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(54) **MULTI-DOMAIN VERTICAL ALIGNMENT LIQUID CRYSTAL DISPLAY DEVICE AND ELECTRONIC DEVICE**

MULTI-DOMÄNEN FLÜSSIGKRISTALLANZEIGEVORRICHTUNG MIT VERTIKALER AUSRICHTUNG UND ELEKTRONISCHE VORRICHTUNG

DISPOSITIF D'AFFICHAGE À CRISTAUX LIQUIDES À ALIGNEMENT VERTICAL ET DOMAINES MULTIPLES, ET DISPOSITIF ÉLECTRONIQUE

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(73) Proprietor: **Sharp Kabushiki Kaisha**
Osaka-shi, Osaka 545-8522 (JP)

(72) Inventors:
- **YOSHIDA, Masahiro**
Osaka-shi, Osaka 545-8522 (JP)
- **HORIUCHI, Satoshi**
Osaka-shi, Osaka 545-8522 (JP)
- **YAMADA, Takaharu**
Osaka-shi, Osaka 545-8522 (JP)
- **HISADA, Yuhko**
Osaka-shi, Osaka 545-8522 (JP)
- **ITOH, Ryohki**
Osaka-shi, Osaka 545-8522 (JP)

(74) Representative: **Müller Hoffmann & Partner**
Patentanwälte mbB
St.-Martin-Strasse 58
81541 München (DE)

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Description

Technical Field

[0001] The present invention relates to an MVA (Multi-domain Vertical Alignment) liquid crystal display device.

Background Art

[0002] Liquid crystal display devices have problems such as a low contrast, a slow response speed, a narrow viewing angle and the like. For solving these problems, various techniques have been proposed.

[0003] For example, in a method called a Vertical Alignment (VA) mode, liquid crystal molecules of liquid crystals having a negative dielectric anisotropy are aligned in a vertical direction by use of a vertical alignment film in a case where voltage is not applied to the liquid crystals. As a result, a black display is carried out. Meanwhile, in a case where voltage is applied to the liquid crystals, the liquid crystal molecules are aligned in a horizontal direction. As a result, a white display is carried out. In this way, in the VA mode, when no voltage is applied, the liquid crystal molecules are vertically aligned. Accordingly, it is possible to obtain a display having little light leakage, a good black display quality, and a high contrast. Further, as compared to a TN (Twisted Nematic) mode, the liquid crystal molecules are arranged in a simpler manner because the liquid crystal molecules are not intricately twisted. Accordingly, when voltage is applied, a time for forming a state where the liquid crystal molecules are twisted is short, that is, a response speed is fast. Therefore, this VA mode has characteristics that are excellent in contrast and responsiveness.

[0004] Meanwhile, as a technique for widening a viewing angle, for example, a method of driving liquid crystals by use of a Multi-Domain design has been proposed. In the Multi-Domain design, one picture element region is divided into a plurality of sectional parts and liquid crystal molecules in each sectional part are aligned in a direction that is different for each sectional part. In this mode, in each picture element region, liquid crystal molecules aligned in different directions are present. Accordingly, a view is not limited in a specific direction. Therefore, a viewing angle can be widened.

[0005] Furthermore, in recent years, a technique called MVA (Multi-domain Vertical Alignment) in which the VA mode and the Multi-Domain design are combined has been proposed.

[0006] In an MVA liquid crystal display devices, alignment dividing means (a protrusion or a cutout section of an electrode) is formed also in an area relevant to display. Therefore, an effective display area tends to be smaller. This causes a problem such that, if the effective display area is ensured, it becomes difficult to provide a large storage capacitance.

[0007] Furthermore, in recent years, a distance between a picture element electrode and each signal line has become shorter (or an overlap amount of the picture element electrode and each signal line has become larger) due to demands for a higher aperture ratio and dot size reduction caused by an increased fineness). Therefore, a parasitic capacitance (Csd) between a picture element electrode and a data line tends to be larger with respect to a total pixel capacitance. In a case where the parasitic capacitance (Csd) between the picture element electrode and the data line becomes lager as described above, there arises a problem of deterioration in display quality, such as shadowing, uneven display within a panel plane, and the like.

[0008] In order to solve such problems, Patent Literature 1 discloses a technique in which, as shown in Fig. 14, a shield electrode 88 is provided on a protective film 180 above a data line 171 so that a parasitic capacitance (Csd) between a picture element electrode 190 and the data line 171 is reduced.

[0009] US 2008/062345 A1 discloses a liquid crystal display device including a first substrate which comprises a plurality of pixels where a thin film transistor and a pixel electrode electrically connected to the thin film transistor are formed, the first substrate including a gate line and a data line which insulatingly intersect each other; and a gate driver which applies a gate driving signal to the gate line, the thin film transistor including a gate electrode which is connected to the gate line; a source electrode which is connected to the data line; and a drain electrode which is connected to the pixel electrode, and the pixels being decreased in a value of Cp/(Cp+Clc+Cst) as going toward the gate driver (where, Cp: a sum of parasitic capacity between the gate electrode and the source electrode and parasitic capacity between the gate electrode and the drain electrode, Clc: liquid crystal capacity, and Cst:; storage capacity).

[0010] US 2004/227888 A1 discloses a liquid crystal display, which includes: a first substrate; a first signal line formed on the first substrate; a second signal line formed on the first substrate and intersecting the first signal line; a pixel electrode including a plurality of partitions; a thin film transistor connected to the gate line, the data line, and the pixel electrode; a second substrate facing the second substrate; a common electrode formed on the second substrate and having an opening facing the first or the second signal line; and first and second domain defining members that define a plurality of domains in the liquid crystal display and are dispose on the first and the second substrates, respectively, the second domain defining member disposed on the second substrate and separated from the opening.

