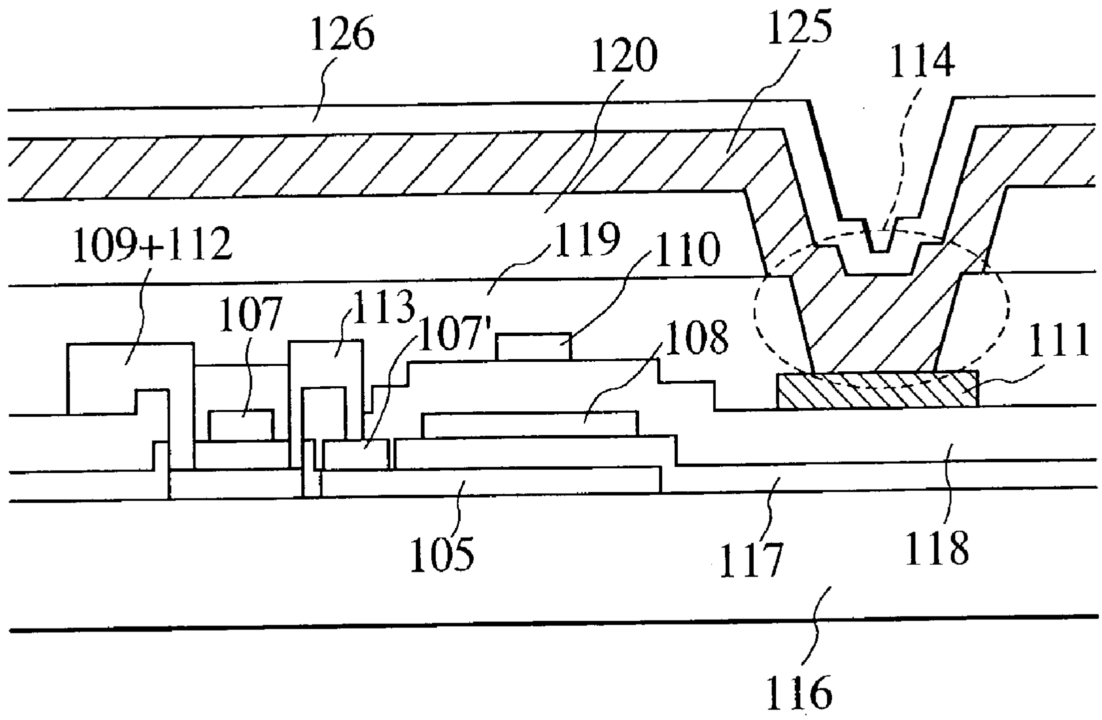

FIG. 1

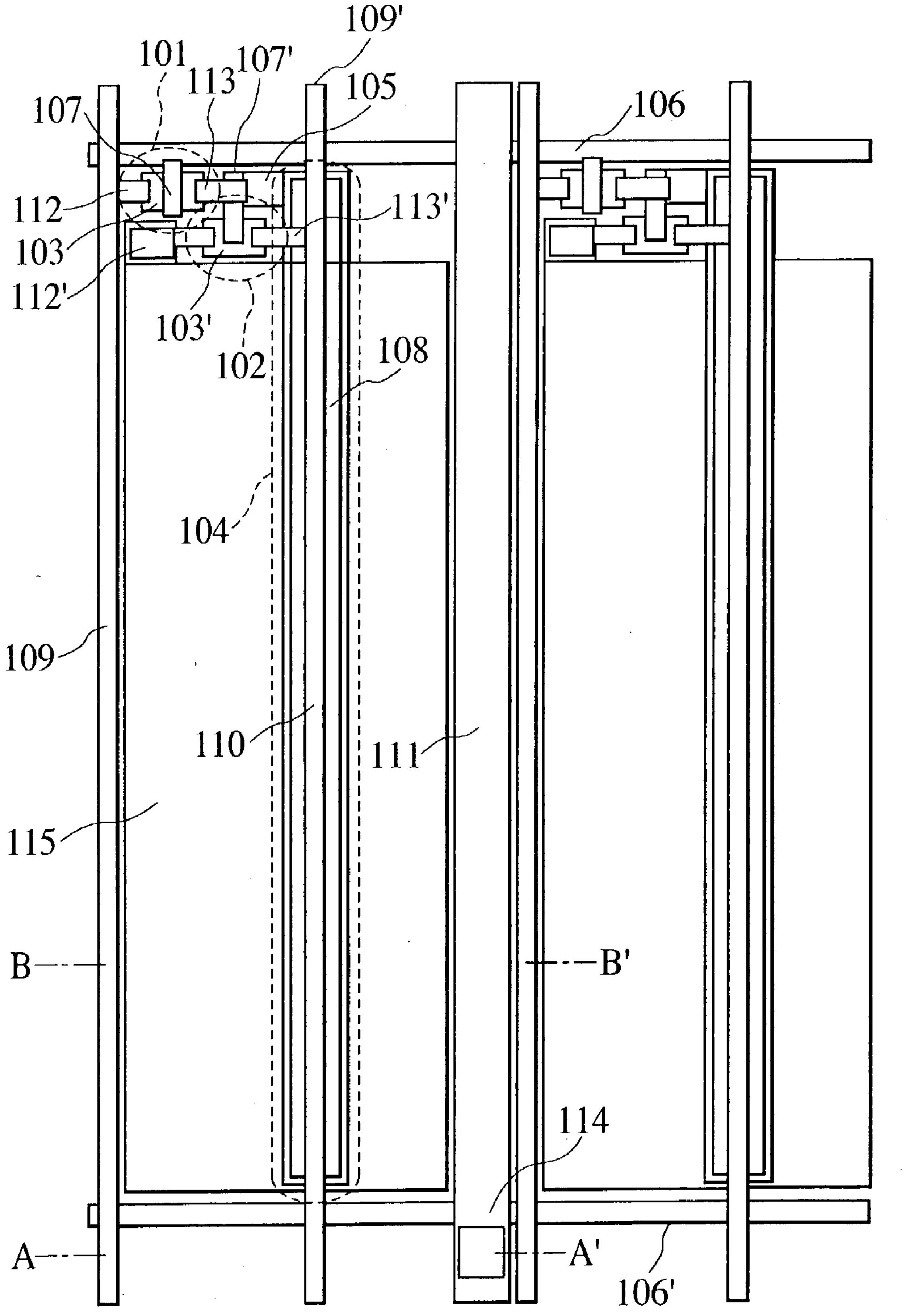

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FIG. 2A

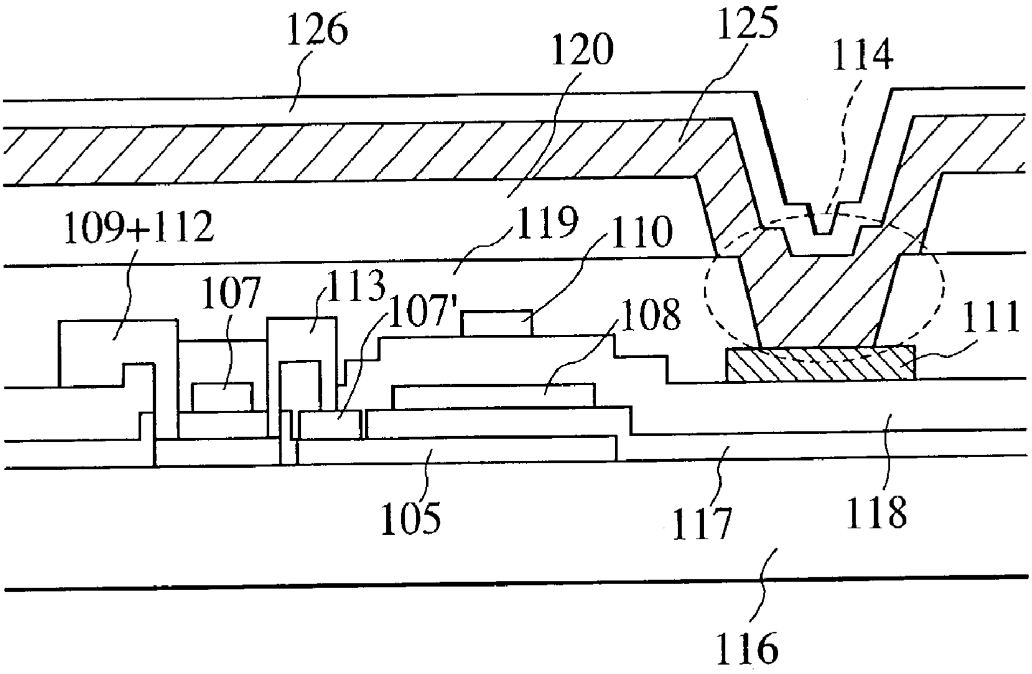
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FIG. 2B

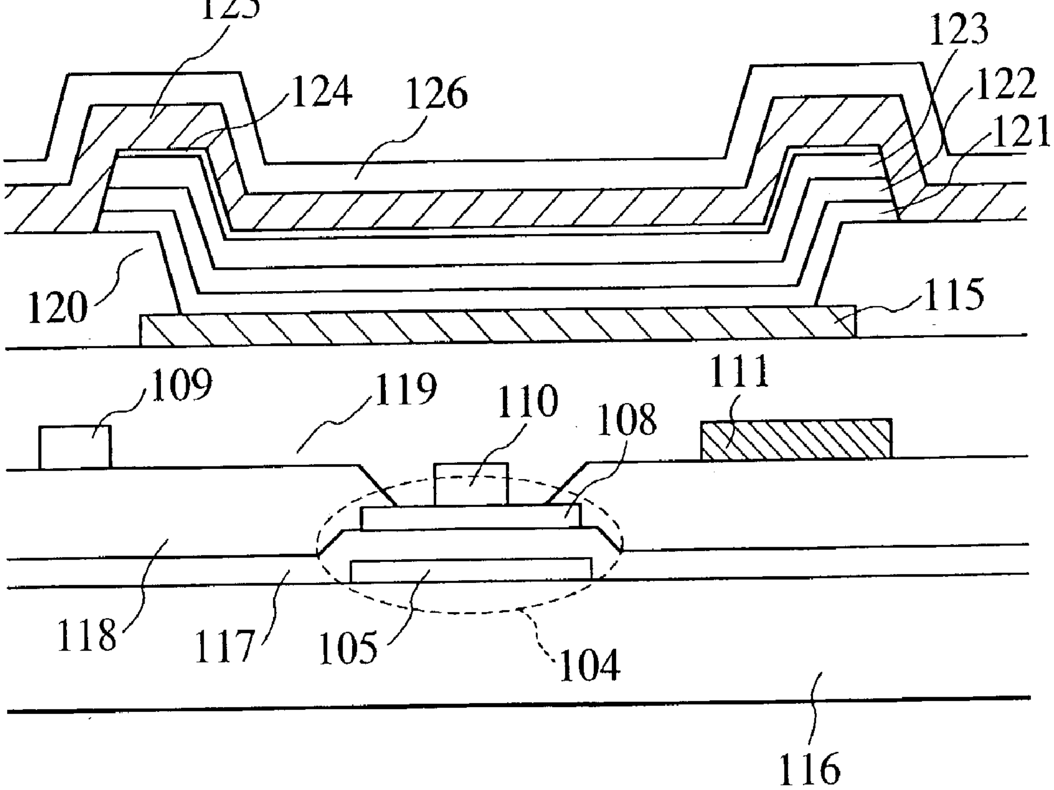
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FIG. 3A

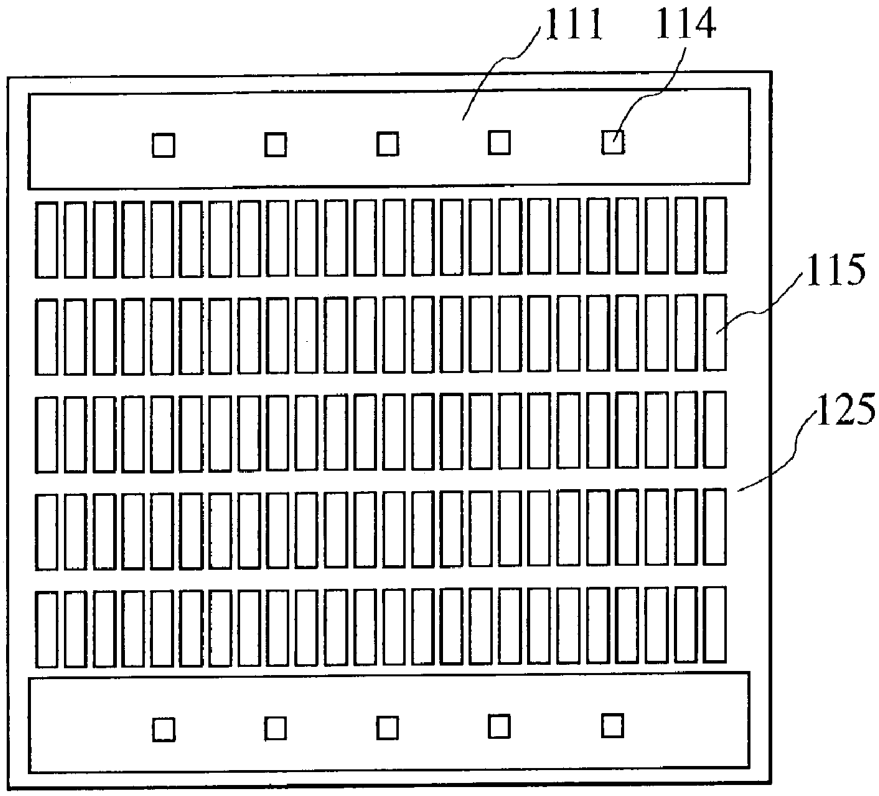

FIG. 3B

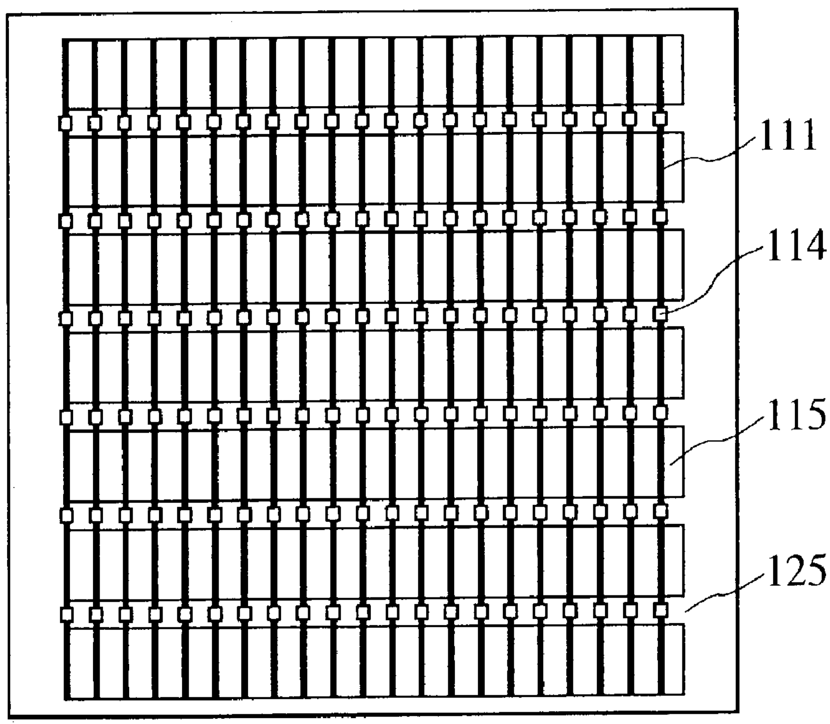

FIG. 4

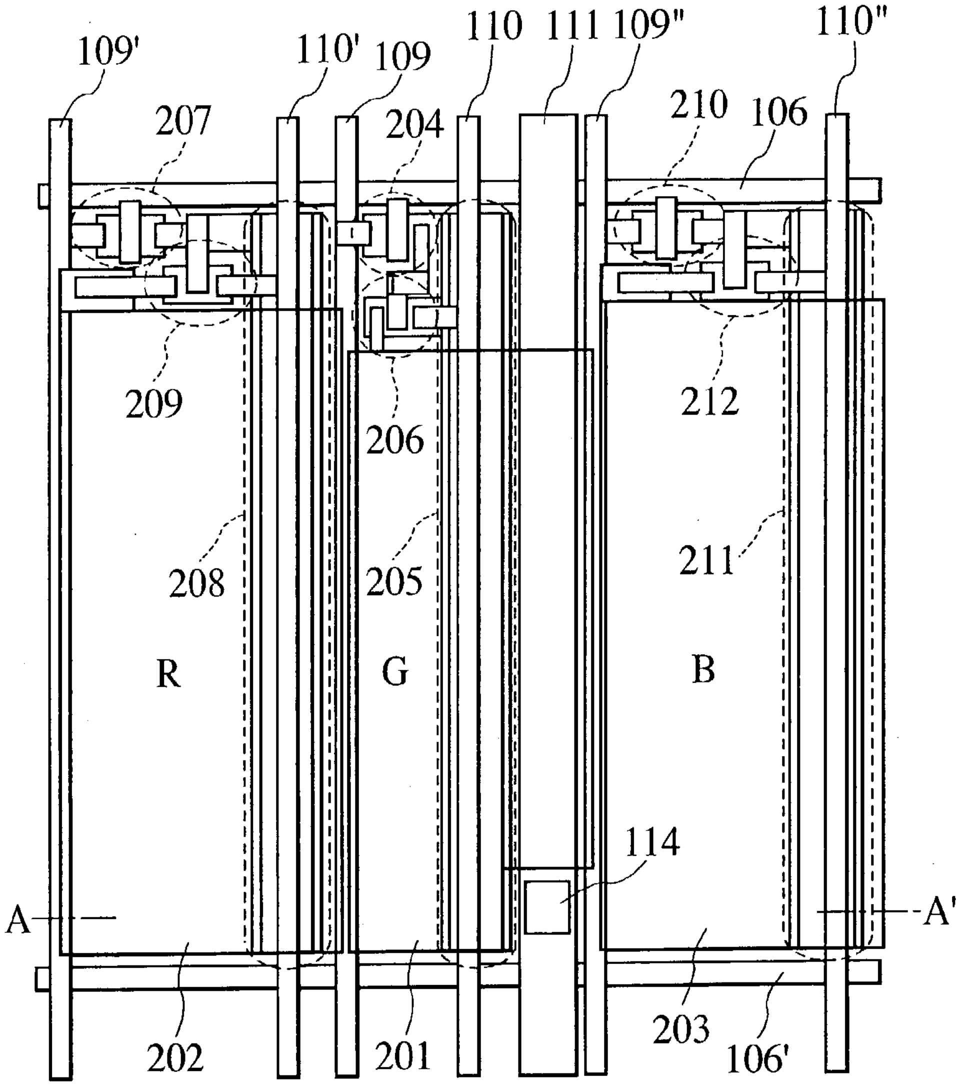
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FIG. 5

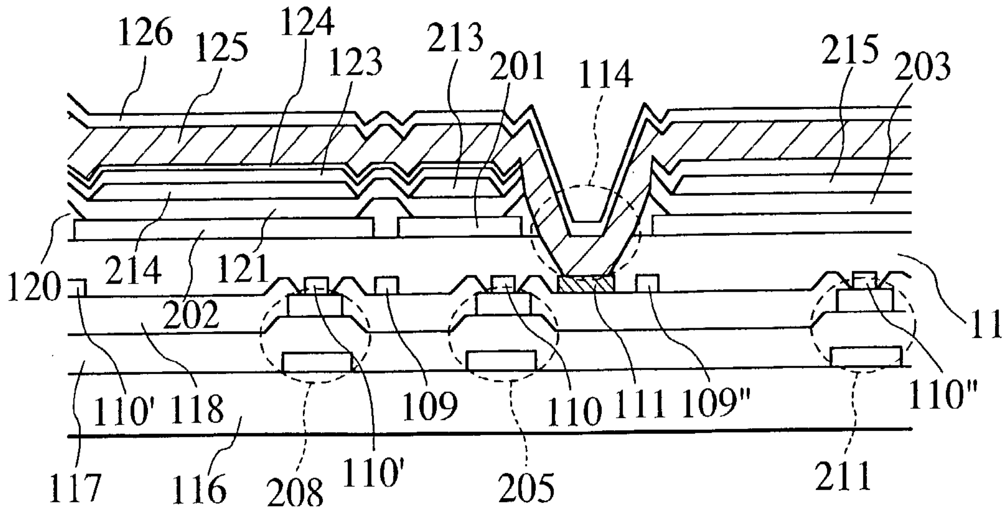
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FIG. 6