[0011] US 6 225 967 B1 discloses a liquid-crystal display capable of reducing the required number of source drivers expensive and having large power consumption, which are used in the display, and providing a cost reduction and less power consumption of the display, and a method of driving the display. In the display, pixels for displaying one color by utilizing a plurality of fundamental colors in combination are arranged in large numbers. The large number of pixels are matrix-driven by a large number of scanning lines and a large number of signal lines. Further, the combinations of the plurality of fundamental colors are repeatedly arranged along the directions of the respective signal lines. The number of the scanning lines is set to several times the number of the fundamental colors with respect to the total number of pixels arranged along the signal lines.

[0012] US 2003/090599 A1 discloses that in a liquid crystal display device, a capacitance element uses a semiconductor layer as one electrode and is formed between the semiconductor layer and a storage capacitance line with an insulating film interposed therebetween, and a voltage which constantly brings a MOS type transistor into an ON state is applied to the storage capacitance line.

[0013] US 2007/171320 A1 discloses a pixel structure of a liquid crystal display (LCD) including a scan line, a data line and a thin film transistor (TFT) disposed on the substrate. The TFT has a source electrically connected to the date line and a gate electrically connected to the scan line. A shielding electrode disposes on the substrate, wherein the same metal layer makes the shielding electrode, the source and the drain. Furthermore, the data line makes at least two different patterned metal, layers which are not formed simultaneously and the patterned metal layers are electrically connected to each other. A pixel electrode covers the part of the shielding electrode and electrically connects to the drain.

Citation List

[Patent Literature]

[0014] [Patent Literature 1]
Japanese Patent Application Publication, *Tokukai,* No. 2005-134889 A (published on May 26, 2005)

Summary of Invention

Technical Problem

[0015] However, according to the technique disclosed in Patent Literature 1, a sufficient distance is required between the shield electrode 88 and the picture element electrode 190 for preventing a short circuit between the shield electrode 88 and the picture element electrode 190. This makes it difficult to ensure an effective display area in one picture element. This consequently causes a problem of deterioration in display quality. Further, because the shield electrode needs to be provided separately from the picture element electrode, there arises a problem such that it becomes difficult to ensure a sufficiently high process yield of an array substrate.

[0016] The present invention is attained in view of the above problems. An object of the present invention is to provide an array substrate that makes it possible to easily ensure a sufficiently high process yield as well as improving a display quality by ensuring an effective display area in one picture element, in an MVA liquid crystal display device.

Solution to Problem

[0017] The above objects are solved by the claimed matter according to the independent claims.

[0018] In order to solve the problem described above, a multi-domain liquid crystal display device according to appended claim 1 is provided.

[0019] According to the above configuration, a long side of the picture element electrode is disposed along a direction in which the plurality of scanning lines are extended and a short side of the picture element electrode is disposed along a direction in which the plurality of data lines are extended. This configuration makes it possible to reduce a proximity distance of a picture element electrode with respect to a data line as compared to a case of a picture element electrode whose long side is disposed along a direction in which the plurality of data lines are extended and whose short side is disposed along a direction in which the plurality of scanning lines are extended, which picture element electrode is longer in a vertical direction.

[0020] This makes it possible to reduce a parasitic capacitance (Csd) that is produced between the picture element electrode and the data line which parasitic capacitance (Csd) increases in proportion to the proximity distance of the picture element electrode with respect to the data line.

[0021] Further, because two corners of the picture element electrode are cut so that the two corners serve as alignment dividing means. This makes it possible to further reduce the proximity distance of the picture element electrode with respect to the data line and the proximity distance between the picture element electrode and a scanning line. As a result, parasitic capacitances (Csd, Cgd) that are produced in accordance with these proximity distances can be reduced. Here, the proximity distance of the picture element electrode with respect to the data line is a length of a portion of a side of the picture element electrode which portion is parallel to the data line on a side provided with the data line. Further, the proximity distance of the picture element electrode with respect to the scanning line is a length of a portion of a side of the picture element electrode which portion is parallel to the scanning line on a side provided with the scanning line.

[0022] According to the above description, it is possible to reduce the parasitic capacitance (Csd) that is produced between the picture element electrode and the data line and the parasitic capacitance (Cgd) that is produced between the picture element electrode and the scanning line. As a result, for reducing a ratio of the parasitic capacitance with respect to a total picture element capacitance, a large storage capacitance is not required. In other words, the above configuration makes it possible to improve display quality by eliminating shadowing while an effective display area is not reduced.

[0023] Preferably, the cut sections are at two adjacent corners of each of the picture element electrodes.

[0024] The cut sections formed at any two corners of the picture element electrode can provide the above-described effect, that is, an effect such that a ratio of the parasitic capacitance with respect to a total picture element capacitance is reduced. However, in a case where formation of multi-domain having four alignment directions is assumed, the cut sections formed to the picture element electrode are preferably formed at two adjacent corners of the picture element electrode.

[0025] Note that in a case where multi-domain having two alignment directions is assumed, the cut sections formed at two corners of the picture element electrode can be formed at two corners opposed to each other in the picture element electrode.

[0026] Each of the picture element electrodes is formed so as to cover at least a part of a scanning line for driving an adjacent picture element electrode.

[0027] According to the above configuration, the picture element electrode is formed so as to cover at least a part of a scanning line for driving an adjacent picture element electrode. Accordingly, the picture element electrode overlapping the scanning line functions as a shield electrode against an electric field of the scanning line.

[0028] This makes it possible to further reduce the parasitic capacitance (Cgd) between the picture element electrode and the scanning line.

[0029] The more the picture element electrode overlaps with the scanning line, the higher the function as a shield becomes.

[0030] A shield electrode is formed between a picture element electrode and a scanning line for driving an adjacent picture element electrode.

[0031] According to the above configuration, the shield electrode is formed between the picture element and the scanning line. Accordingly, an electric field from the scanning line toward the picture element electrode can be shielded. This makes it possible to further reduce the parasitic capacitance (Cgd) between the picture element electrode and the scanning line.

[0032] The array substrate is arranged such that:

the shield electrode is connected to a drain electrode of the switching element via a connecting electrode; the picture element electrode has a cutout section having a letter V shape, the cutout section being formed separately from the cut sections at the two corners and serving as alignment dividing means; and the connecting electrode is provided at a bent section of the cutout section.

[0033] In general, a section where alignment dividing means whose directions are different or extended lines of the alignment dividing means come in contact forms a boundary section between regions having different liquid crystal alignment directions. This section is not preferable as a display area because an alignment direction is not stable or liquid crystals are aligned in undesirable directions in this section. Meanwhile, in a case where the connecting electrode is made of a drain electrode material, a section where the connecting electrode is provided does not serve as a display area. That is, as in the above configuration, the connecting electrode is provided at the bent section of the cutout section. In other words, sections which do not function (which are not preferable) as a display area are superimposed. This makes it possible to prevent the effective display area from being reduced excessively.

[0034] When the cutout section of the picture element electrode is formed on the scanning line for driving the adjacent picture element electrode, the shield electrode may be disposed along a shape of the cutout section.

[0035] According to the above configuration, it is possible to suppress a defect in alignment that occurs in a case where the cutout section of the picture element electrode is formed on the scanning line. In other words, in a case where the cutout section is formed on the scanning line, impurity ions may be trapped in a period in which voltage is retained (in a period where a potential of the scanning line is low). As a result, a section where the impurity ions are trapped may become a peculiar point and may cause a defect in alignment of liquid crystals, that is, defect in display. Further, due to an electric field of a scanning line, liquid crystals in the vicinity of the scanning line may be aligned in a direction that is not preferable. However, by disposing the shield electrode along the shape of the cutout section as described above, the electric field of the scanning line is shielded by the shield electrode. Therefore, it is possible to prevent the defect in display.

[0036] When the cut sections of each of the picture element electrodes are formed at two adjacent corners along the corresponding scanning line, a cut distance of the short side of each of the picture element electrode is preferably 14 μm or more.

[0037] In general, when a picture element pitch indicating a distance between picture element electrodes and/or a size of the picture element electrode vary, an optimum layout of the cutout section and the protrusion for having a large effective display area also varies. In particular, in a case where a length L1 is a length from an edge of the cut section of the picture element electrode to an edge of an area where the protrusion on the counter substrate is projected onto the picture element electrode which edge of the area is on a side provided with the cut section and the length L1 is arranged to be too long, a response speed of the liquid crystals tends to deteriorate. Accordingly, in a case where the picture element electrode is large, it is possible to have an arrangement in which each of the cutout section and the protrusion are plurally provided. Therefore, for causing the cut section to serve as the alignment dividing means, a cut distance of L2 of a short side of the picture element electrode needs to be, for example, 14 μm or more as described above. By setting L2 to 14 μm or more, the parasitic capacitance (Csd) produced between the picture element electrode and the data line and the parasitic capacitance (Cgd) produced between the picture element electrode and the scanning line can be adequately reduced even in a case where various layouts of the cutout section and the protrusion that provide an appropriate response speed and an appropriate effective display area are selected freely.

[0038] The array substrate may further includes: a storage capacitance line formed in a layer where the plurality of scanning lines are formed; and a storage capacitance counter electrode formed in a layer where the plurality of data lines are formed, the storage capacitance counter electrode being connected to a drain electrode of the switching element, the storage capacitance line and the storage capacitance counter electrode being formed so as to overlap with each other via an insulating film.

[0039] According to the above configuration, because the storage capacitance line and the storage capacitance counter electrode are formed so as to be overlap each other via an insulating film, a storage capacitance can be formed in the picture element electrode.

[0040] This makes it possible to increase a total capacitance of one picture element by a storage capacitance. Accordingly, it is possible to reduce a ratio of the parasitic capacitance with respect to the total capacitance. In other words, by reducing a ratio of the parasitic capacitance with respect to the total capacitance, deterioration in level of shadowing can be prevented and an effective display area can be increased. This makes it possible to improve display quality.

Advantageous Effects of Invention

[0041] The present invention provides a multi-domain liquid crystal display device according to appended claim 1.

[0042] This makes it possible to improve display quality by ensuring an effective display area in one picture element.

Brief Description of Drawings

[0043]

Fig. 1
Fig. 1 is a schematic plan view illustrating an array substrate helpful to understand the present invention.
Fig. 2
Fig. 2 is a schematic cross sectional view illustrating a liquid crystal display device including the array substrate shown in Fig. 1.]
Fig. 3
Fig. 3 is a schematic plan view illustrating the array substrate shown in Fig. 1 from which a protrusion on a counter substrate is omitted.
Fig. 4
Fig. 4 is a cross sectional view taken along a line A-A in the direction of arrows in Fig. 3.
Fig. 5
Fig. 5 is a schematic cross sectional view of a liquid crystal display device, illustrating a configuration of Comparative Example (1) as compared to the cross sectional view shown in Fig. 4.
Fig. 6
Fig. 6 is a schematic cross sectional view of a liquid crystal display device, illustrating a configuration of Comparative Example (2) as compared to the cross sectional view shown in Fig. 4.
Fig. 7
Fig. 7 is a graph showing a relation between an overlap amount of an adjacent picture element and a parasitic capacitance per unit distance.

Fig. 8

Fig. 8 is a graph showing a relation between an overlap amount of an adjacent picture element and a parasitic capacitance per unit distance.

Fig. 9

Fig. 9 is a schematic plan view illustrating an array substrate according to an embodiment of the present invention.

Fig. 10

Fig. 10 is a cross sectional view taken along a line B-B in the direction of arrows in Fig. 9.

Fig. 11

Fig. 11 is a schematic plan view illustrating an array substrate according to another embodiment of the present invention.