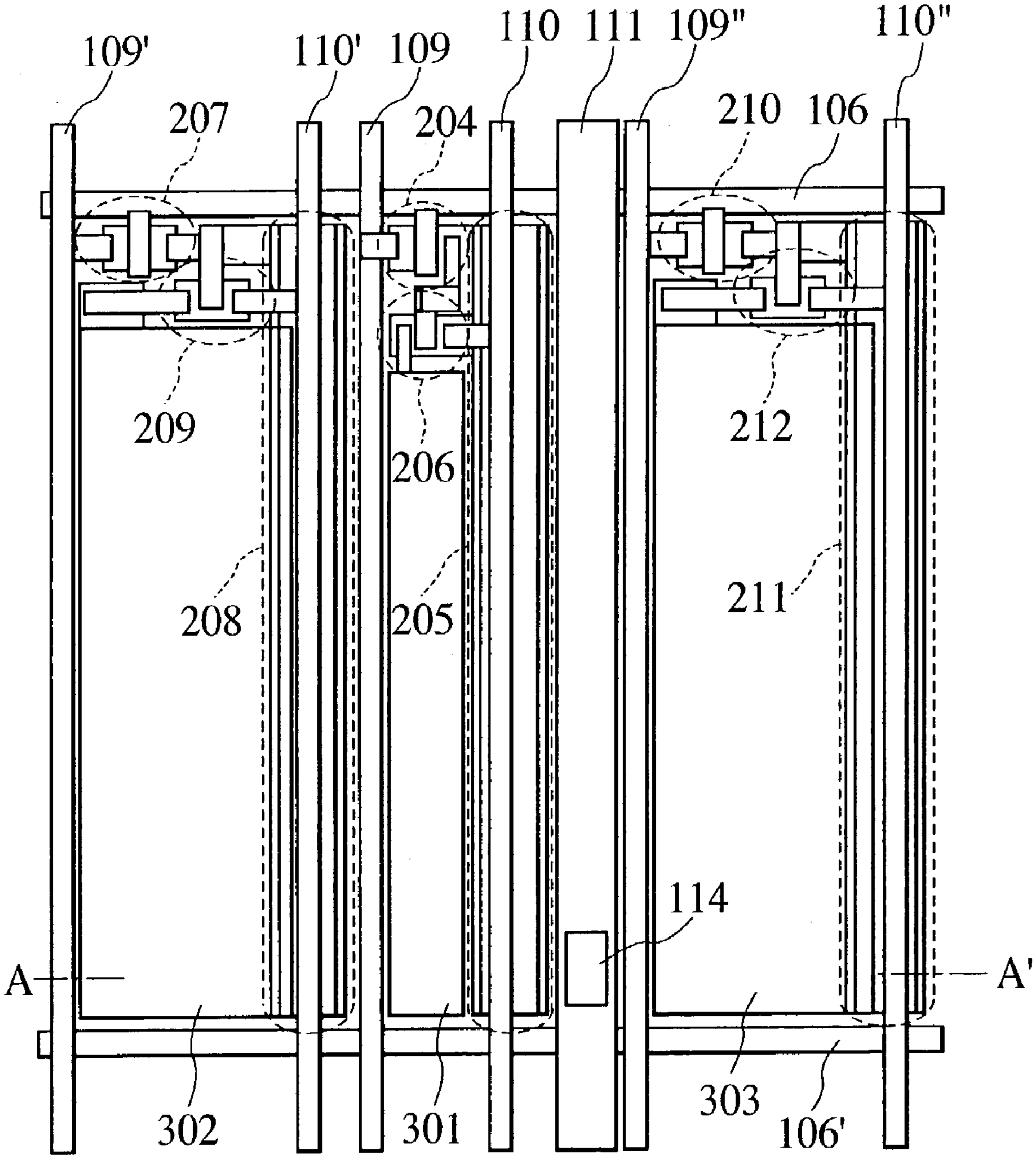
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FIG. 7

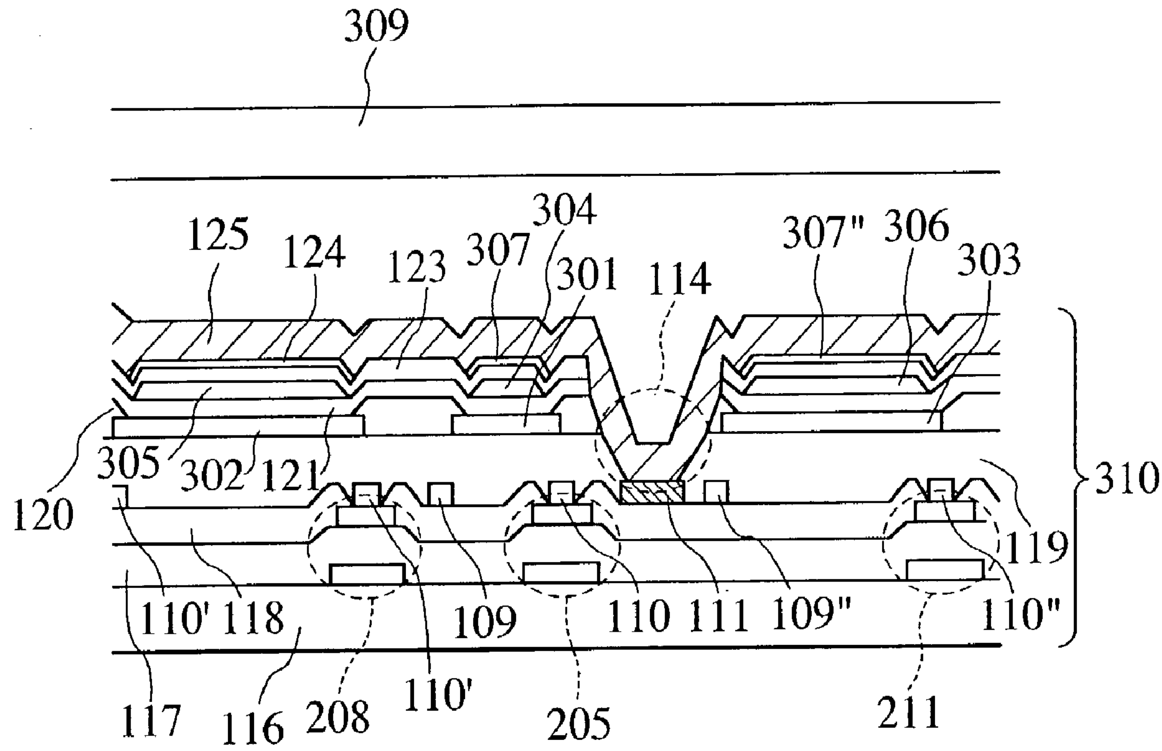

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FIG. 8

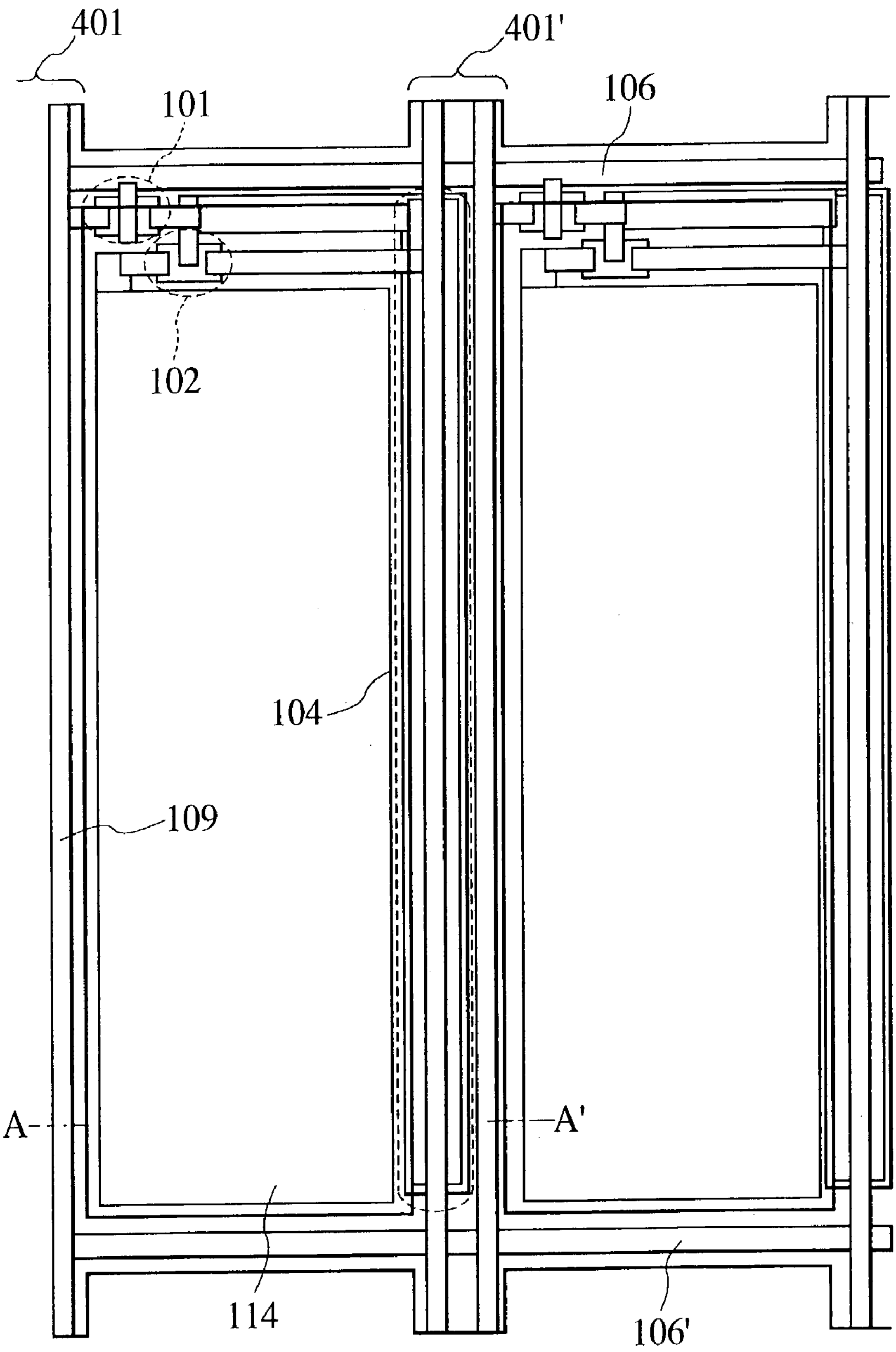

FIG. 9

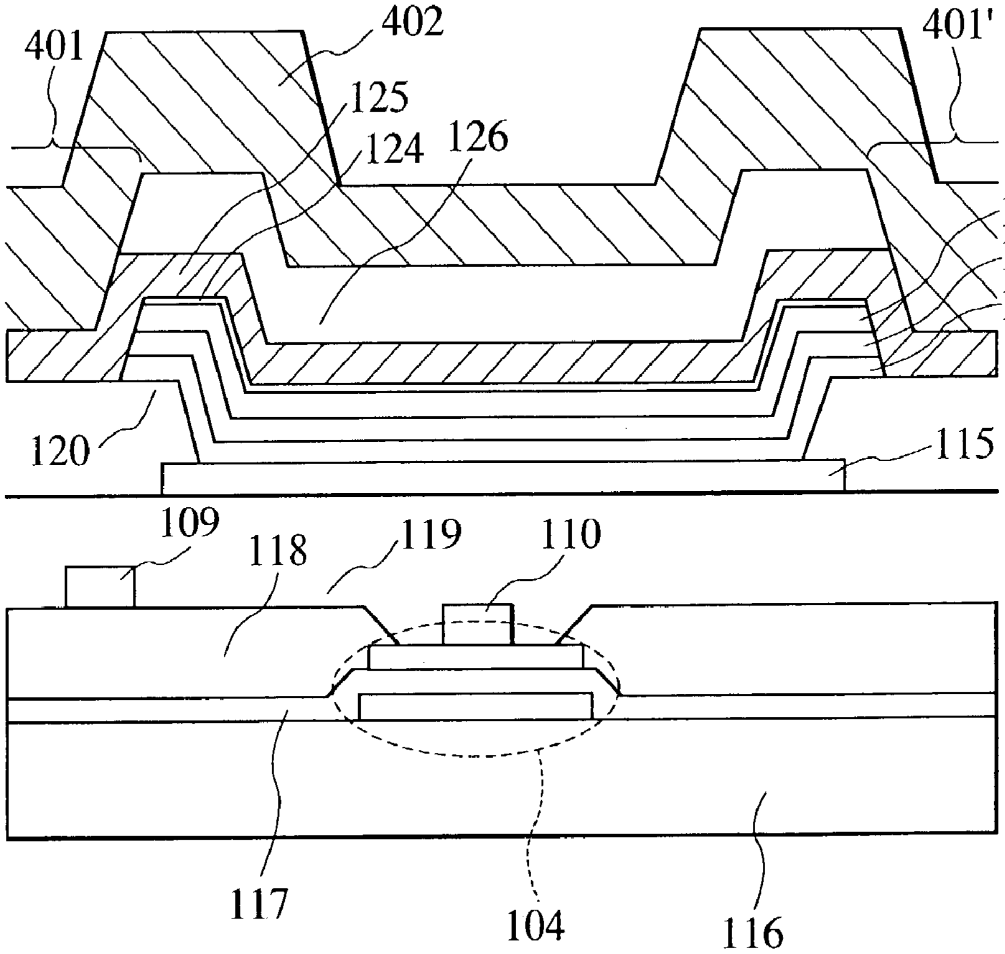
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FIG. 10

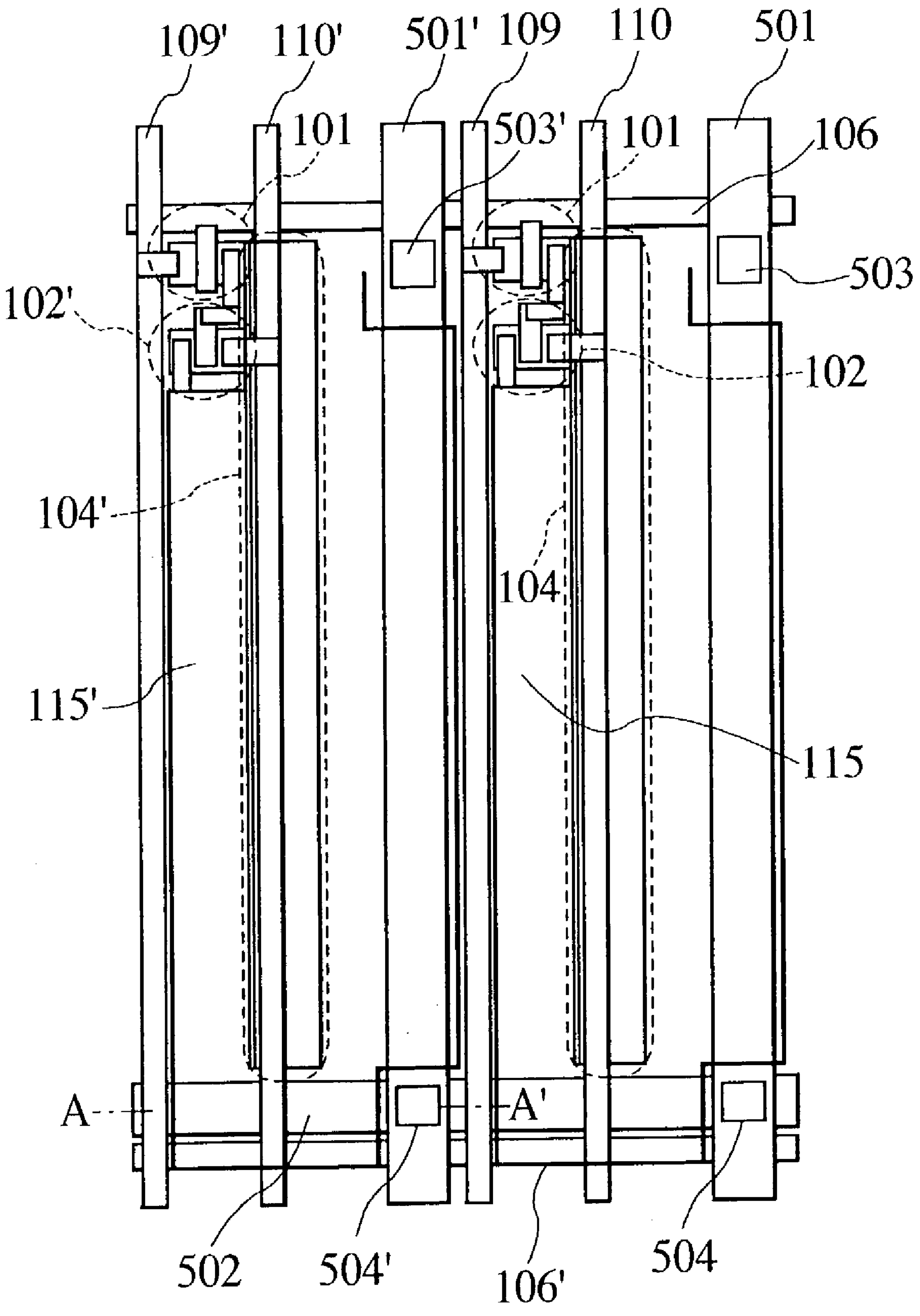
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FIG. 11

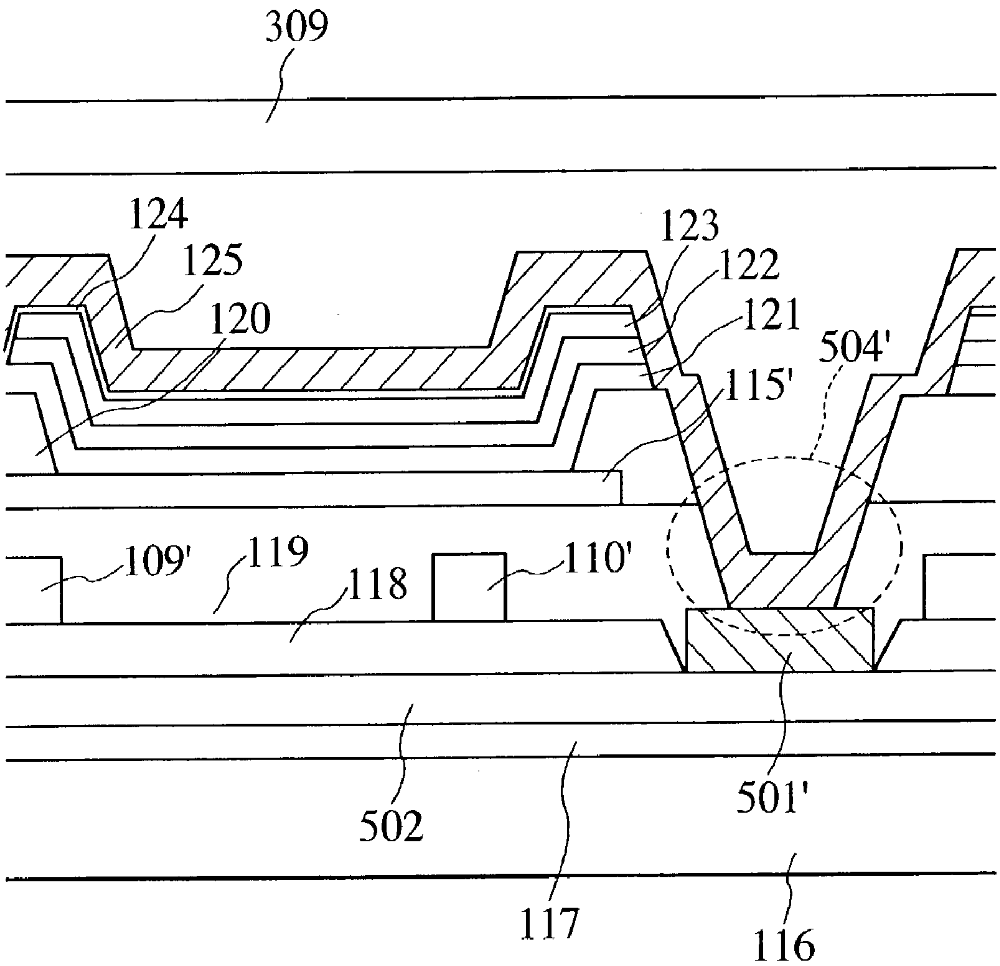
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FIG. 12

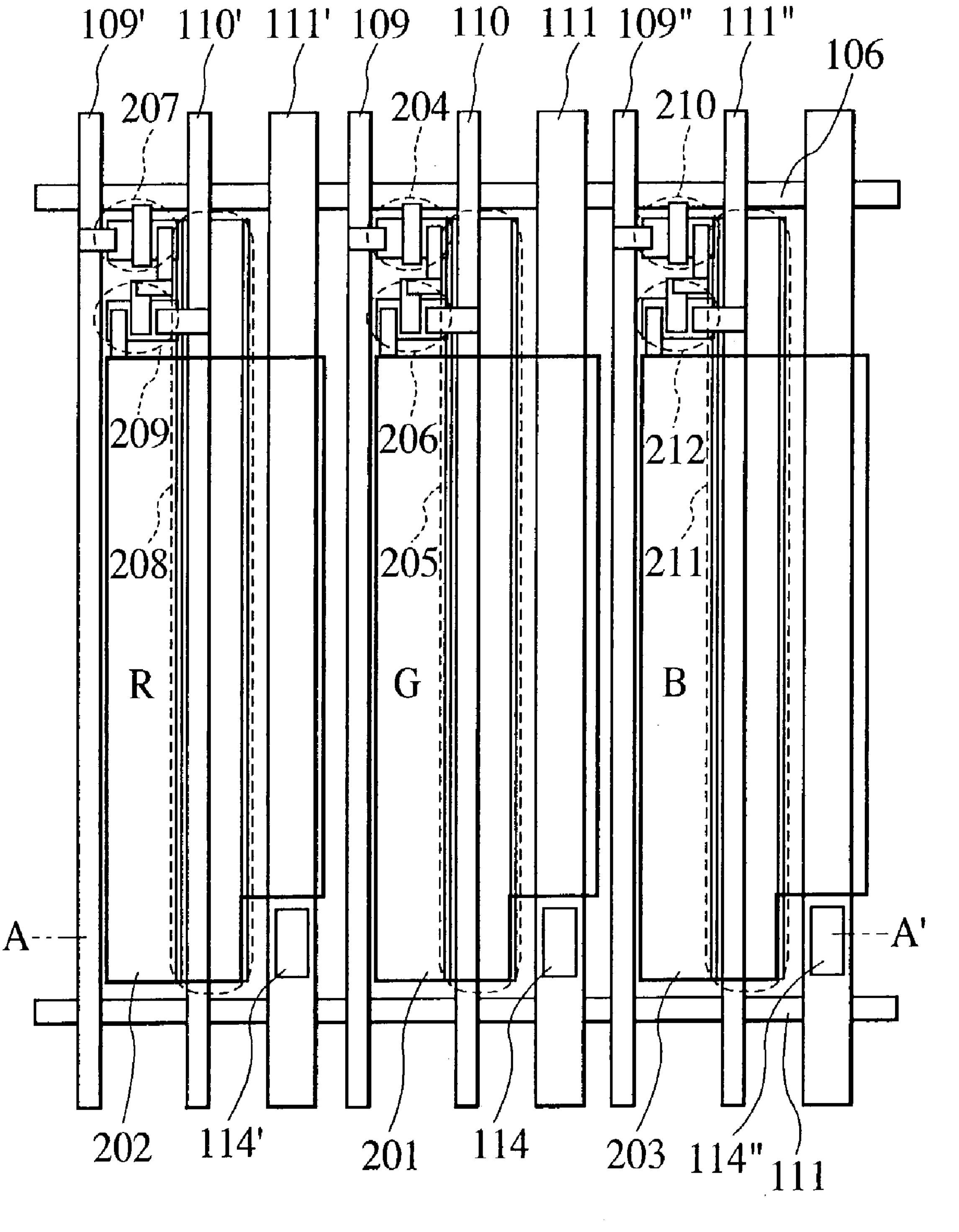
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FIG. 13