Fig. 12

Fig. 12 is a schematic plan view illustrating an array substrate not according to the present invention.

Fig. 13

Fig. 13 is a schematic plan view illustrating another array substrate not according to the present invention.

Fig. 14

Fig. 14 is a schematic plan view illustrating a conventional liquid crystal display device.

Description of Embodiments

[0044] The following explains r examples helpful to understand the present invention and embodiments of the present invention. Note that the examples and embodiments explain a liquid crystal display device (hereinafter, referred to as an MVA liquid crystal display device) of an MVA (Multidomain Vertical Alignment) mode in which one picture element region is divided into a plurality of domains. Further, note that one picture element region does not indicate only a region corresponding to a picture element electrode directly connected to a switching element, but does include a region of a sub-picture element electrode connected via a coupling capacitance to a switching element or a picture element connected to the switching element. The one picture element region also includes a region in a case where the picture element electrode and the sub-picture element electrode each connected to the switching element are viewed as one unit.

[0045] As shown in Fig. 2, the MVA liquid crystal display device of the present example includes an array substrate 10 as a first substrate, a counter substrate 20 as a second substrate, a liquid crystal layer 30 that is sandwiched between the array substrate 10 and the counter substrate 20. This liquid crystal layer 30 is made of a liquid crystal material whose dielectric anisotropy is negative.

[0046] The array substrate 10 at least includes an insulating substrate 11, an interlayer insulating film 12 formed on a first surface of the insulating substrate 11, a picture element electrode 13 formed on the interlayer insulating film 12, and a polarizer 14 formed on a second surface of the insulating substrate 11 which second surface is opposite to the first surface on which the interlayer insulating film 12 is formed. Further, though not shown, the array substrate 10 is configured to include a vertical alignment film on a top surface of the array substrate 10 on a side provided with the liquid crystal layer 30.

[0047] Though not shown, on the array substrate 10, a plurality of scanning lines, a plurality of data lines, and switching elements are formed. Note that the scanning lines, the data lines, and the switching elements are explained later in detail.

[0048] A part of the picture element electrode 13 of the array substrate 10 is cut out and serves as alignment dividing means for dividing alignment of liquid crystals. Further, in the present example, in the picture element electrode 13 of the array substrate 10, cut sections 13a are formed. The cut sections 13a also serve as alignment dividing means. Note that the cut sections 13a and a cutout section (13b) of the picture element electrode 13 are explained later in detail.

[0049] The counter substrate 20 includes an insulating substrate 21, a common electrode 22 formed on a first surface of the insulating substrate 21, a polarizer 23 formed on a second surface of the insulating substrate 21 which second surface is opposite to the first surface on which the common electrode 22 is formed, and a protrusion 24 as alignment dividing means formed on the common electrode 22. Further, though not shown, the counter substrate 20 is configured to include a vertical alignment film on an outermost surface of the counter substrate 20 on a side provided with the liquid crystal layer 30.

[0050] Note that the present example shows, as an example, an arrangement in which the protrusion 24 that is a protruding structure is formed as the alignment dividing means. However, it is also possible to cause a cutout section obtained by cutting the counter electrode 22 to serve as the alignment dividing means. A shape of the protrusion 24 is not limited to a shape shown in Fig. 2. For example, the protrusion 24 may have a triangular cross section or trapezoidal cross section.

[0051] As shown in Fig. 1, the array substrate 10 is configured as follows. That is, on the array substrate 10, a plurality of data lines 1 and a plurality of scanning line 2 are provided so as to intersect each other. At each intersection of the data lines 1 and the scanning lines 2, a switching element 5 is formed. The picture element electrode 13 is connected to a drain electrode 5a of each switching element 5. These lines and electrodes are fabricated by the same method as a method for fabricating a general array substrate used for an MVA liquid crystal display device. A position of the switching element 5 is not specifically limited. In the present example, the switching element 5 is provided in an area that does not contribute to display, that is, at each intersection of the data lines 1 and the scanning lines 2 so that an effective display area is not decreased.

[0052] Further, the array substrate 10 has a storage capacitance that is formed by superimposing a storage capacitance line 3 and a storage capacitance counter electrode 4 via an insulating film (not shown). The storage capacitance line 3 is formed in the same layer as the scanning lines 2. The storage capacitance counter electrode 4 is formed in the same layer as the data lines 1 and connected to a drain electrode 5a of the switching element 5. Here, when viewed in one plane, preferably, a storage capacitance formation section 6 in which the storage capacitance is formed overlaps with the protrusion 24 (a member indicated by a broken line in Fig. 1) as alignment dividing means on the counter substrate 20 for the purpose of obtaining a larger effective display area.

[0053] Here, the following explains the picture element electrode 13 in detail.

[0054] As shown in Fig. 1, the picture element electrode 13 has a substantially rectangular shape and disposed so that a long side of the picture element electrode 13 is in a direction in which the scanning lines 2 are extended and a short side thereof is in a direction in which the data lines 1 are extended. Further, two corners of the picture element electrode 13 are cut so as to form the cut sections 13a on a side provided with a corresponding scanning line 2 that drives the picture element electrode 13.

[0055] Each of the cut sections 13a is obtained by cutting the picture element electrode 13 so that each of the cut section 13a has a slope that is substantially parallel to a slope of the protrusion 24 provided on the counter substrate 20. Therefore, the cut sections 13a serve as alignment dividing means.

[0056] Further, separately from the cut sections 13a, the picture element electrode 13 is provided with the cutout section 13b that serves as alignment dividing means. This cutout section 13b is formed in a substantially letter V shape, by cutting the picture element electrode 13 so that the cut section 13b serves as the alignment dividing means and has a slope that is substantially parallel to the slope of the protrusion 24.

[0057] In addition, the picture element electrode 13 overlaps a scanning line 2 that corresponds to an adjacent picture element electrode 13. Note that, preferably, the picture element electrode 13 is formed so as to cover this scanning line 2 completely over a width of the scanning line 2.

[0058] In this way, by optimizing positions of cut sections (the cut sections 13a and the cutout section 13b) of the picture element electrode 13 that are used as the alignment dividing means necessary for an MVA liquid crystal display device, proximity distances of the picture element electrode 13 for which proximity distance the picture element electrode 13 is close to the scanning line 2 and the data line 1 can be reduced. This consequently makes it possible to reduce a parasitic capacitance.

[0059] The following describes effects of reducing the proximity distance in each point of the present invention.

[0060] Generally, in a liquid crystal display device for color display, at least three picture elements as a set including a Red picture element, a Green picture element, and a Blue picture element form one substantially square pixel. Accordingly, one picture element has a substantially rectangular shape.

[0061] Here, if a long side direction of the picture element electrode is arranged to be in a direction in which a data line is extended, a parasitic capacitance (Csd) between the picture element electrode and the data line becomes large. A ratio (= Csd / Cpix) of Csd to a total capacitance Cpix (a sum of a liquid crystal capacitance, a storage capacitance, and a parasitic capacitance) of one picture element relates to a degree of influence that liquid crystal application voltage receives due to a change in potential of the data line in a period in which the picture element electrode retains voltage.

[0062] More specifically, a level of shadowing deteriorates as the Csd/Cpix increases. In recent years, because of demands for a reduced dot size arising from an increased fineness and for a higher aperture ratio, a distance between a picture element electrode and each signal line has become shorter (or an overlap amount of the picture element electrode and each signal line increases). Accordingly, Csd tends to be larger. Further, in an MVA liquid crystal display device, the alignment dividing means (e.g., a protruding structure on the counter substrate, and/or the like) makes it difficult to have a large effective display area. Therefore, in a high-luminance and low-power-consumption display device that requires a higher aperture ratio, it is difficult to have a large storage capacitance. As a result, the Csd/Cpix tends to be larger.

[0063] In order to solve the above problem, according to the array substrate 10 of the above configuration, as shown in Fig. 3, a short side of the picture element electrode 13 is arranged to be in a direction in which the data lines 1 are extended and the cut sections 13a of the picture element electrode 13 serving as alignment dividing means are provided on respective sides of the picture element electrode 13 each of which respective sides is provided with a data lines 1. Accordingly, it is possible to shorten a proximity distance D2 of the picture element electrode 13 with respect to the data line 1 and consequently to reduce Csd.

[0064] For example, in a case where a picture element pitch shown in Fig 3 is 190.5 μm $\times$ 63.5 and a size of the picture element electrode 13 is 173.5 μm $\times$ 58.5 μm, the proximity distance D2 of the picture element electrode 13 with respect to the data line 1 is 28.25 μm.

[0065] Meanwhile, the picture element electrode 13 having the above-described picture element size is disposed so that a long side of the picture element electrode 13 is in a vertical direction, the proximity distance of the picture element electrode 13 with respect to the data line 1 becomes 173.5 μm.

[0066] As described above, a long side of the picture element electrode 13 is disposed along a direction in which the scanning lines 2 are extended and a short side of the picture element electrode 13 is disposed along a direction in which the data lines 1 are extended. As a result, the proximity distance of the picture element electrode 13 with respect to the data line 1 is significantly reduced and becomes approximately 1/6 as compared to a case where the picture element electrode 13 is longer in the vertical direction, that is, a long side of the picture element electrode 13 is disposed along a direction in which the data lines 1 are extended and a short side of the picture element electrode 13 is disposed along a direction in which the scanning lines 2 are extended. Further, Csd is also reduced in accordance with the ratio of approximately 1/6. In other words, even in a case where a storage capacitance of the same size (having the same aperture ratio) is provided, display quality in regard to shadowing or the like can be improved by arranging the picture element electrode 13 as shown in Fig. 3.

[0067] Note that in a case where the picture element electrode 13 is provided so as to be longer sideways, a proximity distance D1 of the picture element electrode 13 with respect to the scanning line 2 becomes longer and a parasitic capacitance (Cgd) between the picture element electrode 13 and the scanning line 2 tends to be larger. The Cgd/Cpix is also a parameter that influences display quality. More specifically, a certain level of the Cgd/Cpix causes flickering and/or appearance of uneven luminance blocks.

[0068] Accordingly, for reducing a trade-off caused by reduction of Csd, in the array substrate 10 of the above configuration, as shown in Fig. 3, the cut sections 13a of the picture element electrode 13 as alignment dividing means are provided on a side provided with the scanning line 2 for driving the picture element electrode 13. This makes it possible to shorten the proximity distance D1 of the picture element electrode 13 with respect to the scanning line 2. Therefore, it is possible to reduce Cgd.

[0069] However, even in a case where the picture element electrode 13 is provided with the cut sections 13a as the alignment dividing means, the proximity distance D2 of the picture element electrode 13 with respect to the scanning line 2 becomes 113 μm if a size of the picture element electrode 13 is 173.5 μm × 58.5 μm. This is longer than the proximity distance D2 of 58.5 μm of the picture element electrode 13 with respect to the scanning line 2 in a case where the picture element electrode 13 of the above size (173.5 μm × 58.5 μm) is disposed so that the picture element electrode 13 is longer in a vertical direction.

[0070] Accordingly, in the array substrate 10, by overlapping the picture element electrode 13 on an adjacent scanning line 2, the picture element electrode 13 is caused to function as a shield electrode against an electric field of the adjacent scanning line 2. In this way, the parasitic capacitance (Cgd) between the picture element electrode 13 and the scanning line 2 is reduced.

[0071] The following explains a degree of shielding effects obtained against an electric field of the scanning line 2 by overlapping the picture element electrode 13 onto the adjacent scanning line 2 and a degree of reduction in Cgd as a result of the shielding effects, with reference to a simulation.