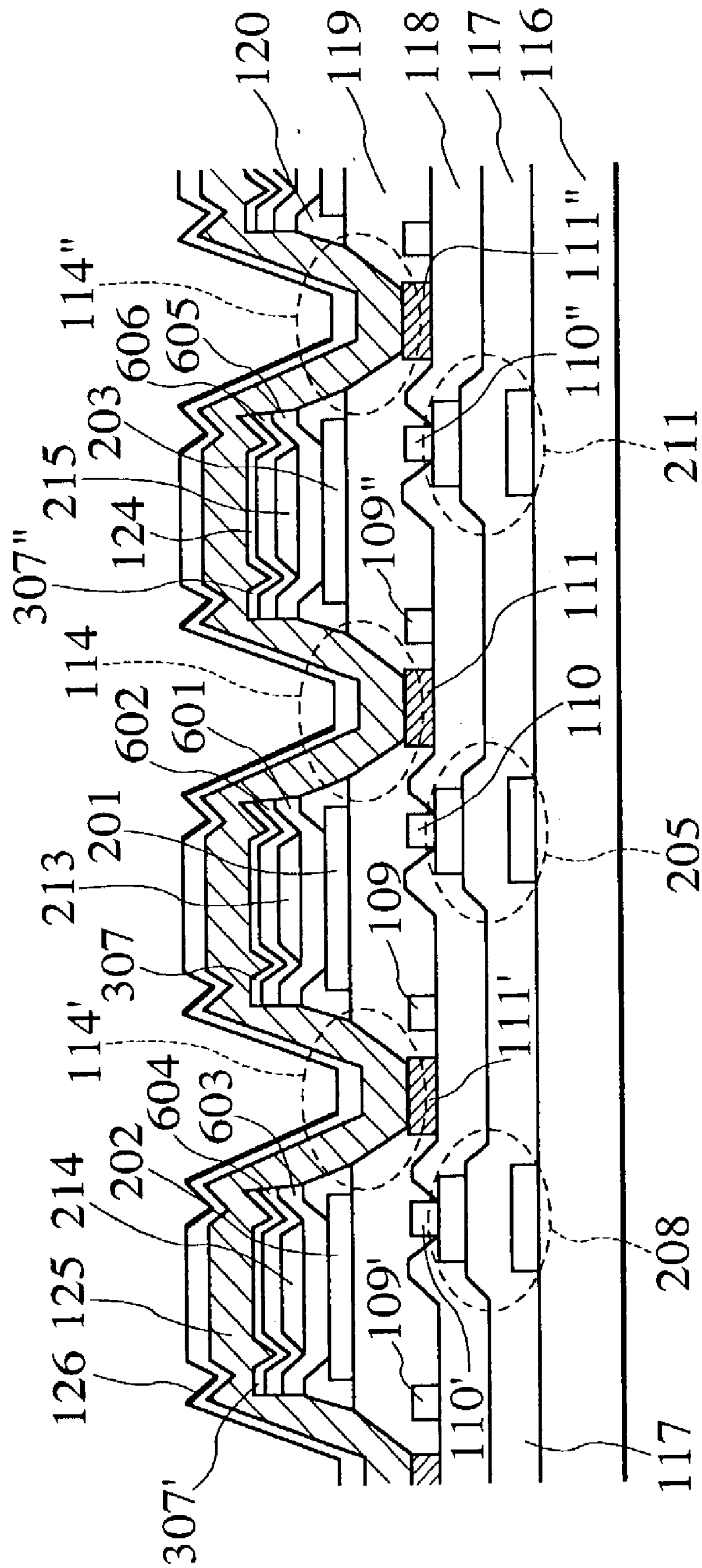
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FIG. 14

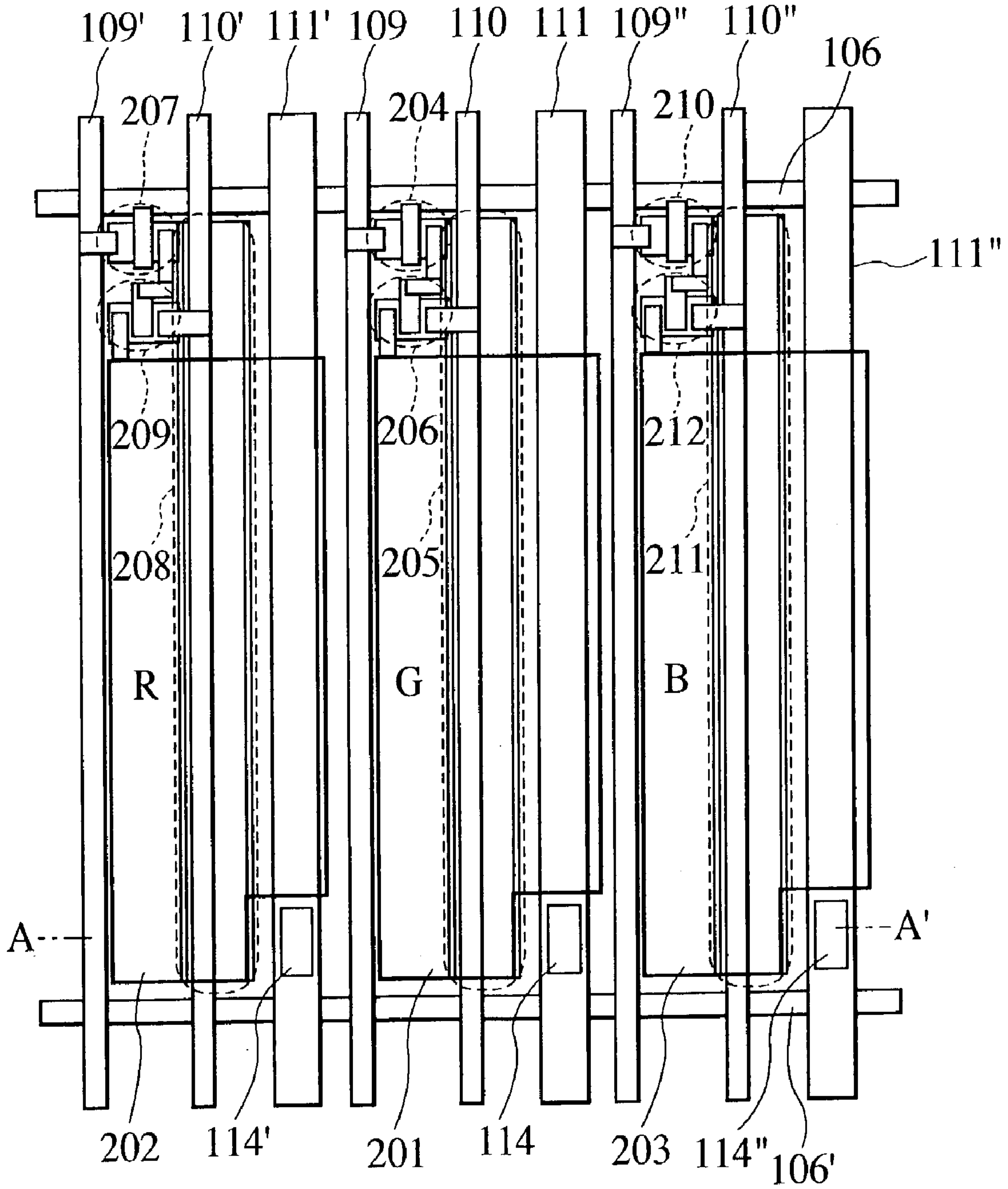
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FIG. 15

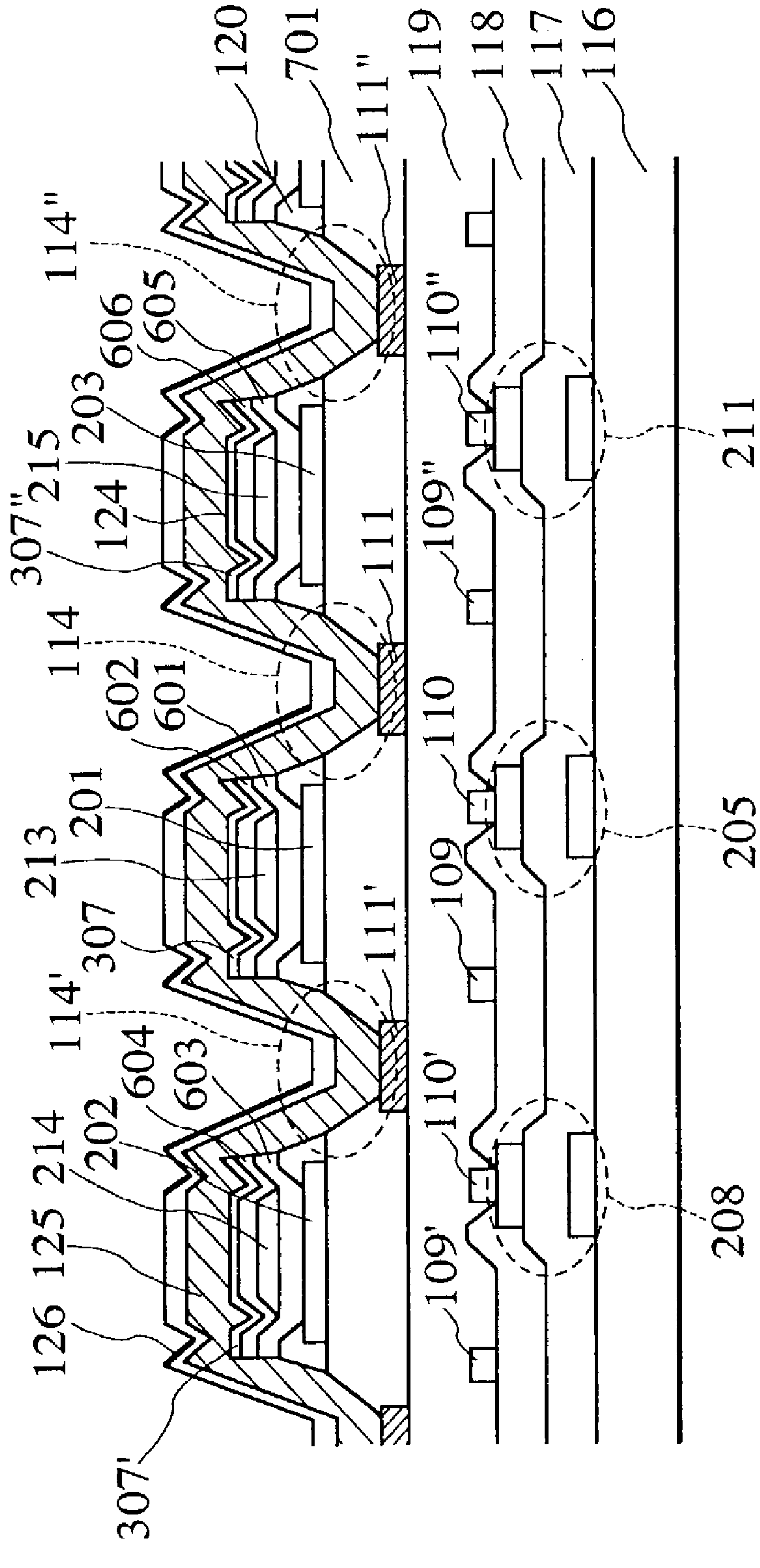
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FIG. 16

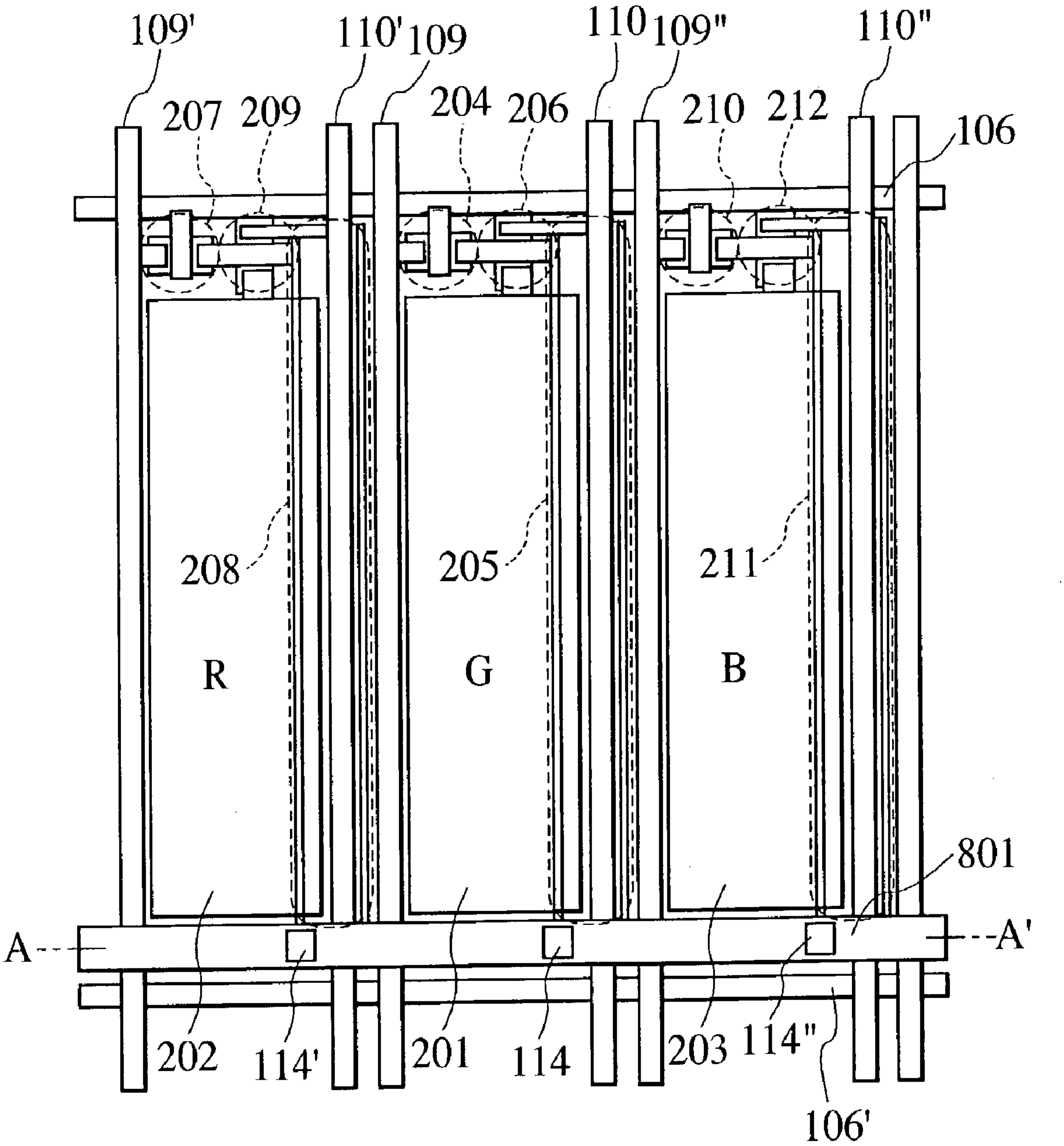

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FIG. 17

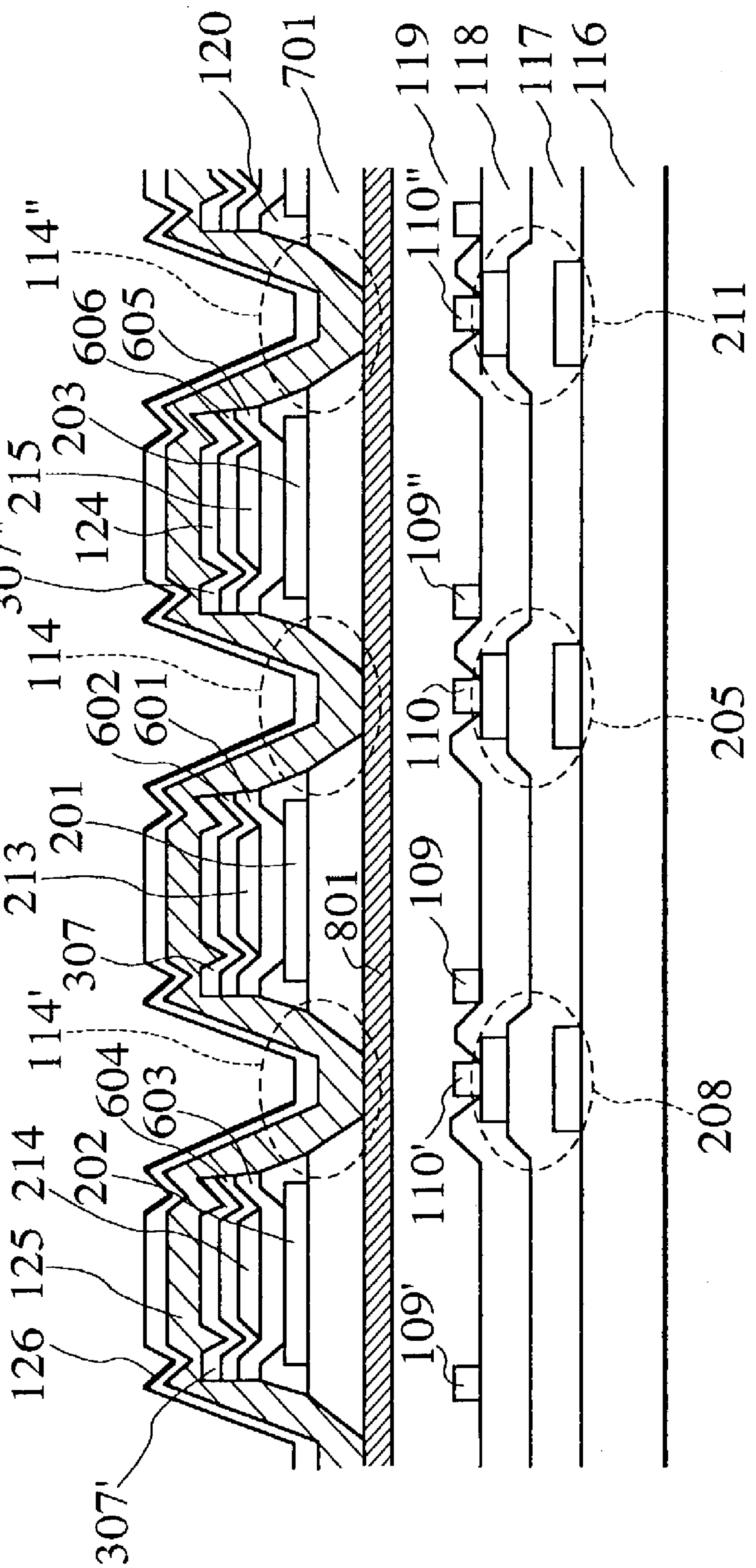

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FIG. 18

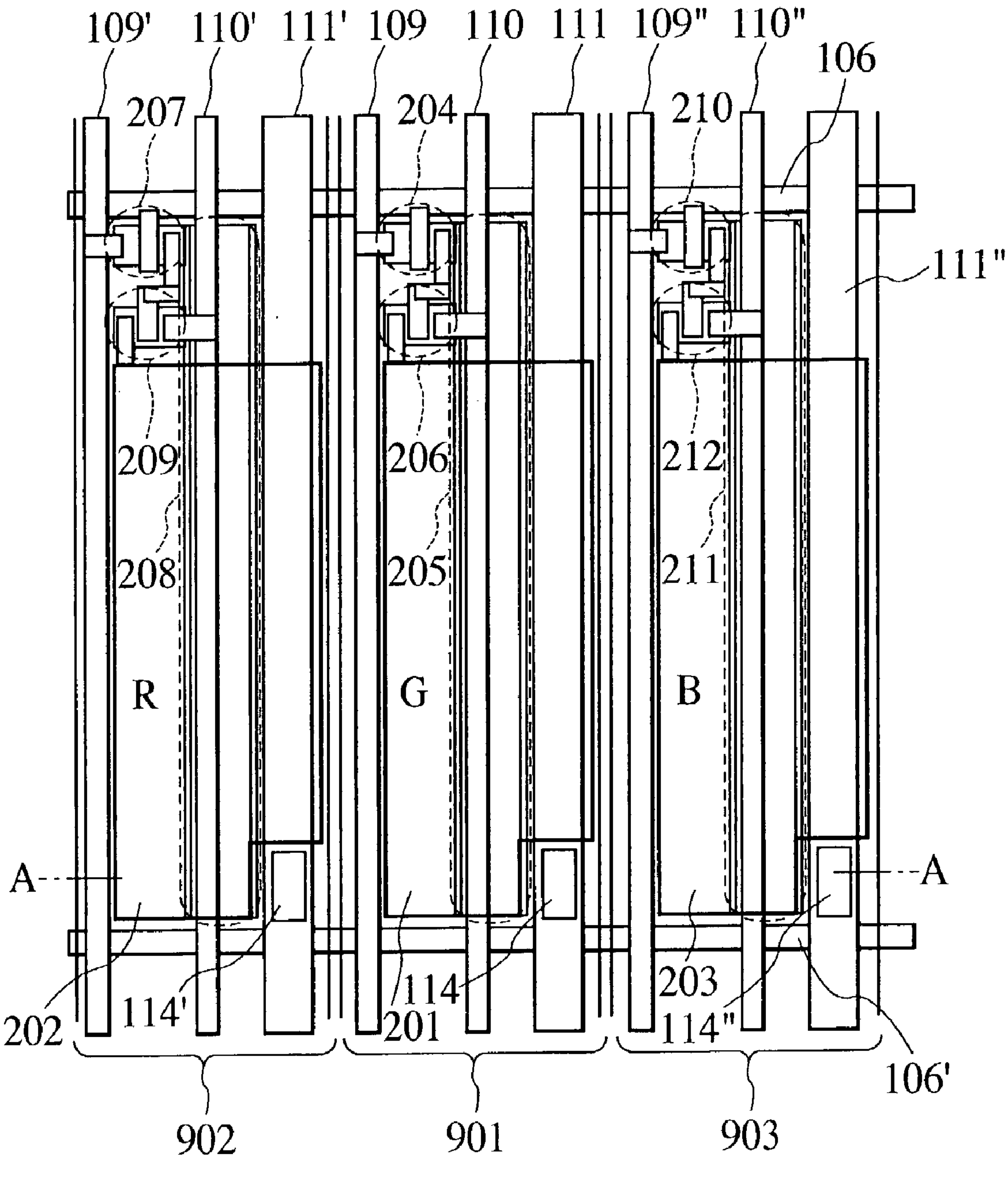
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FIG. 19