[0072] Here, conditions for the simulation is as shown in Table 1 (For the simulation, "2din-DIMOS" manufactured by AUTORONIC-MELCHERS GmbH is used).

[Table 1]

Dielectric Constant			Film Thickness			Potential	
Gate Insulating Film	6.9		Gate Insulating Film	0.4um		Scanning Line	-10V
Protective Film	6.9		Protective Film	0.3um		Common Electrode	±0V
Glass Substrate	5.5		Scanning Line	0.35um		Driving Pixel Electrode	+5V
Liquid Crystal Layer	5.0		Liquid Crystal Layer	3.2um		Adjacent Pixel Electrode	-5V
Interlayer Insulating Film	3.4		Interlayer Insulating Film	3.0um			

[0073] Fig. 4 is a cross sectional view taken along a line A-A of the array substrate 10 in the direction of arrows in Fig. 3. That is, Fig. 4 is a cross sectional view of the array substrate 10 having a structure in which an adjacent picture element electrode 13 overlaps the scanning line 2. This configuration is called a configuration of the present application.

[0074] In Fig. 4, in the configuration of the present application, an overlap amount D3 of the adjacent picture element electrode 13 onto the scanning line 2 is 10 μm (the adjacent element electrode 13 is extended by 5 μm over the scanning line 2 having a line width of 5 μm), and a distance D4 between an edge of the scanning line 2 and an edge of the picture element electrode 13 is 10 μm. In this configuration, a parasitic capacitance per unit distance is 1.49×10^{-11} F/m.

[0075] Fig. 5 is a cross sectional view of an array substrate 10 having a configuration in which, unlike the configuration of the present invention, the adjacent picture element electrode 13 does not overlap the scanning line 2 and an aperture ratio of the same level as that of the configuration of the present invention is expected. This configuration is referred to as a configuration of Comparative Example (1).

[0076] In Fig. 5, according to the configuration of Comparative Example (1), the overlap amount D3 of the adjacent picture element electrode 13 onto the scanning line 2 is 0 μm and the distance D4 between the edge of the scanning line 2 and the edge of the picture element electrode 13 is 10 μm. According to this configuration, a parasitic capacitance per unit distance is 1.78×10^{-11} F/m.

[0077] Fig. 6 is a cross sectional view of an array substrate 10 having a configuration in which, unlike the configuration of the present invention, the adjacent picture element electrode 13 does not overlap the scanning line 2 and an aperture ratio of the same level as that of the configuration of the present invention is expected. This configuration is referred to as a configuration of Comparative Example (2).

[0078] In Fig. 6, according to the configuration of Comparative Example (2), the overlap amount D3 of the adjacent picture element electrode 13 onto the scanning line 2 is -5 μm (a configuration in which both the picture element electrode 13 to be driven and the adjacent picture element electrode 13 are apart from the scanning line 2 and a distance between the picture element electrode 13 and the scanning line 2 is 5 μm) and the distance D4 between the edge of the scanning line 2 and the edge of the picture element electrode 13 is 5 μm. According to this configuration, a parasitic capacitance per unit distance is 3.17×10^{-11} F/m.

[0079] Fig. 7 is a graph showing a relation of the overlap amount of the adjacent picture element electrode 13 onto the scanning line 2, the distance between the edge of the scanning line 2 and the edge of the picture element electrode 13, and the parasitic capacitance per unit distance. Further, Table 2 shows numerical value data at the time when the relation of Fig. 7 is established.

[Table 2]

Overlap Amount of Adjacent Pixel	[um]	-5.0	-2.5	-1.0	0.0	1.0	2.5	4.0	5.0	6.0	7.5	10.0
Distance Between Scanning Line Edge and Pixel Edge	[um]	5.0	7.5	9.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Parasitic Capacitance Per Unit Distance	[$\times 10^{-11}$F/m]	3.17	2.35	1.98	1.78	1.77	1.75	1.72	1.67	1.63	1.57	1.49

[0080] According to the description above, in the configuration of the present invention, it is possible to reduce the parasitic capacitance Cgd by approximately 16% with respect to the configuration of Comparative Example (1) and to reduce the parasitic capacitance by approximately 53 % with respect to the configuration of Comparative Example (2).

[0081] In the configuration of the present invention, the cut sections 13a of the picture element electrode 13 are provided on a side provided with the scanning line 2 for driving the picture element electrode 13. However, the proximity distance D2 of the picture element electrode 13 with respect to the scanning line 2 is longer as compared to a conventional pixel shape that is longer in a vertical direction. More specifically, the proximity distance D2 of the picture element electrode 13 with respect to the scanning line 2 becomes longer from 58.5 μm of the conventional shape that is longer in the vertical direction to 113 μm.

[0082] Though the parasitic capacitance Cgd becomes larger in accordance with a length of the proximity distance D2, it is possible to reduce a trade-off that is an increase in Cgd by overlapping the adjacent picture element electrode 13 onto the scanning line 2 and causing the adjacent picture element electrode 13 to serve as a shield electrode.

[0083] Here, the comparisons of Figs. 4, 5, and 6 are a simulation result in a case where the aperture ratio is arranged to be identical. However, in this case, the "distance D4 between the edge of the scanning line 2 and the edge of the picture element electrode 13" which distance D4 is one of parameters of the parasitic capacitance (Cgd) between the picture element electrode 13 and the scanning line 2 is not fixed.

[0084] Therefore, for checking the shielding effects of the picture element electrode 13, the distance D4 between the edge of the scanning line 2 and the edge of the picture element electrode 13 are fixed at 10 μm. This 10 μm indicates D4 set in the array substrate 10 of the present example. Fig. 8 is a graph showing a result of simulating a relation of the overlap amount of the adjacent picture element electrode 13 onto the scanning line 2, the distance between the edge of the scanning line 2 and the edge of the picture element electrode 13, and the parasitic capacitance per unit distance in the case where D4 is fixed to 10 μm. Further, Table 3 shows numerical value data at the time when the relation of Fig. 8 is established.