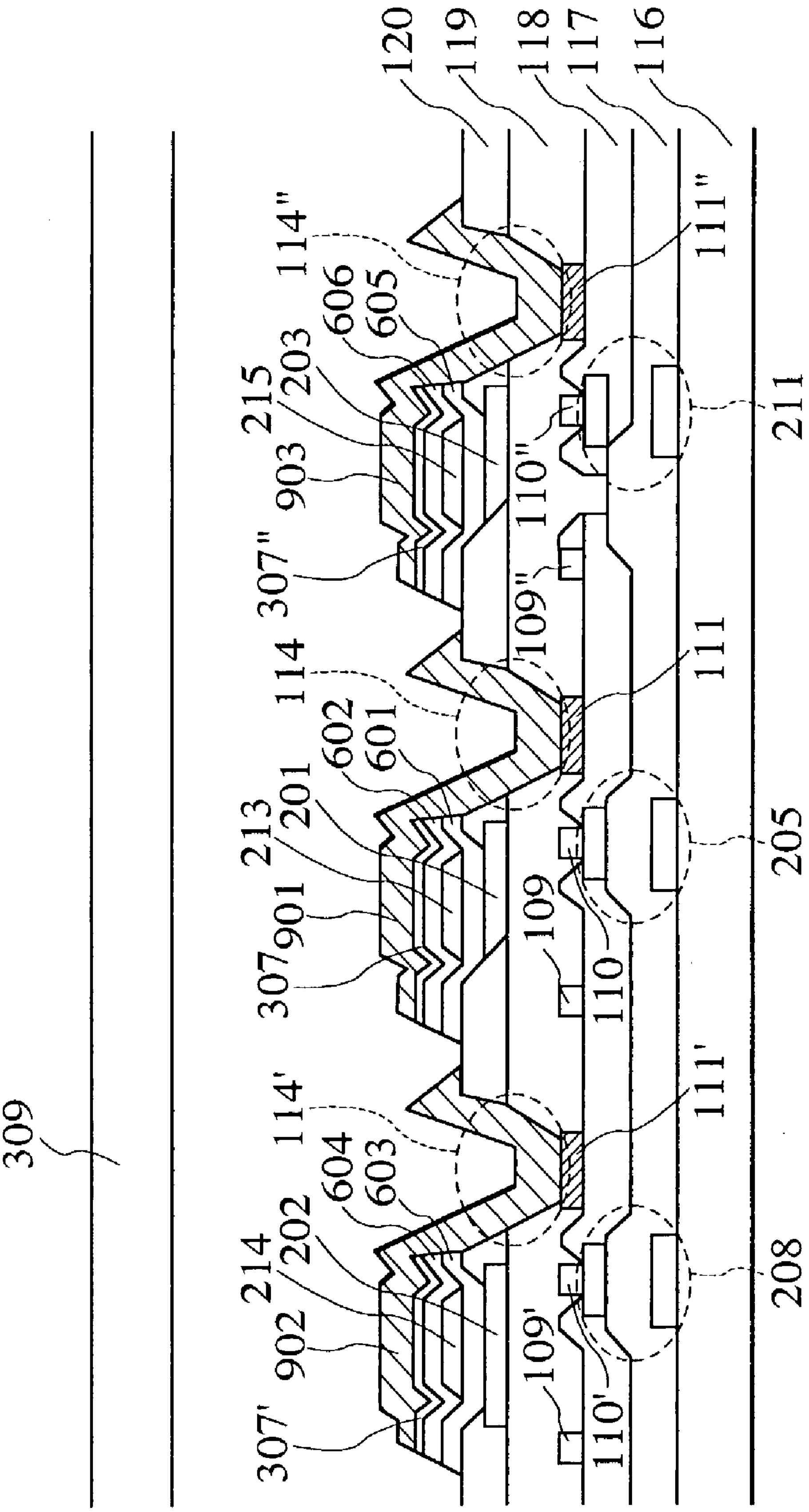
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FIG.20

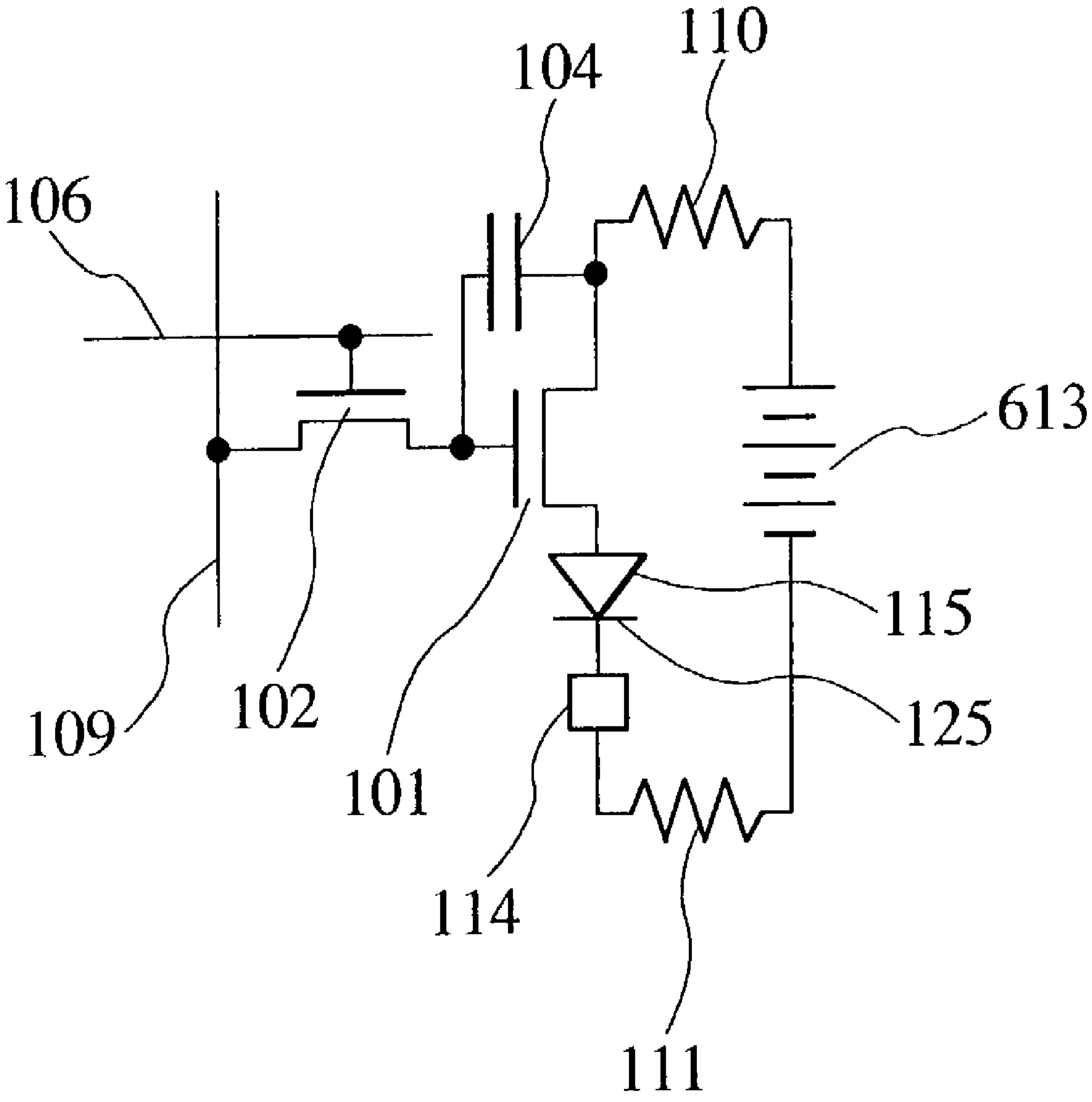

FIG.21

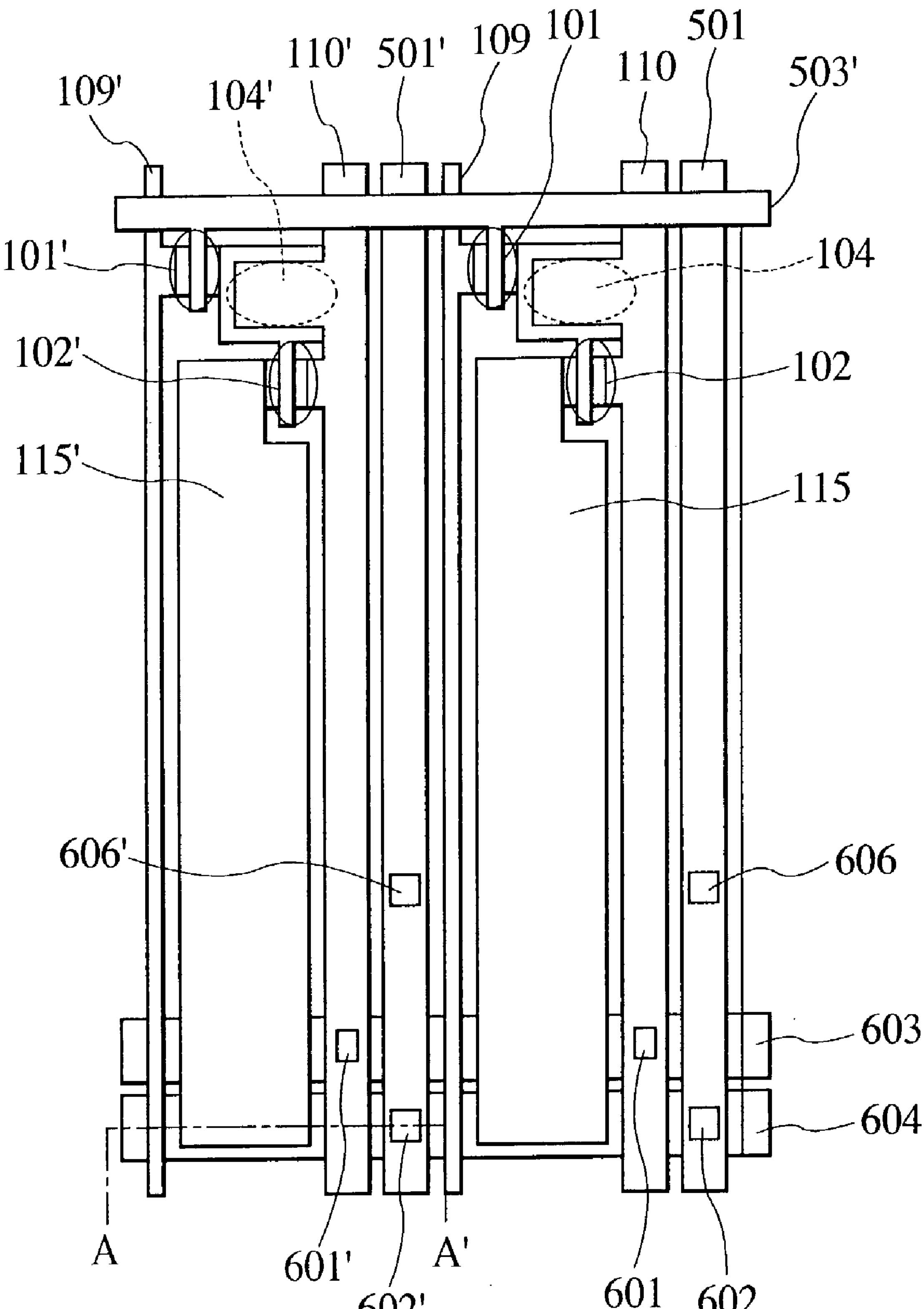

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FIG.22

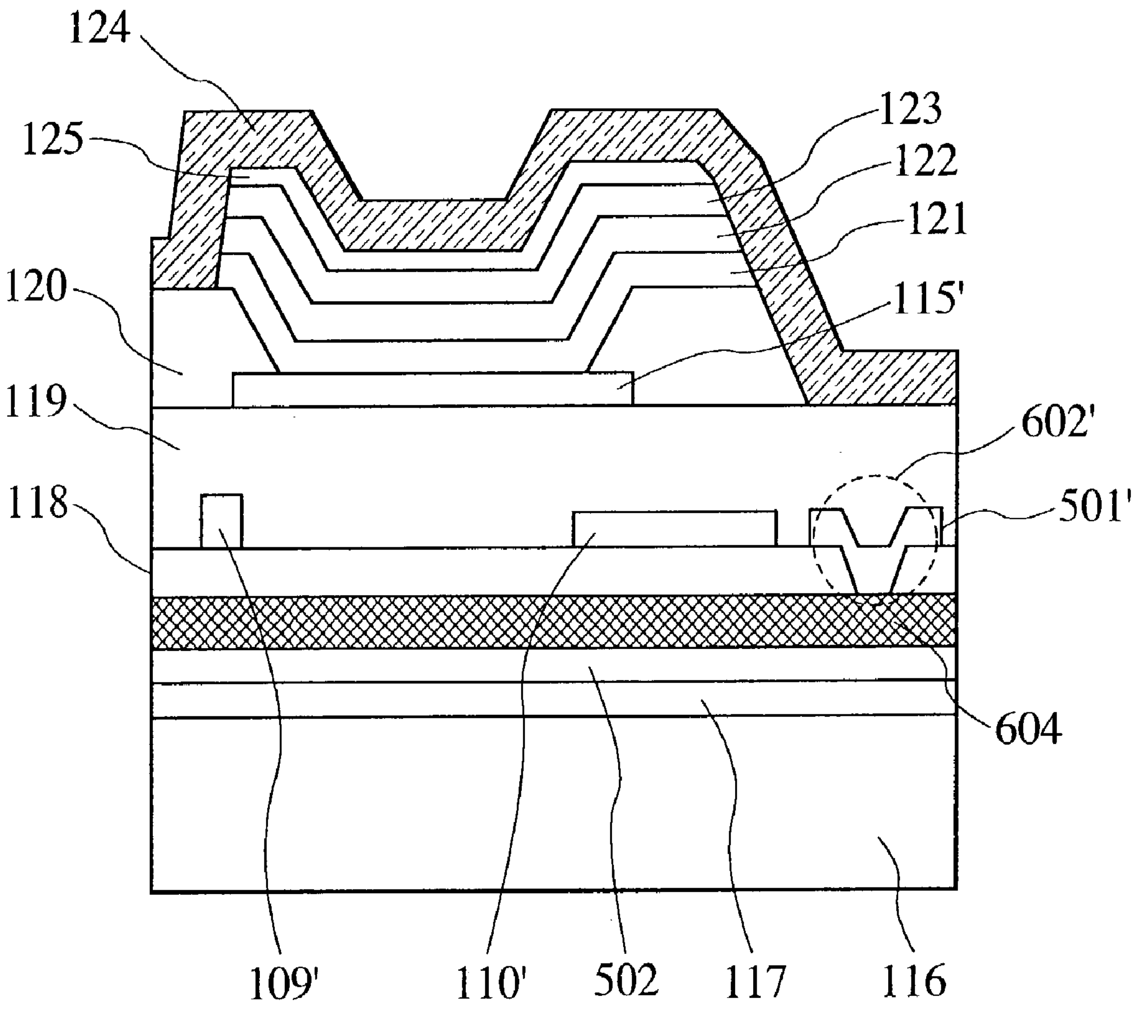
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FIG.23

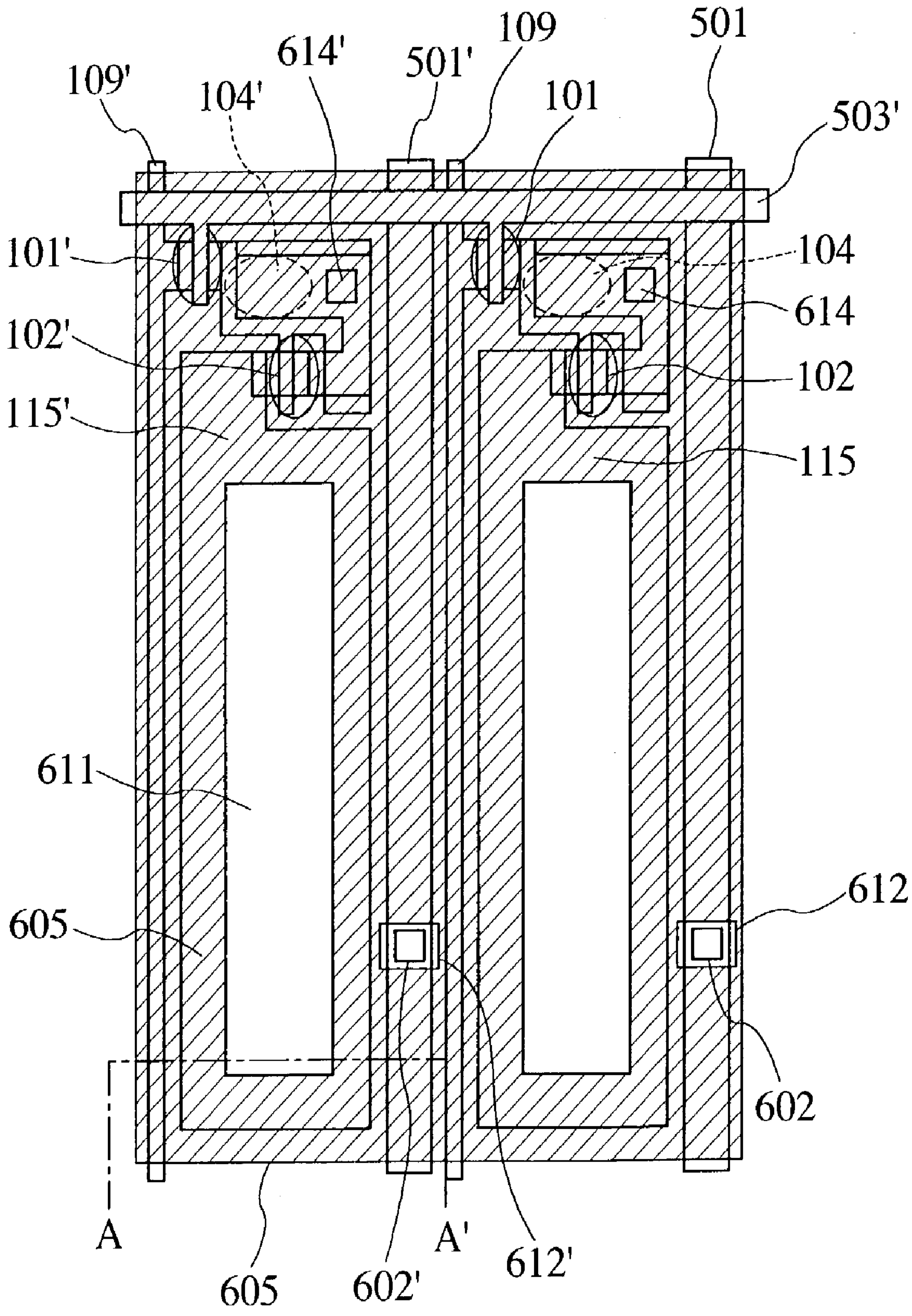
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FIG.24

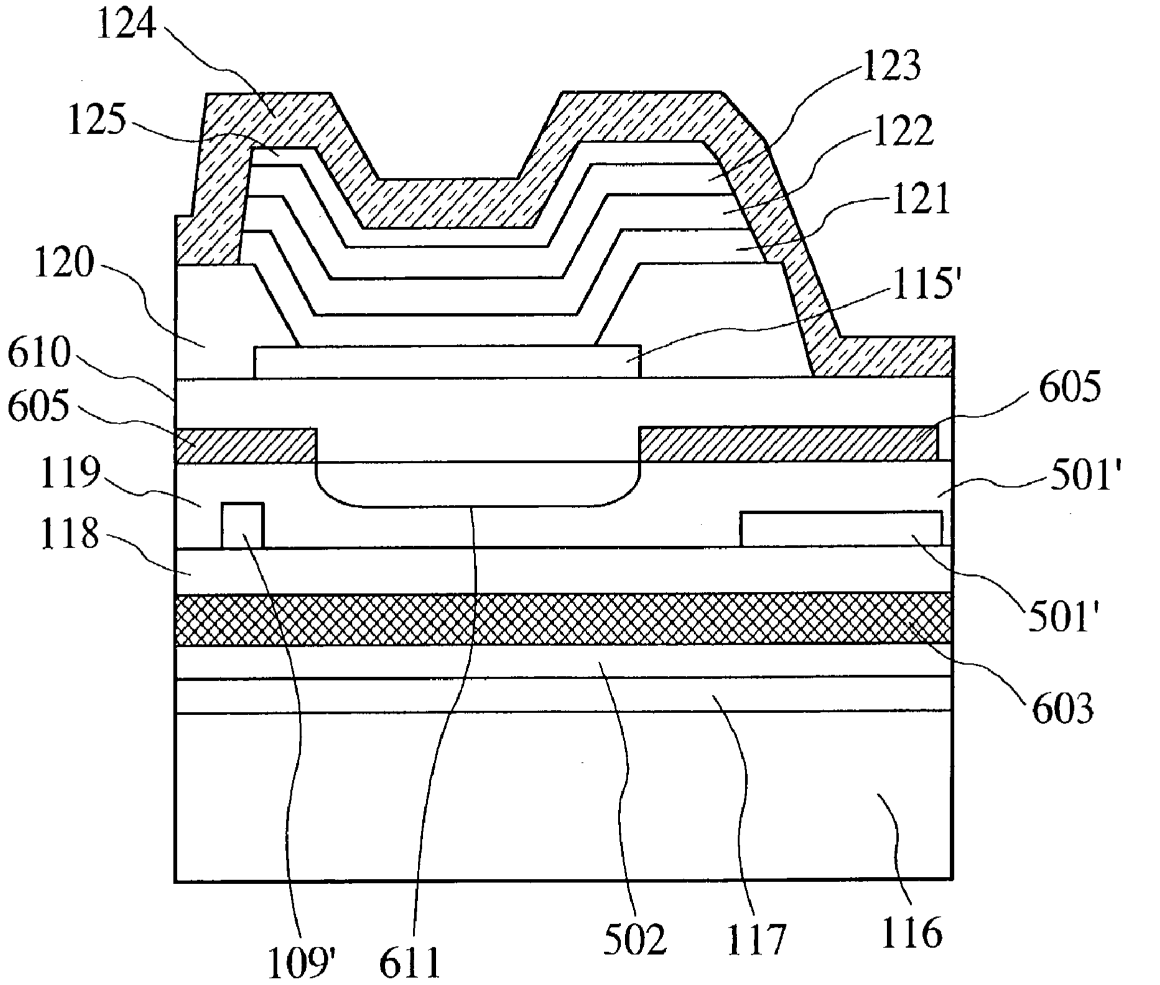
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FIG.25