[Table 3]

Overlap Amount of Adjacent Pixel	[um]	-5.0	-2.5	-1.0	0.0	1.0	2.5	4.0	5.0	6.0	7.5	10.0
Distance Between Scanning Line Edge and Pixel Edge	[um]	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Parasitic Capacitance Per Unit Distance	[$\times 10^{-11}$F/m]	1.80	1.79	1.78	1.78	1.77	1.75	1.72	1.67	1.63	1.57	1.49

[0085] It is clear from the graph of Fig. 8 that, as an overlap amount of the adjacent picture element electrode 13 onto the scanning line 2 increases, the parasitic capacitance gradually decreases.

[0086] It is also clear that even if the adjacent picture element electrode 13 completely exceeds the width of the scanning line 2, the parasitic capacitance can be reduced by further increasing an amount at which the adjacent picture element electrode 13 extends over the scanning line 2.

[0087] That is, in a case where the adjacent picture element electrode 13 and the scanning line 2 overlap with each other at least when the adjacent picture element electrode 13 and the scanning line 2 are viewed in one plane, shielding effects can be obtained. It is clear that, desirably, the adjacent picture element electrode 13 completely covers the scanning line 2 and an amount at which the adjacent picture element electrode 13 extends over the scanning line 2 is increased for obtaining a stronger shielding effect.

[0088] Note that in the configuration of the present invention, by overlapping the adjacent picture element electrode 13 onto the scanning line 2, the shielding effects are obtained. However, according to an embodiment of the present invention, in addition to the overlap of the picture element electrode 13, a shielding electrode 17 is provided on the scanning line 2 as shown in Fig. 9.

[0089] The following explains a case where the shield electrode 17 is provided on the scanning line 2.

[0090] Fig. 9 is a schematic plan view illustrating an array substrate 110 of a multi-domain LCD device according to a first embodiment of the present invention. The array substrate 110 is configured in the substantially same manner as the array substrate 10 shown in Fig. 1 except that the shield electrode 17 is disposed on the scanning line 2. Fig. 10 is a cross sectional view taken along a line B-B of the array substrate 110 in the direction of arrows in Fig. 9.

[0091] As shown in Fig. 10, the shield electrode 17 is provided between the picture element electrode 13 and the scanning line 2 in a cross section. More specifically, the shield electrode 17 is provided in the same layer as the data line 1 (Fig. 9).

[0092] As shown in Fig. 9, the shield electrode 17 is electrically connected with a drain electrode 5a of the switching element 5 via a shield electrode connecting electrode 18. Desirably, the shield electrode connecting electrode 18 is provided at a bent section of the cutout section 13b of the picture element electrode 13 as alignment dividing means.

[0093] In general, a section where alignment dividing means whose directions are different or extended lines of the alignment dividing means come in contact forms a boundary section between regions having different liquid crystal alignment directions. This section is not preferable as a display area because an alignment direction is not stable or liquid crystals are aligned in undesirable directions in this section. Meanwhile, in a case where the connecting electrode is made of a drain electrode material, a section where the connecting electrode is provided does not serve as a display area. That is, as in the above configuration, the shield electrode connecting electrode 18 is provided at the bent section of the cutout section 13b. In other words, sections which do not function (which are not preferable) as a display area are superimposed. This makes it possible to prevent the effective display area from being reduced excessively.

[0094] As described above, by additionally providing the shield electrode 17, Cgd can be reduced as compared to a configuration (for example, configurations shown in Figs. 5 or 6) in which the scanning line 2 does not overlap the adjacent picture element electrode 13. This makes it possible to further reduce a trade-off that is an increase in Cgd in a configuration in which the picture element is disposed so as to be longer in a vertical direction.

[0095] More specifically, according to the configuration shown in Fig. 10, a parasitic capacitance per unit distance is 0.74×10^{-11} F/m. As compared to the configuration of Comparative Example (1) shown in Fig. 5 described above, the parasitic capacitance Cgd can be reduced by approximately 58 %. Further, as compared to the configuration of Fig. 6 described above, the parasitic capacitance Cgd can be reduced by approximately 77 %.

[0096] Note that a shape of the shield electrode 17 may be, for example, a shape of a shield electrode 19 that follows the shape of the cutout section 13b serving as the alignment dividing means of the picture element electrode 13, as shown in Fig. 11. There are various variations for the shape of the shield electrode 17.

[0097] As described above, in a form where the shield electrode 19 is disposed so as to follow the shape of the cutout section 13b, the following effects can also be obtained in addition to the reduction of Cgd.

[0098] In general, in a highly fine display device, there is a case where a layout of the alignment dividing means is limited and the cutout section 13b of the picture element electrode 13 is formed on the scanning line 2. In this case, in a period in which voltage is retained (in a period where a potential of the scanning line 2 is low), impurity ions are trapped. A section where the impurity ions are trapped becomes a peculiar point and may cause a defect in alignment of liquid crystals, that is, defect in display. Further, due to an electric field of a scanning line, liquid crystals in the vicinity of the scanning line may be aligned in an undesirable direction.

[0099] However, as shown in Fig. 11, by forming the shield electrode 19 so as to follow the shape of the cutout section 13b of the picture element electrode 13, the electric field of the scanning line 2 can be shielded. Accordingly, the defect in display can be suppressed.

[0100] Here, the following explains a size of the picture element electrode 13, with reference to Fig. 1.

[0101] As described above, the size of the whole picture element electrode 13 is arranged to be as follows: a long side along a direction in which the scanning line 2 is extended × a short side along a direction in which the data line 1 is extended = 173.5 μm × 58.5 μm; the proximity distance D1 of the picture element electrode 13 with respect to the scanning line 2 for driving this picture element electrode 13 is arranged to be 113 μm; and the proximity distance D2 of the picture element electrode 13 with respect to the data line 1 is arranged to be 28.25 μm.