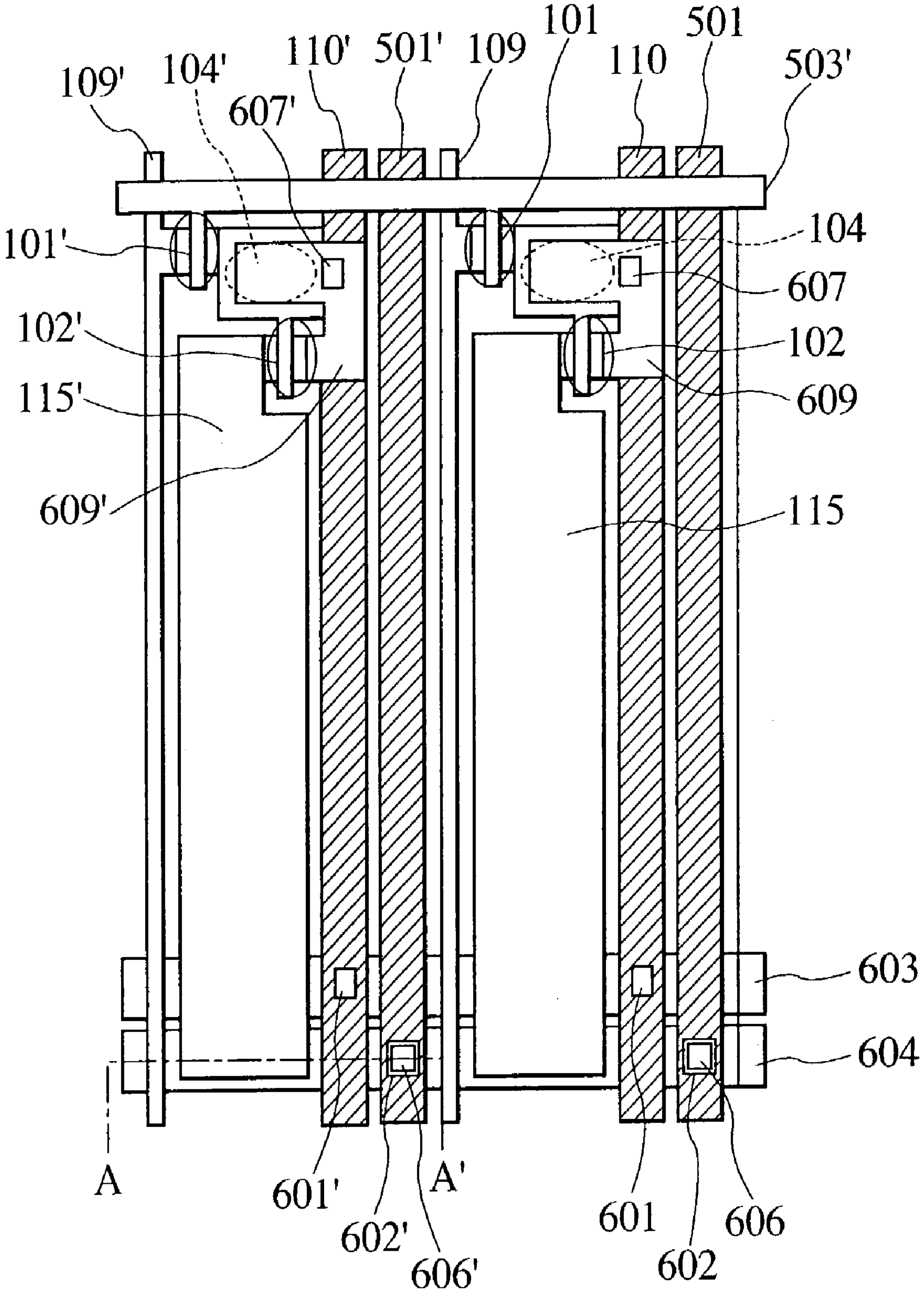

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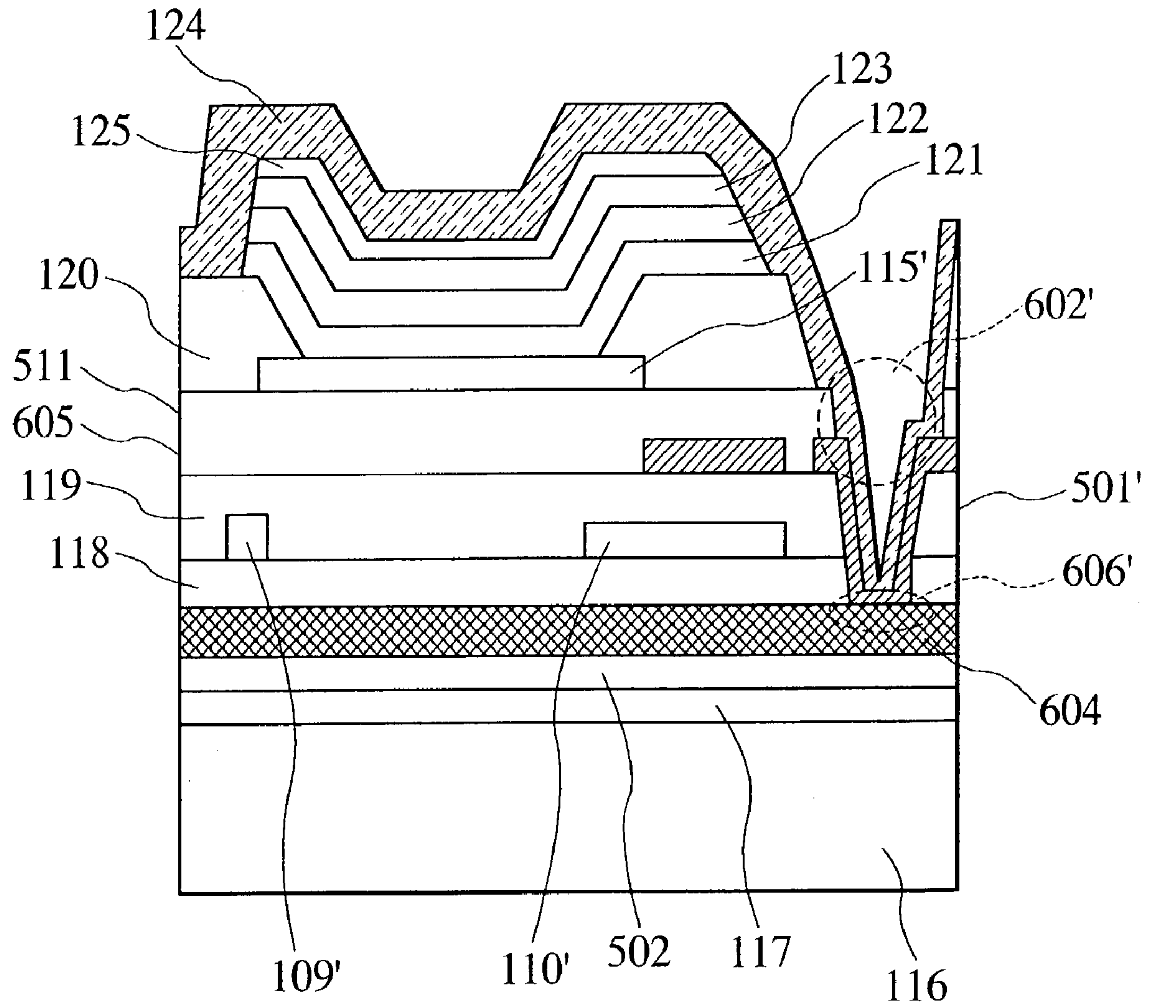
FIG.26



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ORGANIC LIGHT-EMITTING DISPLAY DEVICE

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an organic light-emitting display device, and particularly to an organic light-emitting display device that is preferable for displaying pictures by use of organic light-emitting devices.

[0002] Planar type display devices used as man-machine interfaces have come to attention with the advent of a real multi-media age.

[0003] The planar type display devices have used liquid crystal displays. The liquid crystal display devices, however, have the problems of narrow angle of visibility and low-speed response characteristics.

[0004] In recent years, organic light-emitting display devices have been paid attention to as the next-generation planar type display device. In other word, the organic light-emitting display devices have characteristics excellent in auto-light-emission, wide angle of visibility, and high-speed response.

[0005] In such organic light-emitting display devices, pixels are composed by use of organic light-emitting devices, and the organic light-emitting device has a structure in which a first electrode such as ITO, an organic layer comprised of a hole transport layer, a light-emitting layer, an electron transport layer, etc., and a second electrode having a small work function are provided on a glass substrate.

[0006] When a voltage of about several volts is applied to between the electrodes, holes are injected into the first electrode, whereas electrons are injected into the second electrode, and the holes and electrons pass respectively through the hole transport layer or the electron transport layer to be coupled with each other in the light-emitting layer, whereby excitons are generated. Light is emitted when the exciton returns to its ground state. The light thus emitted is transmitted through the first electrode being transparent, and is taken out from the back side of the substrate.

[0007] The display systems using the organic light-emitting elements for pixels include simple matrix organic light-emitting display devices and active matrix organic light-emitting display devices.

[0008] The simple matrix organic light-emitting display device comprises an organic layer comprised of a hole transport layer, a light-emitting layer, an electron transport layer, etc. provided at positions of intersection of pluralities of anode lines and cathode lines, and each pixel is turned ON for a selected time during one frame period. The selected time is a time width obtained by dividing one frame period by the number of the anode lines. The simple matrix organic light-emitting display device has the advantage of simple structure.

[0009] However, the selected time is shortened as the number of the pixels increases, so that it is necessary to raise the driving voltage to thereby enhance the instantaneous luminance during the selected time and to bring the average luminance during one frame period to a predetermined value. Thus, there is the problem that the life of the organic light-emitting devices is shortened. In addition, since the organic light-emitting devices are driven by electric current, voltage drop due to wiring resistance is generated and voltage cannot be uniformly impressed on each of the pixels, particularly in the case of a large screen, with the result that variations in brightness are produced in the display device. Thus, the simple matrix organic light-emitting display device has limitations as to enhancement of definition and enlargement of screen.

[0010] On the other hand, in the active matrix organic light-emitting display device, a driving device made up of a switching device composed of two to four thin film transistors and a capacitance is connected to an organic EL (light-emitting) device constituting each pixel, and full turning-ON during one frame period is possible. Therefore, it is unnecessary to enhance brightness, and it is possible to prolong the life of the organic light-emitting devices. Accordingly, the active matrix organic light-emitting display device is advantageous from the viewpoint of enhancement of definition and enlargement of screen.

[0011] In the conventional organic light-emitting display devices, the light emitted is taken out from the back side of the substrate, and therefore, an aperture ratio is limited in the active matrix organic light-emitting display device in which a driving portion is provided between the substrate and the organic light-emitting device.

[0012] In order to solve the above-mentioned problems, attempts are provided to make transparent the upper second electrode and to take out the emitted light from the upper electrode side.

[0013] For example, U.S. Pat. No. 5,703,436 discloses an organic EL device in which the upper electrode is constituted of two layers, an injection layer of Mg, Ag, etc. is used as a first layer, a transparent electrode of ITO (Indium Tin Oxide), etc. is used as a second layer, and light is taken out from the upper electrode.

[0014] In addition, Japanese Patent Laid-open No. 6-163158 (1994) discloses an organic EL device comprising an electron injection layer composed of a transparent alkaline earth metal oxide and a transparent cathode material.

[0015] Besides, Japanese Patent Laid-open No. 2001-148291 discloses a pixel structure in which a partition wall is formed at an upper portion at the position where an electrode of a driving device and a lower electrode of an organic light-emitting device constituting a pixel are connected in an active matrix organic light-emitting display device. It is also disclosed that this structure is applicable also to a display device in which light is taken out from the upper electrode side.

[0016] In the prior art mentioned above, a transparent conductive film is used as the second electrode to take out the light from the upper electrode side. In this case, film formation at a low temperature is indispensable in order not to cause damage to the organic layer functioning as an underlying layer. As a result, the resistance of the film is as high as not less than 300 times in resistivity as compared with a metallic film of Al or the like. In addition, even in the case where the second electrode is constituted of a metallic film, in order to reduce the damage to the organic layer functioning as the underlying layer, it is impossible to enlarge the thickness of the metallic film. Therefore, enlargement of the size of the panel poses the problem with the high resistance of the electrode.

[0017] Besides, in the conventional active matrix organic light-emitting display device, current supply lines for connecting the first electrode (anode) and the second electrode (cathode) on the opposite sides of the organic layer of the organic light-emitting device with a power source are formed by use of a metallic film of a driving layer. In this case, the connection between the current supply line connected to a minus terminal of the power source and the second electrode (cathode) of the organic light-emitting device is performed through a contact hole formed in an inter-layer insulation film provided in a region free of pixels, for example, in the vicinity of a panel edge.

[0018] In other words, the second electrode of the organic light-emitting device belonging to each pixel and the current supply line are connected to each other through the contact hole. In this case, since the contact hole serves as a feeding point and the feeding point and the second electrode of each organic light-emitting device are connected by the current supply line, the resistance of wiring varies with the distance from the contact hole to the pixel. Therefore, the effective voltage applied to the organic light-emitting device constituting the pixel varies with the wiring resistance, and the luminance value varies according to the position of the pixel.

SUMMARY OF THE INVENTION

[0019] Accordingly, it is an object of the present invention to provide an organic light-emitting display device in which variations in brightness due to the resistance of wiring connected to an electrode of an organic light-emitting device can be reduced, and a method of manufacturing the organic light-emitting display device.

[0020] It is another object of the present invention is to provide an organic light-emitting display device in which the deterioration of image quality due to the resistance of wiring can be reduced, and a method of manufacturing the organic light-emitting display device.

[0021] In accordance with one aspect of the present invention, there is provided an organic light-emitting display device comprising a plurality of pixels each of which is a minimum unit of a picture, and a plurality of organic light-emitting devices as each pixel, wherein at least an electrode on one side of one organic light-emitting device belonging to each pixel, of a pair of electrodes disposed on the opposite sides of an organic layer of the plurality of organic light-emitting devices, is connected to a current supply line in a display region of each pixel.

[0022] In constructing the organic light-emitting display device, an electrode on one side of the pair of electrodes disposed on the opposite sides of the organic layer of the plurality of organic light-emitting devices may be connected to the current supply line in the display region of each pixel, and a color picture may be formed by use of light-emitting devices different in emitted light color as the plurality of light-emitting devices.

[0023] In addition, in the case of forming a color image by use of a plurality of organic light-emitting devices different in emitted light color, an electrode on one side of the organic light-emitting device of a specified emitted light color of each pixel, of the pair of electrodes disposed on the opposite sides of the organic layer of the plurality of organic light-emitting devices, may be connected to the current supply line in the display region of each pixel.

[0024] Furthermore, at least one current supply line may be provided in a display region containing each pixel, and at least an electrode on one side of one organic light-emitting device belonging to each pixel, of the pair of electrodes disposed on the opposite sides of the organic layer of the plurality of organic light-emitting devices, may be connected to the current supply line in the display region of each pixel.

[0025] In constructing each of the organic light-emitting display devices above-mentioned, the following elements (1) to (11) may be added.

[0026] (1) A driving layer comprising driving devices for driving the organic layer is stacked on a substrate, a wiring layer comprising signal lines and scanning lines connected to the driving devices is stacked, the organic layer of the plurality of organic light-emitting devices is stacked on the wiring layer on a pixel basis together with the pair of electrodes disposed on the opposite sides of the organic layer, and the current supply line is disposed in the wiring layer and connected to the electrode on one side through an inter-layer insulation film.

[0027] (2) A driving layer including driving devices for driving the organic layer is stacked on a substrate, a wiring layer comprising signal lines and scanning lines connected to the driving devices is stacked, the organic layer of the plurality of organic light-emitting devices is stacked on the wiring layer on a pixel basis together with the pair of electrodes disposed on the opposite sides of the organic layer, and the current supply line is disposed between the wiring layer and the organic layer and connected to the electrode on one side through an interlayer insulation film.

[0028] (3) The electrode on one side, of the pair of electrodes disposed on the opposite sides of the organic layer of the plurality of organic light-emitting devices, are formed at an upper portion of the organic layer on the substrate as second electrodes, against a first electrode formed at a lower portion of the organic layer on the substrate, and the current supply line are connected to an upper portion of the second electrode.

[0029] (4) A driving layer including driving devices for driving the organic layer is stacked on a substrate, a wiring layer comprising signal lines and scanning lines connected to the driving devices is stacked, the organic layer of the plurality of organic light-emitting devices is laminated on the wiring layer on a pixel basis together with the pair of electrodes disposed on the opposite sides of the organic layer, the electrode on one side of the pair of electrodes disposed on the opposite sides of the organic layer of the plurality of organic light-emitting devices are formed at an upper portion of the organic layer on the substrate as a second electrode, against a first electrode formed at a lower portion of the organic layer on the substrate, and the current supply line is formed at an upper portion of the second electrode.

[0030] (5) The current supply line is formed in a mesh form along each pixel.

[0031] (6) The current supply line is divided into a plurality of current supply lines in correspondence with each organic light-emitting device of each pixel, and the plurality of current supply lines thus divided are connected to each organic light-emitting device of each pixel as exclusive-use current supply lines, respectively.

[0032] (7) The current supply line is formed along each space between the pixels.

[0033] (8) The current supply line is formed to overlap each pixel.

[0034] (9) The organic light-emitting device of a specified emitted light color are composed of a material having a higher efficiency or a longer life as compared with the materials for the organic light-emitting devices of other emitted light colors.

[0035] (10) The electrode on one side, of the pair of electrodes disposed on the opposite sides of the organic layer of the plurality of organic light-emitting devices, are formed at an upper portion of the organic layer on a substrate as a second electrode, against a first electrode formed at a lower portion of the organic layer on the substrate, the first electrode is connected to a plus terminal of a power source as anode, and the second electrode is connected to a minus terminal of the power source as cathode.

[0036] (11) The second electrodes are composed of a transparent material which transmits light therethrough.

[0037] In accordance with another aspect of the present invention, there is provided a method of manufacturing an organic light-emitting display device, for manufacturing one of the above-mentioned organic light-emitting display device, which comprises the steps of: forming an organic layer comprising a plurality of organic light-emitting devices on a substrate, forming a driving layer comprising driving devices for driving the plurality of organic light-emitting devices, forming a wiring layer comprising signal lines and scanning lines connected to the driving devices, forming current supply lines on the upper side of the organic layer or on the lower side of the organic layer, forming contact holes in an interlayer insulation film provided in the surroundings of the current supply lines, and connecting the electrodes on one side of pairs of electrodes disposed on the opposite sides of the organic layer of the plurality of organic light-emitting devices and the current supply lines through the contact holes.

[0038] According to the above-mentioned means, at least the electrode on one side of one organic light-emitting device belonging to each pixel is connected to the current supply line in a display region of each pixel, so that the wiring resistance of the current supply lines for connecting the electrodes on one side of the organic light-emitting devices and a power source is uniform for each pixel, and the wiring resistance in each pixel is negligibly small; therefore, variations in brightness due to the resistance of wiring for connecting the electrodes of the organic light-emitting devices and the power source can be reduced, and variations in the brightness in the display region can be suppressed.

[0039] Here, the pixel means the minimum unit a plurality of which are disposed in a matrix form on a screen of a display device for displaying characters or graphics. In addition, a sub-pixel means the minimum unit into which the pixel is further divided, in the display device for performing color display. A structure in which a color picture is composed of sub-pixels of three colors, namely, green, red and blue sub-pixels, is generally used. Besides, the display region means the region in which a picture is displayed, in a display device.

[0040] Here, the organic light-emitting device is a device having a structure in which a first electrode, a first injection layer, a first transport layer, a light-emitting layer, a second transport layer, a second injection layer, a second electrode, and a protective film or a sealing (opposed) substrate are provided on a substrate.

[0041] The organic light-emitting device takes either of the following two constitutions.

[0042] The first constitution is one in which the first electrode is anode and the second electrode is cathode. In this case, the first injection layer and the first transport layer are a hole injection layer and a hole transport layer, respectively. In addition, the second transport layer and the second injection layer are an electron transport layer and an electron injection layer, respectively.

[0043] The second constitution is one in which the first electrode is cathode and the second electrode is anode. In this case, the first injection layer and the first transport layer are an electron injection layer and an electron transport layer, respectively. In addition, the second transport layer and the second injection layer are a hole transport layer and a hole injection layer, respectively.

[0044] In the above constitutions, there may be contemplated a structure which lacks the first injection layer or the second injection layer. Besides, there may be a structure in which the light-emitting layer serves also as the first transport layer or the second transport layer.

[0045] Herein, the anode is desirably a conductive film which has a large work function and enhances the injection efficiency of holes. Concrete examples include gold and platinum, but these materials are not limitative.

[0046] Besides, the anode may be based on a binary system such as indium tin oxide (ITO), indium zinc oxide (IZO), indium germanium oxide, etc., or a ternary system such as indium tin zinc oxide, etc. Not only the compositions containing indium oxide as a main constituent but also compositions containing tin oxide, zinc oxide or the like as a main constituent may be used. In the case of ITO, compositions containing 5 to 10 wt % of tin oxide in indium oxide are often used. Examples of the method of producing the oxide semiconductor include a sputtering method, an EB vapor deposition method, and an ion plating method.

[0047] The work functions of an In_2O_3—SnO_2 based transparent conductive film and an In_2O_3—ZnO based transparent conductive film are 4.6 eV and 4.6 eV, respectively, which can be enhanced to about 5.2 eV by UV ozone irradiation, an oxygen plasma treatment or the like.

[0048] When the In_2O_3—SnO_2 based transparent conductive film is formed by sputtering under the condition where the substrate temperature is elevated to about 200° C., the conductive film is obtained in a polycrystalline state. Since the polycrystalline state leads to a bad surface planarity due to the crystal grains, the surface is desirably polished. As another method, formation of the transparent conductive film in an amorphous state and then bringing it into a polycrystalline state by heating is desirably adopted.

[0049] With the hole injection layer provided, the anode need not be formed by use of a material having a large work function, and may be composed of an ordinary conductive film.

[0050] Desirable concrete examples of the material of the conductive film include metals such as aluminum, indium, molybdenum, and nickel, alloys of these metals, and inorganic materials such as polysilicon, amorphous silicon, tin oxide, indium oxide, and indium tin oxide (ITO).

[0051] In addition, organic materials such as polyaniline, and polythiophene, and conductive inks, used with a simple coating method as the formation process of the conductive film may desirably be adopted. These materials are not limitative, and these materials may be used in combination of two or more thereof.

[0052] The hole injection layer herein is desirably composed of a material having an appropriate ionization potential in order to lower the injection barrier between the anode and the hole transport layer. Besides, the hole injection layer desirably plays the role of burying the surface roughness of the underlying layer. Concrete examples of the material of the hole injection layer include copper phthalocyanine, starburstoamine compounds, polyaniline, polythiophene, vanadium oxide, molybdenum oxide, ruthenium oxide, and aluminum oxide, which are not limitative.

[0053] The hole transport layer herein plays the role of transporting holes and injecting the holes into the light-emitting layer. Therefore, the hole transport layer desirably has a high hole mobility. In addition, the hole injection layer is desirably stable chemically. The hole injection layer desirably has a small ionization potential, and a small electron affinity. Besides, the hole transport layer desirably has a high glass transition temperature. Desirable examples of the material of the hole transport layer include N,N'-bis(3-methylphenyl)-N,N'-diphenyl-[1,1'biphenyl]-4,4'-diamine (TPD), 4,4'-bis[N-(1-naphthyl)-N-phenylamino]biphenyl (α-NPD), 4,4',4"-tri(N-carbazolyl)triphenylamine (TCTA), and 1,3,5-tris[N-(4-diphenylaminophenyl)phenylamino] benzene (p-DPA-TDAB). Naturally, these materials are not limitative, and these materials may be used in combination of two or more thereof.

[0054] The light-emitting layer herein means a layer in which the injected holes and electrons are coupled with each other, resulting in emission of light at a wavelength intrinsic of the material. There are a case where the host material itself constituting the light-emitting layer emits light and a case where a dopant material added in a trace amount to the host material emits light. Desirable concrete examples of the host material include distyrilarylene derivatives (DPVBi), silole derivatives having a benzene ring in its skeleton (2PSP), oxodiazole derivatives having triphenylamine structures at both ends (EM2), perinone derivatives having a phenanthrene group (P1), oligothiophene derivatives having triphenylamine structures at both ends (BMA-3T), perylene derivatives (tBu-PTC), tris(8-quinolinol)aluminum, polyparapheylenevinylene derivatives, polythiophene derivatives, polyparaphenylene derivatives, polysilane derivatives, and polyacetylene derivatives. Naturally, these materials are not limitative, and these materials may be used in combination of two or more thereof.

[0055] Desirable concrete examples of the dopant material include quinacridone, coumarin-6, Nile Red, rubrene, 4-(dicyanomethylene)-2-methyl-6-(para-dimethylaminostyryl)-4H-pyran (DCM), and dicarbazole derivatives. Naturally, these materials are not limitative, and these materials may be used in combination of two or more thereof.

[0056] The electron transport layer herein plays the role of transporting electrons and injecting the electrons into the light-emitting layer. Therefore, the electron transport layer desirably has high electron mobility. Desirable concrete examples of the material of the electron transport layer include tris(8-quinolinol)aluminum, oxadiazole derivatives, silole derivatives, and zinc-benzothiazole complex. Naturally, these materials are not limitative, and these materials may be used in combination of two or more thereof.

[0057] Examples of methods for manufacturing the hole injection layer, the hole transport layer, the light-emitting layer, and the electron transport layer noted above include a vacuum vapor deposition method, an electron beam (EB) vapor deposition method, a sputtering method, a spin coating method, a cast method, and an ink-jet method.

[0058] It is desirable that patterning for each of the layers be performed in the deposition method as follows: a mask provided with an opening shaped correspondingly to the shape of a pattern is kept in intimate contact with or close to a substrate, and in this state a material is evaporated from a source of evaporation to the substrate so as to form the pattern thereon.

[0059] It is desirable that patterning by the spin coating method and the cast method be performed as follows: a portion other than a pattern of a thin film formed over the entire surface of a substrate is exfoliated by laser ablation or the like, leaving the pattern on the substrate.

[0060] It is desirable that patterning for each of the layers be performed in an ink-jet method as follows: a soluble organic material is dissolved in a solvent, and the resulting solution is ejected from a movable nozzle onto a substrate so as to form the shape of a pattern thereon.

[0061] The electron injection layer herein is used for enhancing the efficiency of electron injection from the cathode into the electron transport layer. Desirable concrete examples of the material of the electron injection layer include lithium fluoride, magnesium fluoride, calcium fluoride, strontium fluoride, barium fluoride, magnesium oxide, and aluminum oxide. Naturally, these materials are not limitative, and these materials may be used in combination of two or more thereof.

[0062] The cathode herein is desirably a conductive film which has a small work function and enhances the injection efficiency of electrons. Concrete examples of the material of the cathode include magnesium-silver alloy, aluminum-lithium alloy, aluminum-calcium alloy, aluminum-magnesium alloy, and metallic calcium, which are not limitative.

[0063] With the above-mentioned electron injection layer provided, the cathode need not be formed by use of a material having a low work function, and a general metallic material can be used. Desirable concrete examples include metals such as aluminum, indium, molybdenum, and nickel, alloys of these metals, polysilicon, and amorphous silicon.

[0064] In the present invention, when the cathode is used as the second electrode (transparent electrode), it is desirable to provide the electron injection layer at a lower portion of the cathode. With the electron injection layer provided, a transparent conductive film having a high work function can be used as the cathode. Concrete examples include an In_2O_3—SnO_2 based transparent conductive film and an In_2O_3—ZnO based transparent conductive film. In particular, the In_2O_3—SnO_2 based transparent conductive film is used as pixel electrodes in a liquid crystal display system.

[0065] The protective layer herein is formed on the second electrode, for the purpose of preventing H_2O and O_2 in the atmosphere from penetrating into the second electrode or into the organic layer provided under the second electrode.

[0066] Concrete examples of the material of the protective layer include inorganic materials such as SiO_2, SiNx, and Al_2O_3, and organic materials such as polychloropyrene, polyethylene terephthalate, polyoxymethylene, polyvinyl chloride, polyvinilydene fluoride, cyanoethyl-pullulan, polymethyl methacrylate, polysulfone, polycarbonate, and polyimide, which are not limitative.

BRIEF DESCRIPTION OF THE DRAWINGS

[0067] Other objects and advantages of the invention will become apparent from the following description of embodiments with reference to the accompanying drawings in which:

[0068] **FIG. 1** is a plan view of a pixel region in an organic light-emitting display device according to a first embodiment of the present invention;

[0069] **FIG. 2A** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 1**;

[0070] **FIG. 2B** is a sectional view taken along line B-B' of the pixel region shown in **FIG. 1**;

[0071] **FIG. 3A** is a schematic diagram illustrating the relationship between a second current supply line and a feeding point in a conventional organic light-emitting display device;

[0072] **FIG. 3B** is a schematic diagram illustrating the relationship between a second current supply line and a feeding point in an organic light-emitting display device according to the present invention;

[0073] **FIG. 4** is a plan view of a pixel region in an organic light-emitting display system according to a second embodiment of the present invention;

[0074] **FIG. 5** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 4**;

[0075] **FIG. 6** is a plan view of a pixel region in an organic light-emitting display system according to a third embodiment of the present invention;

[0076] **FIG. 7** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 6**;

[0077] **FIG. 8** is a plan view of a pixel region in an organic light-emitting display system according to a fourth embodiment of the present invention;

[0078] **FIG. 9** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 8**;

[0079] **FIG. 10** is a plan view of a pixel region in an organic light-emitting display system according to a fifth embodiment of the present invention;

[0080] **FIG. 11** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 10**;

[0081] **FIG. 12** is a plan view of a pixel region in an organic light-emitting display system according to a sixth embodiment of the present invention;

[0082] **FIG. 13** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 12**;

[0083] **FIG. 14** is a plan view of a pixel region in an organic light-emitting display system according to seventh embodiment of the present invention;

[0084] **FIG. 15** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 14**;

[0085] **FIG. 16** is a plan view of a pixel region in an organic light-emitting display system according to eighth embodiment of the present invention;

[0086] **FIG. 17** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 16**;

[0087] **FIG. 18** is a plan view of a pixel region in an organic light-emitting display system according to a ninth embodiment of the present invention;

[0088] **FIG. 19** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 18**;

[0089] **FIG. 20** is a pixel circuit diagram of the organic light-emitting display system according to the first embodiment of the present invention;

[0090] **FIG. 21** is a plan view of a pixel region in an organic light-emitting display system according to a tenth embodiment of the present invention;

[0091] **FIG. 22** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 21**;

[0092] **FIG. 23** is a plan view of a pixel region in an organic light-emitting display system according to an eleventh embodiment of the present invention;

[0093] **FIG. 24** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 23**;

[0094] **FIG. 25** is a plan view of a pixel region in an organic light-emitting display system according to a twelfth embodiment of the present invention; and

[0095] **FIG. 26** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 25**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0096] [Embodiment 1]

[0097] An organic light-emitting display system according to a first embodiment of the present invention will be described below with reference to the drawings. **FIG. 1** is a plan view of a pixel in the organic light-emitting display device; **FIG. 2A** is a sectional view taken along line A-A' of **FIG. 1**; and **FIG. 2B** is a sectional view taken along line B-B' of **FIG. 1**. In **FIGS. 1 and 2**, a plurality of scanning lines **106, 106'** is disposed at a predetermined interval on a glass substrate **116**, and signal lines **109**, **109'**, **109''** for transmitting picture data and the like are disposed at a predetermined interval in a direction orthogonal to each of the scanning lines. That is, the scanning lines and the signal lines are arranged in a grid form, and the region surrounded by the scanning lines and the signal lines constitutes a display region for one pixel. On the glass substrate **116**, further, a plurality of first current supply lines **110** connected to a plus terminal of a power source are disposed in parallel to the signal lines **109**, and a plurality of second current supply lines **111** connected to a minus terminal of the power source are disposed in parallel to the signal lines **109** and the first current supply lines **110**. The scanning lines **106**, the signal lines **109**, the first current supply lines **110** and the second current supply lines **111** are provided as wiring belonging to a wiring layer on the glass substrate **116**, with an inter-layer insulation film disposed therebetween.

[**0098**] A plurality of organic light-emitting devices constituting a pixel that is a minimum unit of a color picture is disposed on the upper side of the wiring layer. Each of the organic light-emitting devices is provided as a sub-pixel, which comprises an organic layer including a hole transport layer **121**, a light-emitting layer **122**, an electron transport layer **123**, and an electron injection layer **124**, and a first electrode (anode) **115** and a second electrode (cathode) **125** disposed on the opposite sides of the organic layer. The first electrode **115** of the organic light-emitting device belonging to each pixel is connected to the first current supply line **110** through a transistor serving as a driving device, whereas the second electrode **125** of the organic light-emitting device belonging to each pixel is connected to the second current supply line **111** through a contact hole **114** formed in a second interlayer insulation film **119** and a third interlayer insulation film **120** in the display region of each pixel. That is, the second electrode **125** of the organic light-emitting device belonging to each pixel is connected to the second current supply line **111** with the contact hole **114** serving as a feeding point.

[**0099**] On the glass substrate **116**, in addition, a driving layer for driving the organic layer of each pixel is provided. The driving layer comprises a first transistor **101**, a second transistor **102** and a capacitance **104** as driving devices. The gate of the first transistor **101** is connected to the scanning line **106**, the source is connected to the signal line **109**, and the drain is connected to the gate of the second transistor and an upper electrode **108** of the capacitance **104**. The drain of the second transistor **102** is connected to a lower electrode **105** of the capacitance **104** and the first current supply line **110**, and the source is connected to the first electrode **115**. **FIGS. 1 and 2** show only the structure of one pixel.

[**0100**] Next, a method of manufacturing the organic light-emitting display system constituted as above will be described. First, an amorphous silicon (a-Si) film of 50 nm in thickness is formed on the glass substrate **116** by a low-pressure chemical vapor deposition method (LPCVD method). The material is Si_2H_6, and the substrate temperature is set at 450° C. Next, the whole surface of the film is subjected to a laser anneal treatment by use of XeCl excimer laser. The laser anneal treatment is conducted in two stages, and the irradiation energies at the first time and the second time are 188 mJ/cm^2 and 290 mJ/cm^2, respectively. With this, the amorphous silicon is crystallized to be polycrystalline silicon (p-Si). Next, the polycrystalline silicon is patterned by dry etching using CF_4, to form an active layer **103** of the first transistor **101**, an active layer **103'** of the second transistor **102**, and the lower electrode **105** of the capacitance **104**.

[**0101**] Next, an SiO_2 film of 100 nm in thickness is formed as a gate insulation film **117**. The SiO_2 film was formed by a plasma-enhanced chemical vapor deposition method (PECVD method) using tetraethoxysilane (TEOS) as a material.

[**0102**] Subsequently, a TiW film of 50 nm in thickness is formed by a sputtering method, and is patterned to form gate electrodes **107, 107'**. In conjunction with this, the scanning line **106** and the upper electrode **108** of the capacitance are also patterned.

[**0103**] Next, P ions were injected into the patterned polycrystalline silicon layer from the upper side of the gate insulation film **117** by an ion injection method under the conditions of 4×10^{15} ion/cm^2 and 80 keV. At this time, the P ions are not injected into the regions where the gate electrodes **107, 107'** are present on the upper side, and the regions become active regions **103, 103'**.

[**0104**] Subsequently, the substrate **116** is heated in an inert N_2 gas atmosphere at 300° C. for 3 hours to activate the ions so that doping can be performed effectively. The ion-injected region of the polycrystalline silicon (p-Si) comes to have a sheet resistance of 2 kΩ/□. A silicon nitride (SiNx) film is formed thereon as a first interlayer insulation film **118** in a thickness of 200 nm.

[**0105**] Next, contact holes (not shown) are formed in the gate insulation film **117** and the first interlayer insulation film **118** at upper portions at both ends of the active layers **103, 103'**. Further, a contact hole (not shown) is formed in the first interlayer insulation film **118** at an upper portion of the gate electrode **107'** of the second transistor **102**.

[**0106**] On the upper side of this, an Al film of 500 nm in thickness is formed by a sputtering method. The signal line **109**, the first current supply line **110** and the second current supply line **111** are formed by a photolithographic step. In addition, a source electrode **112** and a drain electrode **113** of the first transistor **101** as well as a source electrode **112'** and a drain electrode **113'** of the second transistor **102** are formed.

[**0107**] Next, the capacitance lower electrode **105** is connected to the drain electrode **113** of the first transistor **101**, and the source electrode **112** of the first transistor **101** is connected to the signal line **109**. In addition, the drain electrode **113** of the first transistor **101** is connected to the gate electrode **107'** of the second transistor **102**, and the drain electrode **113'** of the second transistor **102** is connected to the first current supply line **110**. Further, the upper electrode **108** of the capacitance **104** is connected to the first current supply line **110**.

[**0108**] Subsequently, an SiNx film is formed through the second interlayer insulation film **119**. The SiNx film has a thickness of 500 nm. A contact hole (not shown) is formed at an upper portion of the drain electrode **112'** of the second transistor **102**, and an ITO film of 150 nm in thickness is formed thereon by a sputtering method, and the first electrode **115** is formed by a photolithographic method.

[**0109**] Next, as a third interlayer insulation film **120**, a positive type photosensitive protective film (PC452), a product by JSR, is formed. In this case, the film is formed by a spin coating method under coating conditions of 1000 rpm and 30 sec, the substrate **116** is placed on a hot plate, and prebaking is at 90° C. for 2 min.

[**0110**] Subsequently, exposure to ghi line mixture is conducted by use of a photomask to form contact holes **114** in a stripe pattern. Next, development is conducted by use of a developing liquid PD-523, a product by JSR, at room temperature for 40 sec, and after the development, rinsing with pure water is at room temperature for 60 sec. After the rinsing, post-exposure is conducted at a wavelength of 365 nm and an intensity of 300 mJ/cm^2, and post-baking is conducted in a clean oven at 220° C. for 1 hr.

[**0111**] The thickness of the third interlayer insulation film **120** formed of PC452 is 2 μm, and the edges of the first electrode **115** is covered by 6 μm.

[**0112**] Next, the structure of the organic light-emitting device constituting a pixel will be described referring to **FIG. 2B**. The glass substrate **116** provided with up to the first electrode **115** is subjected to ultrasonic cleaning for 3 min sequentially in acetone and in pure water, followed by spin drying and drying in an oven at 120 C. for 30 min.

[**0113**] Subsequently, O_2 plasma cleaning is conducted. The degree of vacuum in the plasma-cleaning chamber is 3 Pa, the flow rate of O_2 is 22 ml/min, the RF power is 200 W, and the cleaning time is 3 min. After the O_2 plasma cleaning, the substrate **116** is set into a vacuum vapor deposition chamber without exposure to the atmosphere.

[**0114**] Next, a 4,4-bis[N-(1-naphthyl)-N-phenylamino]biphenyl film (hereinafter referred to as α-NPD film) of 50 nm in thickness is formed on the first electrode **115** by a vacuum vapor deposition method.

[**0115**] About 60 mg of the material is put in a Mo-made sublimation boat, and vapor deposition is conducted at a vapor deposition rate of 0.15±0.05 nm/sec. At this time, the pattern is formed by use of a shadow mask. The vapor deposition area is 1.2 times each side of the first electrode **115**. The (αNPD film functions as a hole transport layer **121**.

[**0116**] On the upper side of this, a co-vapor deposition film of tris(8-quinolinol)aluminum and quinacridon (hereinafter referred to as Alq and Qc, respectively) of 20 nm in thickness is formed by a binary simultaneous vacuum vapor deposition method.

[**0117**] The materials Alq and Qc in amounts of about 40 mg and about 10 mg are put in two Mo-made sublimation boats, respectively, and co-vapor deposition is conducted at vapor deposition rates of 0.40±0.05 nm/sec and 0.01±0.005 nm/sec, respectively. The Alq+Qc co-vapor deposition film functions as the light-emitting layer **122**. An Alq film of 20 nm in thickness is formed thereon by a vacuum vapor deposition method. About 40 mg of the material is put in an Mo-made sublimation boat, and vapor deposition is conducted at a vapor deposition rate of 0.15±0.05 nm/sec. The Alq film functions as the electron transport layer **123**.

[**0118**] A mixture film of Mg and Ag as the electron injection layer **124** is formed on the electron transport layer **123**. In this case, a film of 10 nm in thickness is formed by a binary simultaneous vacuum vapor deposition method at vapor deposition rates of 0.14±0.05 nm/sec and 0.01±0.005 nm/sec for Mg and Ag, respectively.

[**0119**] Next, an In—Zn—O film (hereinafter referred to as IZO film) of 50 nm in thickness is formed by a sputtering method. The film functions as the second electrode **125**, and is an amorphous oxide film. A target with In/(In+Zn)=0.83 is used. The film formation conditions are an Ar:O_2 mixture gas as atmosphere, a degree of vacuum of 0.2 Pa, and a sputtering output of 2 W/cm^2. The second electrode **125** composed of an Mg:Ag/In—Zn—O laminate film functions as cathode, which has a transmittance of 65%. In this case, as shown in **FIG. 2**A, the second electrode **125** is connected to the second current supply line **111**, with the contact hole **114** formed in the second interlayer insulation film **119** and the third interlayer insulation film **120** as a feeding point. That is, the second electrode **125** of the organic light-emitting device of each pixel is connected to the second current supply line **111** in the region of each pixel, with the contact hole **114** as a feeding point.

[**0120**] Subsequently, an SiNx film of 50 nm in thickness is formed on the second electrode **125** by a thermal CVD method. This film functions as the protective film **126**.

[**0121**] In the organic light-emitting display device according to the present embodiment, the emitted light is taken out from the side of the protective layer **126**, so that the IZO film is used as the second electrode **125**. The IZO film has a sheet resistance of 80 Ω/□.

[**0122**] In the case of using the IZO film as the second electrode **125** and connecting the second electrode **125** to the second current supply line **111**, when the feeding point for the second electrode **125** of each pixel is provided at an end portion of the display region of the panel and the feeding point and this feeding point is connected to the second electrode **125** of each pixel through the second current supply line **111** as shown in **FIG. 3**A, differences are generated in the wiring resistance due to the IZO film between the pixels disposed at the end portion of the display region of the panel and the pixels disposed at a central portion of the display region of the panel, so that variations are generated in the voltage applied to each pixel, and thereby variations in the brightness of the panel is generated.

[**0123**] On the other hand, in the organic light-emitting display device according to this embodiment, as shown in **FIGS. 2**A, **2**B and **3**B, the second electrode **125** of the organic light-emitting device of each pixel and the second current supply line **111** are connected to each other in the display region of each pixel, with the contact hole **114** serving as a feeding point. Therefore, the wiring resistance due to the IZO film in each pixel becomes uniform, generation of the variations in the voltage applied to each pixel can be prevented, and thereby generation of the variations in the brightness of the panel can be prevented.

[**0124**] In addition, the second current supply line **111** in this embodiment has a total wiring resistance of about 0.2Ω, so that the wiring resistance in each pixel is negligibly small, and generation of the variations in the brightness of the panel can be suppressed.

[**0125**] [Embodiment 2]

[**0126**] A full-color organic light-emitting display device according to a second embodiment of the present invention will be described with reference to **FIGS. 4 and 5**. This display device comprises a second current supply line and a feeding point at a lower portion of a green light emission pixel region and has a high efficiency and a long life. **FIG. 4** is a plan view of a pixel of an organic light-emitting display device according to this embodiment, and **FIG. 5** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 4**.

[**0127**] The present embodiment has a structure in which, to display a color picture, a plurality of pixels as minimum units of the color picture are provided, green, red and blue organic light-emitting devices are provided as sub-pixels constituting each pixel, and a second electrode **125** of the organic light-emitting device of each pixel is connected to a second current supply line **111** in the display region of the green organic light-emitting device, the other constitutions being substantially the same as those in the first embodiment.

[**0128**] Concretely, there are formed on a glass substrate **116**a a green pixel first transistor **204**, a green capacitance **205**, a green second transistor **206**, a red pixel first transistor **207**, a red capacitance **208**, a red second transistor **209**, a blue pixel first transistor **210**, a blue capacitance **211**, a blue second transistor **212**, signal lines **109**, **109**', **109**", scanning lines **106**, **106**', first current supply lines **110**, **110**', **110**", a second current supply line **111**, a first interlayer insulation film **118**, a second inter-layer insulation film **119** and a contact hole **114**, using the same methods as in the first embodiment.

[**0129**] The organic light-emitting devices constituting the green pixel, red pixel and blue pixel are formed by the method as follows.

[**0130**] A green pixel first electrode **201**, a red pixel first electrode **202** and a blue pixel first electrode **203** are formed on the second interlayer insulation film **119**. The method used for this is the same as that for forming the first electrode **115** in the first embodiment. The first electrodes **201**, **202**, **203** are connected respectively to source electrodes of the second transistors **206**, **209**, **212** through contact holes (not shown) formed in the second interlayer insulation film **119**, and the green pixel first electrode **201** is not covered with the feeding point constituted of the contact hole **114**.

[**0131**] Next, as with the first embodiment, a third interlayer insulation film **120** is formed, and the third interlayer insulation film **120** is also not covered with the feeding point constituted of the contact hole **114**.

[**0132**] Subsequently, an (αNPD layer as a hole transport layer **121** common for each pixel is formed on the first electrodes **201**, **202**, **203**. The formation conditions are the same as in Embodiment 1, the film thickness is controlled to 50 nm, and the vapor deposition rate is controlled to 0.15±0.05 nm/sec. The vapor deposition is conducted by use of a mask so that the feeding point is not covered with the hole transport layer **121**.

[**0133**] Next, light-emitting layers **213**, **214**, **215** of each pixel are formed. A co-vapor deposition layer of Alq and Qc is formed as the light-emitting layer **213** of the green pixel. The formation conditions are the same as in the first embodiment.

[**0134**] Subsequently, the light-emitting layer **214** of the red pixel is formed. That is, a co-vapor deposition film of Alq and Nile Red (hereinafter abbreviated to Nr) of 40 nm in thickness is formed by a binary simultaneous vacuum vapor deposition method.

[**0135**] The materials Alq and Nr in respective amounts of about 10 mg and about 5 mg are put in two Mo-made sublimation boats, and vapor deposition is conducted at vapor deposition rates of 0.40±0.05 nm/sec and 0.01±0.005 nm/sec for Alq and Nr, respectively.

[**0136**] Next, the light-emitting layer **215** of the blue pixel is formed. That is, a distyrylarylene derivative film (hereinafter abbreviated to DPVBi) of 40 nm in thickness is formed by a vacuum vapor deposition method. The material DPVBi in an amount of about 40 mg is put in an Mo-made sublimation boat, and vapor deposition is conducted at a vapor deposition rate of 0.40±0.05 nm/sec.

[**0137**] Subsequently, an electron transport layer **123** common for each pixel is formed. That is, an Alq film of 20 nm in thickness is formed by a vacuum vapor deposition method. In this case, about 40 mg of the material is put in an Momade sublimation boat, and vapor deposition is conducted at a vapor deposition rate of 0.15±0.05 nm/sec.

[**0138**] Next, an Mg—Ag alloy film as an electron injection layer **124** is formed on the electron transport layer **123**. The formation conditions are the same as in the first embodiment. An IZO film as a second electrode **125** is formed thereon. The formation conditions are the same as in the first embodiment.

[**0139**] The second electrode **125** is connected to the second current supply line **111**, with the contact hole **114** formed in the second interlayer insulation film **118** and the third interlayer insulation film **119** serving as a feeding point.

[**0140**] Subsequently, an SiNx film of 50 nm in thickness is formed by a thermal CVD method. This film functions as a protective layer **126**.

[**0141**] In this embodiment, as with the first embodiment, the contact hole **114** is provided for connecting the second electrode **125** and the second current supply line **111** in the display region of each pixel, so that variations in wiring resistance due to the second electrode **125** are suppressed, and the variations in brightness of the panel can be reduced.

[**0142**] In addition, in this embodiment, the second current supply line **111** is formed in the green pixel region and is not formed in the red pixel and blue pixel regions, so that lowering of an aperture ratio due to formation of the contact hole **114** is not generated in the red pixel and blue pixel region, though the lowering of the aperture ratio is generated in the green pixel region. In this case, if the lowering of the aperture ratio in the green pixel region is 10%, it is possible to accommodate the lowering of the aperture ratio by increasing the brightness by 10%. In other words, since current density is proportional to brightness, it is possible to accommodate the lowering of the aperture ratio by increasing the current density by 10%. It should be noted that even if the current density is increased by 10%, the current flowing to the green pixel is not varied because the aperture ratio is lowered by 10%.

[**0143**] On the other hand, if the brightness in a non-linear relationship with voltage is increased by 10%, the voltage is increased by 1 to 2%. Therefore, if the brightness is increased by 10%, an increase in power is 1 to 2%. Incidentally, the efficiency of the organic light-emitting device used for the green pixel is several fold greater than those of the materials of the red and blue devices, so that the increase in power does not matter in a full-color panel.

[0144] Therefore, by adopting the structure according to this embodiment, variations in brightness in the panel can be suppressed without lowering the efficiency of the full-color panel.

[0145] [Embodiment 3]

[0146] A full-color organic light-emitting display device according to a third embodiment of the present invention will be described with reference to **FIGS. 6 and 7**. This display device comprises a second current supply line and a feeding point at a lower portion of a green light emission pixel region, is so constructed as to take out light from the back side of a substrate, and has a high efficiency and a long life. **FIG. 6** is a plan view of a pixel of the organic light-emitting display device in this embodiment, and **FIG. 7** is a sectional view taken along line A-A' of **FIG. 6**.

[0147] In this embodiment, a sealing substrate **309** for the purpose of preventing water, oxygen and the like gases in the atmosphere from penetrating into a second electrode **125**, an organic layer under the second electrode, or the interface between the second electrode and the organic layer is provided on the upper side of the second electrode **125**, the other constitutions being substantially the same as in the second embodiment.

[0148] Concretely, there are formed on a glass substrate **116** a green pixel first transistor **204**, a green capacitance **205**, a green second transistor **206**, a red pixel first transistor **207**, a red capacitance **208**, a red second transistor **209**, a blue pixel first transistor **210**, a blue capacitance **211**, a blue second transistor **212**, signal lines **109**, **109'**, **109"**, scanning lines **106**, **106'**, first current supply lines **110**, **110'**, **110"**, a second current supply line **111**, a first inter-layer insulation film **118**, and a second inter-layer insulation film **119**, using the same methods as in the second embodiment.

[0149] Next, first electrodes **301**, **302**, **303** of green, red and blue pixels are formed on the second interlayer insulation film. The formation conditions are the same as in the second embodiment. This embodiment differs from the second embodiment in that the green pixel first electrode **301** is so small that it does not overlap with the capacitance **205**, the first current supply line **110** or the second current supply line **111**.

[0150] Subsequently, as with the second embodiment, a contact hole **114** is formed in the second interlayer insulation film **119** and the third interlayer insulation film **120**, and the contact hole **114** is made to be a feeding point.

[0151] On the upper side of this, a hole transport layer **121** common for green, red and blue pixels is formed. The formation method is the same as in the second embodiment.

[0152] Next, light-emitting layers **304**, **305**, **306** of each pixel are formed by the same method as in the second embodiment.

[0153] An electron transport layer **123** common for green, red, blue pixels is formed on the light-emitting layers **304**, **305**, **306** of each pixel, by the same method as in Embodiment 2.

[0154] Subsequently, an LiF film as an electron injection layer **124** is formed on the electron transport layer **123**. The film of 0.5 nm in thickness was formed by a vacuum vapor deposition method at a vapor deposition rate of 0.05±0.01 nm/sec.

[0155] Next, an Al film as a second electrode **125** is formed on the electron injection layer **124**. The film of 150 nm in thickness is formed by a vacuum vapor deposition method at a vapor deposition rate of 1±0.05 nm/sec.

[0156] The second electrode **125** is connected to the second current supply line **111** with the contact hole **114** formed in the second inter-layer insulation film **119** and the third inter-layer insulation film **120** serving as a feeding point.

[0157] Subsequently, the substrate (organic EL substrate) **106** provided with the driving portions and the organic light-emitting devices is moved into a sealed chamber in which the dew point is maintained at −90° C. while circulating a dried nitrogen gas, without exposing the substrate **106** to the atmosphere.

[0158] Next, a glass substrate is introduced into the sealed chamber. The glass substrate becomes a sealing substrate (opposed substrate) **309**. A photo-curable resin was applied to edge portions of the sealing substrate **309** constituted of the glass substrate by use of a seal dispenser device.

[0159] The sealing width of the photo-curable resin is 200 μm. Glass beads of 10 μm in diameter are loaded in the photo-curable resin in an amount of 1 wt %. The sealing substrate **309** and the organic EL substrate **310** are adhered to each other in the sealed chamber, and are pressed against each other under a load of 0.5 kgw/cm^2. A light shield plate is placed on the outside of the sealing substrate **309** so that the whole part of the display region is shielded from UV light, and irradiation with UV light from the side of the sealing substrate **309** is conducted to cure the photo-curable resin.

[0160] An alkali meta-halide lamp is used as a source of UV light at an irradiation intensity of 4000 mJ/cm^2 for an irradiation time of 4 min.

[0161] The gap length between the organic EL substrate **310** and the sealing substrate **309** is determined by the diameter of the glass beads contained in the photo-curable resin to be 10 μm.

[0162] In this embodiment, as with the first embodiment, a feeding point for connecting the second electrode **125** and the second current supply line **111** is provided in the inside of the pixel, so that dispersion of wiring resistance due to the resistance of the second electrode **125** is suppressed, and variations in the brightness of the panel are reduced.

[0163] Besides, in this embodiment, as with the second embodiment, the second current supply line **111** is formed only at a lower portion of the green pixel region, so that the current per pixel is not varied even in the case where the aperture ratio of the green pixel is about 50%. On the other hand, voltage is increased by about 7%. Therefore, in this embodiment, power is increased by about 7%, but this does not lead to a lowering of the performance of the full-color panel in the same manner as in the second embodiment.

[0164] [Embodiment 4]

[0165] A full-color organic light-emitting display device according to a fourth embodiment of the present invention will be described with reference to **FIGS. 8 and 9**. This display device comprises a second current supply line on the upper side of a second electrode. **FIG. 8** is a plan view of a pixel of the organic light-emitting display device according to this embodiment, and **FIG. 9** is a sectional view taken along line A-A' of **FIG. 8**.

[**0166**] In this embodiment, in place of forming a second current supply line **111** in the same layer as a signal line **109**, an Al film **402** as the second current supply line is formed on the upper side of a protective layer **126** covering a second electrode **125** of an organic light-emitting device belonging to each pixel, and emitted light is taken out from the back side of a substrate, the other constitutions being substantially the same as in the first embodiment.

[**0167**] Concretely, there are formed on a glass substrate **116** a first transistor **101**, a capacitance **104**, a second transistor **102**, signal lines **109**, **109'**, scanning lines **106**, **106'**, first current supply lines **110**, **110'**, a second interlayer insulation film **119**, a first electrode **115**, and a third interlayer insulation film **120**, using the same methods as in the first embodiment.

[**0168**] On the upper side of this, a hole transport layer **121**, a light-emitting layer **122** and an electron transport layer **123** are formed by the same method as in the embodiment.

[**0169**] Next, an LiF film as an electron injection layer **124** is formed on the electron transport layer **123** under the same conditions as in the third embodiment.

[**0170**] Subsequently, an Al film as a second electrode **124** is formed on the electron injection layer **124** under the same conditions as in the third embodiment.

[**0171**] Next, an SiNx film of 100 nm in thickness is formed by a thermal CVD method. The film is removed, while leaving an upper portion on the pixel region where the first electrode **115** and the second electrode **125** overlap with each other, by a photolithographic method. In **FIGS. 8 and 9**, the removed regions are **401** and **401'**. In this case, the SiNx film functions as a protective layer **126** in the pixel region.

[**0172**] An Al film is formed on the protective layer **126** by a sputtering method, in a film thickness of 500 nm. This layer functions as a second current supply line. With the protective film **126** provided in the pixel region, the damage to the electron transport layer **123**, the light-emitting layer **122** and the hole transport layer **121** as lower layers due to the formation of the Al film is reduced.

[**0173**] In the organic light-emitting display system according to this embodiment, the second current supply line **402** formed at an upper portion of the second electrode **125** of each pixel is connected to the second electrode **125** through the contact hole (not shown) formed in the protective layer **126** and the regions **401**, **401'** in the vicinity of each pixel, so that variations in the wiring resistance of the second electrode **125** is reduced, and, as a result, variations in the brightness of the panel surface can be reduced.

[**0174**] In addition, since the second current supply line **402** formed on the protective layer **126** has a protective function, the life of the organic light-emitting display device can be prolonged.

[**0175**] [Embodiment 5]

[**0176**] An organic light-emitting display device according to a fifth embodiment of the present invention will be described with reference to **FIGS. 10 and 11**. This display device comprises second current supply lines in a mesh form (grid form). **FIG. 10** is a plan view of a pixel of the organic light-emitting display device according to this embodiment, and **FIG. 11** is a sectional view taken along line A-A' of **FIG. 10**.

[**0177**] In this embodiment, in forming the second current supply lines in a mesh form, the second current supply lines **501**, **501'** are formed in parallel to signal lines **109**, **109'**, and the second current supply line **502** is formed in parallel to scanning lines **106**, **106'**, so that the area of the second current supply lines as a whole is increased, whereby a lowering in the resistance of the second current supply lines is contrived, the other constitutions being substantially the same as in the first and second embodiments.

[**0178**] Concretely, an active layer **103** of a first transistor **101**, an active layer **103'** of a second transistor **102**, and a lower electrode **105** of a capacitance are formed on a glass substrate **116** by the same methods as in the first embodiment.

[**0179**] Next, a gate insulation film **117** is formed, by the same method as in the first embodiment. On the upper side of this, a gate electrode **107**, the scanning lines **106**, **106'**, and an upper electrode **108** of the capacitance are formed by patterning. In this layer, the second current supply line **502** is formed.

[**0180**] On the upper side of this, a first inter-layer insulation layer **118** is formed under the same conditions as in the first embodiment.

[**0181**] Next, contact holes are formed in the gate insulation film **117** and the first interlayer insulation layer **118** at upper portions of both ends of the active layers **103**, **103'**. Further, a contact hole was formed in the first interlayer insulation layer **127** at an upper portion of the gate electrode **121** of the second transistor **102**. Furthermore, a contact hole **504'** is formed on the second current supply line **502**.

[**0182**] On the upper side of this, a signal line **109**, a first current supply line **110** and the second current supply lines **501**, **501'** are formed in the same manner as in the first embodiment. The second current supply line **502** is connected to the second current supply line **501'** at a feeding point **504'**.

[**0183**] In addition, a source electrode **112** and a drain electrode **113** of the first transistor **101** as well as a source electrode **112'** and a drain electrode **113'** of the second transistor **102** are formed.

[**0184**] The capacitance lower electrode **105** is connected to the drain electrode **113** of the first transistor **101**, the source electrode **112** of the first transistor **101** is connected to the signal line **109**, and the drain electrode **113** of the first transistor **101** is connected to the gate electrode **107'** of the second transistor **102**. In addition, the drain electrode **102'** of the second transistor **102** is connected to the first current supply line **110**, and the capacitance upper electrode **108** is connected to the first current supply line **110**.

[**0185**] Next, the second interlayer insulation layer **118**, the first electrode **114** and the third inter-layer insulation layer

119 are formed in the same manner as in the first embodiment. On the upper side of this, a hole transport layer **121**, a light-emitting layer **122**, an electron transport layer **123**, an electron injection layer **124**, and a second electrode **125** are formed by the same methods as in the first embodiment.

[**0186**] The second electrode **125** is connected to the second current supply line **501**' at the feeding points **503**', **504**'.

[**0187**] Thereafter, the substrate provided with the driving devices and the organic light-emitting devices and a sealing substrate **309** are adhered to each other in the same manner as in the third embodiment.

[**0188**] In the organic light-emitting display system according to this embodiment, the second electrode **125** and the second current supply lines **501**', **502**' are connected to each other in the display region of each pixel, so that variations in the wiring resistance of the second electrode **125** are reduced. In particular, since the second current supply lines **501**', **502**' are formed in a mesh form, the wiring resistance of the second current supply lines is further lowered, and, as a result, variations in the brightness of the panel surface can be lowered.

[**0189**] The embodiment invention adopts the mesh configuration in which the second current supply lines are disposed in the directions of the signal lines (the longitudinal direction) and the scanning lines (lateral direction) for each sub-pixel. To reduce the variations in the wiring resistance, the second current supply lines are not necessarily disposed in the longitudinal and lateral directions for every sub-pixel. For example, the second current supply lines are disposed in the longitudinal direction for each sub-pixel as with this embodiment, while the second current supply lines are disposed in the lateral direction only for sub-pixels located at the central portion of the display region. This configuration reduces the variations in the wiring resistance as compared with a configuration in which the second current supply lines are disposed only in the longitudinal direction. In addition, as compared with the fifth embodiment, although the variation in the wiring resistance is increased, the number of the contact holes that connect the second current supply lines disposed in the longitudinal directions with the second current supply lines disposed in the lateral lines is decreased, which improves a process percent defective.

[**0190**] The second current supply lines disposed in the lateral direction may be formed every two, three or four sub-pixels. In addition, even if the dispositions of the second current supply lines formed in the lateral and longitudinal directions are exchanged for each other, the same effects can be produced.

[**0191**] [Embodiment 6]

[**0192**] A full-color organic light-emitting display device according to a sixth embodiment of the present invention will be described with reference to **FIGS. 12 and 13**. This display device has feeding points to second current supply lines provided at a plurality of sub-pixels constituting a pixel. **FIG. 12** is a plan view of a pixel of the organic light-emitting display system according to this embodiment, and **FIG. 13** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 12**.

[**0193**] In this embodiment, to form feeding points to the second current supply lines **111**, **111**', **111**" for each sub-pixel constituting each pixel of each color picture, the second current supply lines **111**, **111**', **111**" are formed respectively in display regions of red, green and blue pixels, and a second electrode **125** is connected to the second current supply lines **111**, **111**', **111**" through contact holes **114**, **114**', **114**" in the display regions of each sub-pixel, the other constitutions being substantially the same as in the second embodiment.

[**0194**] Concretely, there are formed on a glass substrate **116** a green pixel first transistor **204**, a green capacitance **205**, a green second transistor **206**, a red pixel first transistor **207**, a red capacitance **208**, a red second transistor **209**, a blue pixel first transistor **210**, a blue capacitance **211**, a blue second transistor **212**, signal lines **109**, **109**', **109**", scanning lines **106**, **106**', first current supply lines **110**, **110**', **110**", second current supply lines **111**, **111**', **111**", a first inter-layer insulation film **118** and a second inter-layer insulation film **119** by the same methods as in the second embodiment.

[**0195**] Next, contact holes **114**, **114**', **114**" are formed in the first interlayer insulation film **118** and the second inter-layer insulation film **119** at upper portions of the second current supply lines **111**, **111**', **111**", respectively, and each of the contact holes **114**, **114**', **114**" is made to be a feeding point.

[**0196**] Subsequently, first electrodes **201**, **202**, **203** for green, red and blue pixels are formed under the same formation conditions as in the second embodiment. The shapes of the first electrodes **201**, **202**, **203** are shown in **FIG. 12**.

[**0197**] Next, a third inter-layer insulation film **120** is formed by the same method as in the second embodiment.

[**0198**] Subsequently, hole transport layers **601**, **603**, **605** are respectively formed on the first electrodes **201**, **202**, **203** of the sub-pixels under the same formation conditions as in the second embodiment. The hole transport layers **601**, **603**, **605** are formed in such a pattern as not to cover the contact holes **114**, **114**', **114**", respectively, the contact holes serving as feeding points.

[**0199**] Next, light-emitting layers **213**, **214**, **215** are formed on the hole transport layers **601**, **603**, **605**, respectively, by the same method as in the second embodiment.

[**0200**] Subsequently, electron transport layers **602**, **604**, **605** are formed on the light-emitting layers **213**, **214**, **215**, respectively, by the same method as in the second embodiment.

[**0201**] Next, an Mg—Ag alloy film as an electron injection layer **124** is formed on the electron transport layers **602**, **604**, **605** under the same formation conditions as in the second embodiment. An IZO film as a second electrode **125** is formed on the electron injection layer **124** under the same formation conditions as in the second embodiment.

[**0202**] The second electrode **125** is connected to the second current supply lines **111**, **111**', **111**" through the contact holes **114**, **114**', **114**", respectively, which are formed in the first inter-layer insulation film **118** and the second inter-layer insulation film **119**. That is, the second electrode **125** of each sub-pixel is connected to the second current supply lines **111**, **111**', **111**" in the display region of each sub-pixel, with the contact holes **114**, **114**', **114**" serving as feeding points.

[0203] Subsequently, an SiNx film of 50 nm in thickness is formed by a thermal CVD method. This film functions as a protective layer **126**.

[0204] According to this embodiment, the second electrode **125** is connected to the second current supply lines **111, 111'**, **111"** in the display regions of the sub-pixels of each pixel, so that variations in wiring resistance due to the resistance of the second electrode **125** of each pixel can be suppressed, and variations in the brightness of the panel can be reduced. [Embodiment 7]

[0205] A full-color organic light-emitting display system according to a seventh embodiment of the present invention will be described with reference to **FIGS. 14 and 15**. This display device has a configuration in which a new metallic layer and an interlayer insulation film are provided at a driving layer comprising an organic layer and a second current supply line is formed of the new metallic layer. **FIG. 14** is a plan view of a pixel of the organic light-emitting display system according to this embodiment, and **FIG. 15** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 14**.

[0206] In this embodiment, a metallic layer and an interlayer insulation film are provided between a wiring layer comprising signal lines **109**, **109'**, **109"** and first current supply lines **110, 110'**, **110"** and a driving layer comprising an organic layer to form second current supply lines **111, 111'**, **111"**, the other constitutions being the same as in the sixth embodiment.

[0207] Concretely, up to the step of forming a second interlayer insulation film **119** on a glass substrate **116** is the same as in the sixth embodiment except that the second current supply lines **111, 111'**, **111"** are formed to be a layer other than the wiring layer comprising the signal lines **109, 109'**, **109"** and the first current supply lines **110, 110'**, **110"**.

[0208] Next, the second current supply lines **111, 111'**, **111"** are formed on the second inter-layer insulation film **119** by the same method as in the sixth embodiment.

[0209] Subsequently, a polyimide coat film as a fourth interlayer insulation film **701** is formed on the second current supply lines **111, 111'**, **111"**. The polyimide film is formed by use of a self (thin film) non-photosensitive polyimide (code No. PIX-1400), a product of Hitachi Chemical DuPont MicroSystems. The film is formed by a spin coating method, with two-fold dilution using NMP as a solvent. First, the solution is diffused on the entire surface of the substrate at 500 rpm for 10 sec, then a polyimide film is really formed under the conditions of 6000 rpm and 30 sec. Thereafter, the substrate is placed on a hot plate in the atmosphere, and baking is conducted by sequentially changing the baking temperature (baking time) in the manner of 110° C. (3 min) , 190° C. (3 min), 270° C. (3 min) and 350° C. (5 min). The thickness of the polyimide film is 500 nm. The fourth interlayer insulation film **701** is also provided with contact holes **114, 114'**, **114"** as feeding points.

[0210] Subsequently, first electrodes **205**, **208**, **211** for green, red and blue pixels, a third interlayer insulation film **120**, hole transport layers **601**, **603**, **605**, light-emitting layers **213**, **214**, **215**, electron transport layers **602**, **604**, **606**, an electron injection layer **124**, a second electrode **125**, and a protective layer **126** are formed on the fourth interlayer insulation film **701** by the same methods as in the sixth embodiment.

[0211] According to this embodiment, the second electrode **125** and the second current supply lines **111, 111'**, **111"** are connected to each other in the display regions of each sub-pixel, with the contact holes **114, 114'**, **114"** serving as feeding points, so that variations in wiring resistance due to the second electrode **125** can be suppressed, and variations in the brightness of the panel can be reduced.

[0212] Besides, according to this embodiment, the second current supply lines **111, 111'**, **111"** are formed in a layer different from the layer of the first current supply lines **110, 110'**, **110"**, so that it is possible to enlarge the width of the wiring, and a lowering in the resistance of the second current supply lines **111, 111'**, **111"** can be contrived.

[0213] [Embodiment 8]

[0214] A full-color organic light-emitting display device according to an eighth embodiment of the present invention will be described with reference to **FIGS. 16 and 17**. This display device has a configuration in which a metallic layer and an interlayer insulation film are formed at a driving layer comprising an organic layer and a second current supply line is formed of the metallic layer. **FIG. 16** is a plan view of a pixel of the organic light-emitting display device according to this embodiment, and **FIG. 17** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 16**.

[0215] In this embodiment, a metallic layer and an interlayer insulation film are formed between a wiring layer comprising signal lines **109**, **109'**, **109"** and first current supply lines **110, 110'**, **110"** and a driving layer comprising an organic layer, and a second current supply line is formed of the metallic layer, in the same manner as in the seventh embodiment except that the second current supply line **801** is formed in parallel to the scanning lines **106**, **106'** in this embodiment, as contrasted to the seventh embodiment in which the second current supply lines **111, 111'**, **111"** are formed in parallel to the signal lines **109**, **109'**, **109"**, and that the second current supply line **801** is provided with contact holes **114, 114'**, **114"**.

[0216] Concretely, up to the step of forming a second inter-layer insulation film **119** on a glass substrate **116** is the same as in the seventh embodiment.

[0217] Next, the second current supply line **801** is formed on the second interlayer insulation film **119**. The second current supply line **801** is formed in parallel to the scanning lines **106**, **106'** by the same method as in the seventh embodiment. The subsequent steps are the same as in the seventh embodiment.

[0218] According to this embodiment, the second electrode **125** is connected to the second current supply line **801** on a sub-pixel basis, with the contact holes **114, 114'**, **114"** serving as feeding points, so that variations in wiring resistance due to the second electrode **125** can be suppressed, and variations in the brightness of the panel can be reduced.

[0219] In addition, according to this embodiment, the second current supply line **801** is formed in a layer different from the layer of the first current supply lines **110, 110'**, **110"**, so that the wiring width of the second current supply line **801** can be enlarged, and a lowering in the resistance of the second current line **801** can be contrived.

[0220] [Embodiment 9]

[0221] A full-color organic light-emitting display device according to a ninth embodiment of the present invention will be described with reference to **FIGS. 18 and 19**. This display device has a configuration in which second current supply lines for exclusive use for individual sub-pixels are connected to individual color sub-pixels. **FIG. 18** is a plan view of a pixel of the organic light-emitting display system according to this embodiment, and **FIG. 19** is a sectional view taken along line A-A' of the pixel region shown in **FIG. 18**.

[0222] In this embodiment, second current supply lines **111**, **111'**, **111"** parallel to signal lines are formed for each of sub-pixel of each pixel, and second electrodes **901**, **902**, **903** are respectively connected to the second current supply lines **111**, **111'**, **111"** of the individual sub-pixels are connected in the display regions of the individual sub-pixels, with contact holes **114**, **114'**, **114"** serving as feeding points. In addition, green pixels, red pixels and blue pixels are formed in a stripe pattern with each kind of pixels arranged in a row, and a sealing substrate **309** for the purpose of preventing water, oxygen and the like gases in the atmosphere from penetrating into the second electrodes, an organic layer under the second electrodes or the interface between the second electrodes and the organic layer is provided on the upper side of the second electrodes **901**, **902**, **903**. Other constitutions are the same as in the sixth embodiment.

[0223] Concretely, the steps from the step of forming first transistors **204**, **207**, **210** on a glass substrate **116** up to the step of forming electron injection layers **307**, **307'**, **307"** are the same as in the sixth embodiment, whereby the green pixels, red pixels and blue pixels are formed in a stripe pattern with each kind of pixels arranged in a row.

[0224] The second electrodes **901**, **902**, **903** in a stripe pattern are formed on the electron injection layers **307**, **307'**, **307"** by use of a metal mask under the same conditions as in the sixth embodiment 6.

[0225] Although the metal mask is used for patterning in forming the second electrodes **901**, **902**, **903**, this is not limitative. For example, edge portions of a third interlayer insulation film **120** may be formed in a reverse-tapered shape, and the second electrodes **901**, **902**, **903** may be formed in a cut-apart state to be in a stripe pattern, without using a mask.

[0226] Subsequently, sealing is conducted by use of a sealing substrate **309**, in the same manner as in the third embodiment.

[0227] According to this embodiment, the second electrodes **901**, **902**, **903** are respectively connected to the second current supply lines **111**, **111'**, **111"** in the display regions of the individual sub-pixels of each pixel with the contact holes **114**, **114'**, **114"** serving as feeding points, so that variations in wiring resistance due to the second electrodes **901**, **902**, **903** can be suppressed, and variations in the brightness of the panel can be reduced.

[0228] In addition, according to this embodiment, the green pixel, red pixel and blue pixel constituting the sub-pixels of each pixel are connected through the second current supply lines **111**, **111'**, **111"** for exclusive use, with the contact holes **114**, **114'**, **114"** serving as feeding points, so that the voltage or current applied to each sub-pixel can be controlled independently.

[0229] According to the present invention, at least the electrode on one side of one organic light-emitting device belonging to each pixel is connected to the current supply line in the display region of each pixel, so that dispersion of luminance due to the resistance of wiring for connecting the electrodes of the organic light-emitting devices and a power source can be reduced, and dispersion of luminance in the display region can be suppressed.

[0230] [Embodiment 10]

[0231] Next, a description will be made of a tenth embodiment in which first current supply lines and second current supply lines are disposed in a mesh form with reference to **FIGS. 21 and 22**. **FIG. 21** is a plan view of a pixel of an organic light-emitting display system in this embodiment. **FIG. 22** is a sectional view of a pixel region taken along line A-A' of **FIG. 21**. This display system comprises first current supply lines **110'**, **110** and second current supply lines **501'**, **501** that are formed in a longitudinal direction in a wiring layer in which also signal lines **109**, **109'** are formed, and a first current supply line **603** and a second current supply line **604** that are formed in a lateral direction in a wiring layer in which also a gate line **503'** is formed. The first longitudinal current supply lines **110'** and **110** are connected to the first lateral current supply line **603** at their respective intersections through contact holes **601'** and **601**, respectively. The second longitudinal current supply lines **501'** and **501** are connected to the second lateral current supply line **604** at their respective intersections through contact holes **602'** and **602**, respectively. Thus, the first and second current supply lines are each formed in a mesh manner. In addition, second electrodes are connected to the second current supply lines **501'** and **501** through contact holes **606'** and **606**, respectively, serving as feeding points. Other portions are configured similarly to those of the fifth embodiment.

[0232] With this configuration, since the resistance of the first and second current supply lines can be reduced, variations in the wiring resistance can be suppressed and, as a result, variations in the brightness of the panel surface can be lowered. In particular, a drop in the voltage of the first current supply line varies the reference voltages of second transistors **102**, **102'** that determine the display brightness of a pixel, so that a small variation in voltage causes a large variation in current. To suppress the variation in drops in the voltage of the first current supply lines is therefore effective at suppressing the variations in the brightness of the panel surface.

[0233] For example, a variation in voltage of 0.5 V in the first current supply lines approximately corresponds to a variation in gate bias voltage of a transistor. Accordingly, an S value of 0.5 V/dec of the transistor causes the variation in current as much as ten times. On the other hand, a variation in voltage of 0.5 V in the second current supply lines, which corresponds to a variation in EL drive voltage, affects the brightness. Therefore, assumed that VDS=8 V, a voltage-current characteristic is an exponential function, and an index I is $Ioe^{0.8V}$, a current ratio is 1.5 times and the brightness varies by about 1.5 times. Thus, even small drops in the voltage of 1 V or less in the first current supply line and the second current supply line result in a large variation in the brightness in either case. In particular, the variation in the voltage of the first current supply line results in the greater variations in the brightness. The reduction in the variations of the resistance presented by this embodiment produces the effect of reducing the variations in the brightness.

[0234] In addition, the thus configured mesh-like wiring can reduce the variations in voltage between laterally adjacent pixels or sub-pixels, so that smear can be reduced.

[0235] The smear occurs in the following manner. As described in the proceeding embodiments, in the case where the first current supply lines are disposed parallel with the signal lines in a stripe pattern, the current of the first current supply line varies in response to the average brightness of a longitudinally disposed sub-pixel connected to the corresponding first current supply line, and consequently, a drop in voltage freely varies on a longitudinal line basis. Accordingly, even if patterns with the same brightness are to be displayed at the generally central portion of the panel, a variation in brightness of one of the patterns positioned at the central portion occurs in response to the corresponding displayed pattern that is positioned at the peripheral portion of the panel in each of the longitudinal directions.

[0236] Since the lateral current supply lines are connected to the longitudinal current supply lines in this embodiment, the variations in voltage can be reduced in both the longitudinal and lateral directions, thereby preventing the smear from occurring.

[0237] [Embodiment 11]

[0238] An eleventh embodiment will be described with reference to **FIGS. 23 and 24**. In this embodiment, an aluminum wiring layer with low resistance and an insulating interlayer are additionally provided in a grid form and are used as a first current supply line layer. **FIG. 23** is a plan view and **FIG. 24** shows a sectional configuration. The additional aluminum wiring layer **605** and interlayer insulation film **610** are formed by the process similar to that of the third embodiment. A second interlayer film **119** is formed and second current wiring contacts **602, 602'** and first current wiring contacts **614, 614'** are formed. Thereafter, the aluminum wiring layer **605** and the additional interlayer insulating film **610** are formed and a contact hole **608** is provided. Then, an EL device is formed and a second electrode **125** is formed as an uppermost layer.

[0239] Each aluminum wiring layer **605** is provided with an opening **11** for each pixel so as to allow light from a substrate surface to pass therethrough. A second electrode **124** formed in the uppermost layer is connected to second current supply lines **501, 501'** through the respective contacts **602, 602'** provided below the respective contact openings **612, 612'**. On the other hand, the aluminum wiring layer **605** as a first current supply line is connected to second transistors **102, 102'** through the first current supply line contacts **614, 614'**, respectively.

[0240] With this configuration, the area of the first current supply line having a large effect on variations in brightness can be remarkably increased to reduce a drop in voltage, so that the variations in brightness can be reduced. In addition, this configuration produces a large effect of reducing smear. This is because the aluminum wiring layers having low resistance are used in a grid form. In particular, an effect of improving image quality due to the grid-like wiring in an organic EL panel, which is a current drive device, is remarkably larger than that in a liquid crystal display. Also a liquid crystal display system is provided with wiring which supplies the same potential to each pixel in common. However, since the liquid crystal display is voltage-driven and the device is driven by an electric capacitive load in its operation principle, it is required to improve the image quality of display by matching the selected time for a pixel with the time constant of a transient response of wiring. For the current drive device such as an organic EL, since an electric current flows steadily during the period of display after the period of scanning, it is required to suppress the variations in brightness of display by suppressing a drop in voltage due to wiring resistance itself. Thus, the current drive device is significantly different from the liquid crystal display in the manner of exhibiting the wiring resistance effect. Since the current wiring layer is made of aluminum having a low resistivity and is formed in a grid form so as to be low-resistant, this embodiment has advantages of eliminating variations in brightness and smear.

[0241] [Twelfth embodiment]

[0242] A twelfth embodiment will be described with reference to **FIGS. 25 and 26**. In the present embodiment, first and second longitudinal current supply lines are each disposed parallel with a signal line and first and second lateral current supply lines are each disposed parallel with a scanning line. The first and second longitudinal current supply lines are connected to the first and second lateral current supply lines in a grid form. In particular, for the longitudinal lines disposed parallel to the signal line, an aluminum wiring layer having low resistance and an interlayer insulation film, which are additionally provided as with the eleventh embodiment, are used. This configuration enlarges the respective widths of the first and second longitudinal lines to provide effects of reducing the resistance thereof and reducing smear.

[0243] The manufacturing process of this embodiment is similar to that of the eleventh embodiment. That is, first current supply lines **110, 110'** and second current supply lines **501, 501'** are formed of aluminum wiring and are disposed parallel with signal lines **109, 109'**. On the other hand, first and second lateral current supply lines **603, 604** are disposed parallel with a scanning line and formed in a scanning wiring layer. The first longitudinal current supply lines **110** and **110'** are connected to the first lateral current supply line **603** through contact holes **601** and **601'**, respectively, while the second longitudinal current supply lines **501** and **501'** are connected to the second lateral current supply lines **604** through contact holes **602** and **602'**, respectively. Incidentally, second electrodes **125** are connected to the second current supply lines **501** and **501'** through contact holes **606** and **606'**, respectively, serving as feeding points. In addition, the first current supply line **110** is connected to a second transistor **102** through a connection pattern **609** and a contact hole **607**; the first current supply line **110'** is connected to a second transistor **102'** through a connection pattern **609'** and a contact hole **607'**.

[0244] While the invention has been described in its preferred embodiments, it is to be understood that the words which have been used are words of description rather than limitation and that changes within the purview of the appended claims may be made without departing from the true scope and spirit of the invention in its broader aspects.

What is claimed is:

1. An organic light-emitting display device comprising:

a plurality of pixels each of which is a minimum unit of a picture; and

a plurality of organic light-emitting devices as each said pixel;

wherein at least an electrode on one side of one organic light-emitting device belonging to each said pixel, of pairs of electrodes disposed on the opposite sides of an organic layer of said plurality of organic light-emitting devices, is connected to a current supply line in a display region of each said pixel.

2. An organic light-emitting display device comprising:

a plurality of pixels each of which is a minimum unit of a picture; and

a plurality of organic light-emitting devices as each said pixel;

wherein an electrode on one side, of a pair of electrodes disposed on the opposite side of an organic layer of said plurality of organic light-emitting devices, is connected to a current supply line in a display region of each said pixel.

3. An organic light-emitting display device comprising:

a plurality of pixels each of which is a minimum unit of a color picture; and

a plurality of organic light-emitting devices different in emitted light color as each said pixel;

wherein at least an electrode on one side of one organic light-emitting device belonging to each said pixel, of a pair of electrodes disposed on the opposite sides of an organic layer of said plurality of organic light-emitting devices, is connected to a current supply line in a display region of each said pixel.

4. An organic light-emitting display device comprising:

a plurality of pixels each of which is a minimum unit of a color picture, and

a plurality of organic light-emitting devices different in emitted light color as each said pixel;

wherein an electrodes on one side, of a pair of electrodes disposed on the opposite sides of an organic layer of said plurality of organic light-emitting devices, is connected to a current supply line in a display region of each said pixel.

5. An organic light-emitting display device comprising:

a plurality of pixels each of which is a minimum unit of a color picture; and

a plurality of organic light-emitting devices different in emitted light color as each said pixel;

wherein an electrode on one side of said organic light-emitting device of a specified emitted color light of each said pixel, of a pair of electrodes disposed on the opposite sides of an organic layer of said plurality of organic light-emitting devices, is connected to a current supply line in a display region of each said pixel.

6. An organic light-emitting display device comprising:

a plurality of pixels each of which is a minimum unit of a picture;

a plurality of organic light-emitting devices as each said pixel; and

at least one current supply line disposed in a display region including each said pixel;

wherein at least an electrode on one side of one organic light-emitting device belonging to each said pixel, of a pair of electrodes disposed on the opposite sides of an organic layer of said plurality of organic light-emitting devices, is connected to said current supply line in a display region of each said pixel.

7. An organic light-emitting display device as set forth in claim 1, wherein a driving layer comprising a driving device for driving said organic layer is stacked on a substrate, a wiring layer comprising signal lines and scanning lines connected to said driving device is stacked, said organic layer of said plurality of organic light-emitting devices is stacked on said wiring layer on a pixel basis together with a pair of electrodes disposed on the opposite sides of said organic layer, and said current supply line is disposed in said wiring layer and connected to said electrode on one side through an interlayer insulation film.

8. An organic light-emitting display device as set forth in claim 1, wherein a driving layer including a driving device for driving said organic layer is stacked on a substrate, a wiring layer comprising signal lines and scanning lines connected to said driving device is stacked, said organic layer of said plurality of organic light-emitting devices is stacked on said wiring layer on a pixel basis together with a pair of electrodes disposed on the opposite sides of said organic layer, and said current supply line is disposed in a layer between said wiring layer and said organic layer and connected to said electrode on one side through an interlayer insulation film.

9. An organic light-emitting display device as set forth in claim 1, wherein an electrode on one side of a pair of electrodes disposed on the opposite side of said organic layer of said plurality of organic light-emitting devices is formed at an upper portion of said organic layer on a substrate as a second electrode, against a first electrode formed at a lower portion of said organic layer on said substrate, and said current supply line is connected to an upper portion of said second electrode.

10. An organic light-emitting display system as set forth in claim 1, wherein a driving layer including a driving device for driving said organic layer is stacked on a substrate, a wiring layer comprising signal lines and scanning lines connected to said driving device is stacked, said organic layer of said plurality of organic light-emitting devices is stacked on said wiring layer on a pixel basis together with a pair of electrodes disposed on the opposite sides of said organic layer, an electrode on one side of a pair of electrodes disposed on the opposite sides of said organic layer of said plurality of organic light-emitting devices is formed at an upper portion of said organic layer on said substrate as second electrodes, against a first electrode formed at a lower portion of said organic layer on said substrate, and said current supply line is connected to an upper portion of said second electrode.

11. An organic light-emitting display device as set forth in claim 1, wherein at least two said current supply lines are connected to each other.

12. An organic light-emitting display device as set forth in claim 1, wherein said current supply line is divided into a plurality of current supply lines in correspondence with each said organic light-emitting device of each said pixel, and said plurality of current supply lines thus divided are each connected to each said organic light-emitting device of each said pixel as an exclusive-use current supply line.

13. An organic light-emitting display device as set forth in claim 1, wherein said current supply line is formed along each space between said pixels.

14. An organic light-emitting display device as set forth in claim 1, wherein said current supply line is formed to overlap each said pixel.

15. An organic light-emitting display device as set forth in claim 5, wherein said organic light-emitting device of said specified emitted light color has a higher efficiency or a longer life as compared with said organic light-emitting devices of other emitted light colors.

16. An organic light-emitting display device as set forth in claim 1, wherein an electrode on one side of a pair of electrodes disposed on the opposite sides of said organic layer of said plurality of organic light-emitting devices is formed at an upper portion of said organic layer on a substrate as a second electrode, against a first electrode formed at a lower portion of said organic layer on said substrate, said first electrode is connected to a plus terminal of a power source as an anode, and said second electrode is connected to a minus terminal of said power source as a cathode.

17. An organic light-emitting display device as set forth in claim 16, wherein said second electrode is formed of a transparent material which transmits light therethrough.

18. A method of manufacturing an organic light-emitting display device as set forth in claim 1, comprising the steps of:

forming an organic layer comprising a plurality of organic light-emitting devices on a substrate;

forming a driving layer including driving devices for driving said plurality of organic light-emitting devices;

forming a wiring layer comprising signal lines and scanning lines connected to said driving devices

forming current supply lines on the upper side of said organic layer or on the lower side of said organic layer

forming contact holes in an interlayer insulation film formed in the surroundings of said current supply lines; and

connecting electrodes on one side of pairs of electrodes disposed on the opposite side of said organic layer of said plurality of organic light-emitting devices and said current supply lines through said contact holes.

* * * * *

patsnap

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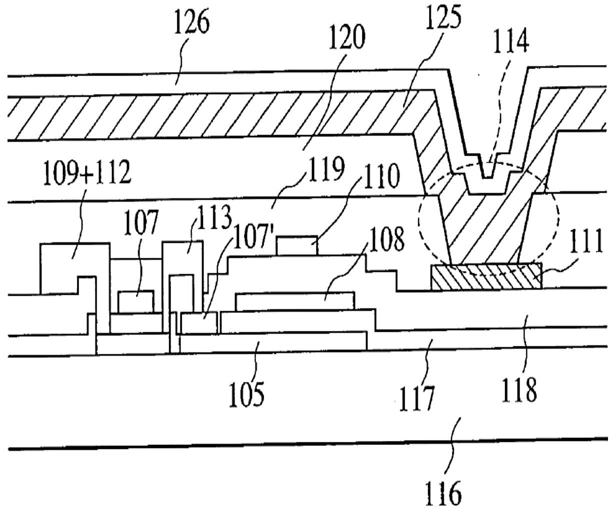
摘要(译)

扫描线，信号线，第一电流供应线和第二电流供应线形成在玻璃基板上，第一电极形成在包括上述构件的布线层上，有机层包括空穴传输层，在第一电极上形成发光层，电子传输层和电子注入层，在电子注入层上形成第二电极作为阴极，作为阳极的第一电极连接到电源的正端子通过驱动装置和第一电流供应线来源，而作为阴极的第二电极连接到电源的负端子，并且连接到每个像素的显示区域中的第二电流供应线，具有接触孔作为馈电点，由此减小了由于第二电极引起的布线电阻，并且降低了面板亮度的变化。



126
120
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114
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