[0102] Further, on assumption that a length L1 is a length from an edge of a cut section 13a of the picture element electrode 13 to an edge of an area where the protrusion 24 on the counter substrate 20 is projected onto the picture element electrode 13 which edge of the area is on a side provided with the cut section 13a, the length L1 is arranged to be 22 μm. A width L3 of the area on which the protrusion 24 is projected is arranged to be 11 μm. A width L4 of the cutout section 13b of the picture element electrode 13 is arranged to be 9 μm. A length L2 that is obtained by subtracting 1 from a length of a short side of the picture element electrode 13 is arranged to be 30.25 μm. A line width L5 of the data line 1 is arranged to be 5 μm. A line width L6 of the scanning line 2 is arranged to be 5 μm.
The above configuration makes it possible to significantly reduce Csd and Cgd.

[0103] In particular, if the length L1 is long, there is an advantage such that an aperture section of the picture element electrode 13 can be large. However, the long L1 makes both D1 and D2 long. Therefore, even in a case where L1 is arranged to be long, it is possible to reduce Csd.

[0104] For example, Fig. 12 shows a configuration in which L1 is arranged to be longer than L1 of Fig. 1 (22 μm is increased to 28 μm) and the effective display area of the picture element electrode 13 is arranged to be large. In this case, the length L2 obtained by subtracting D1 from the length of the short side of the picture element electrode 13 is 14 μm which is short. Further, a length of the cut section serving as the alignment dividing means also becomes short. However, even in such a configuration, it is possible to obtain a display of a high viewing angle.

[0105] In the above case, the proximity distance D1 between the data line 1 and the picture element electrode 13 becomes 44.5 μm which is longer than that in a case where L1 is 22 μm. However, it is possible to reduce Csd.

[0106] Note that when a picture element pitch and/or a size of the picture element electrode 13 vary, an optimum layout of the cutout section 13b and the protrusion 24 for having a large effective display area also varies. In particular, in a case where L1 is arranged to be too long, a response speed of the liquid crystals tends to deteriorate. Accordingly, in a case where the picture element electrode 13 is large, it is possible to have an arrangement in which each of the cutout section 13b and the protrusion 24 is plurally provided. Therefore, while a length of L2 (for example, L2 = 14 μm as in Fig. 12) at which the cut section serves as the alignment dividing means is ensured, it is possible to have various layouts of the cutout section 13b and the protrusion 24 which layouts makes it possible to have an appropriate response speed and an appropriate effective display area. Even in such various layouts, according to the present invention, Csd and Cgd can be reduced.

[0107] Here, in the array substrate 10 shown in Fig. 1, a contact hole 12a is a connecting hole provided through the interlayer insulating film 12, for electrically connecting the picture element electrode 13 with the drain electrode 5a of the switching element 5. The interlayer insulating film 12 has a film thickness of approximately 1 μm to 4 μm. This film thickness is not negligible in view of a cell thickness of approximately 3 μm to 5 μm of a liquid crystal layer. Accordingly, alignment of liquid crystals around the contact hole 12a tends to be disordered. This becomes a cause of deterioration in display quality.

[0108] As an example for solving the above problem, Fig. 13 shows an exemplary configuration of an array substrate that makes it possible to improve the above problem. Fig. 13 shows a modified example of the configuration of Fig. 1. In other words, an array substrate 310 shown in Fig. 13 is different from the configuration of Fig. 1 in that: (i) fine slits are additionally formed to the picture element electrode 13 of the array substrate 10 as shown in Fig. 1; and (ii) a position of the contact hole is changed.

[0109] In the array substrate 310 shown in Fig. 13, first, the contact hole 12a is formed in a position that is farther from the cutout section 13b. In the present example, the alignment dividing means of the counter substrate is arranged to be the protrusion 24 and in general, alignment regulation force caused by a fringe field of the cutout section 13b is weaker than alignment regulation force produced by the protrusion 24. Therefore, in a case where the contact hole 12a is close to the cutout section 13b, it is difficult to control disorder of alignment in a section where the contact hole 12a is formed. For suppressing the disorder in alignment, it is preferable to arrange a distance between the contact hole 12a and the protrusion 24 to be shorter than a distance between the contact hole and the cutout section 13b.

[0110] Further, in the array substrate 310 as shown in Fig. 13, an assistant slit (A) 13c is formed to the picture element electrode 13. The assistant slit (A) 13c is a slit formed to the cutout section 13b that is close to the contact hole 12a. This assistant slit (A) 13c is formed to extend in a direction that is substantially the same as a preferable alignment direction of liquid crystals, that is, a direction that is substantially orthogonal to a direction in which the cutout section 13b extends. Here, in a case where a width of the assistant slit (A) 13c is too wide, the liquid crystals are aligned in a direction that is not preferable, in other words, in a direction that is perpendicular to the assistant slit (A) 13c. Accordingly, preferably, the assistant slit (A) 13c has a width of approximately 2 μm to 4 μm. Further, preferably, a distance between adjacent assistant slits (A) 13c is also approximately 2 μm to 4 μm.

[0111] In the present example, in addition to the assistant slit (A) 13c, as shown in Fig. 13, an assistant slit (B) 13d is provided to a periphery section of the picture element electrode 13. By having such a configuration, the liquid crystals can be more stably aligned and display quality can be further improved. Note that, like the assistant slit (A) 13c, this assistant slit (B) 13d is formed so as to extend in a direction that is substantially the same as the alignment direction of the liquid crystals, in other words, in a direction that is substantially orthogonal to the direction in which the cutout section 13b extends.

[0112] As described above, by forming the assistant slit (A) 13c and the assistant slit (B) 13d to the picture element electrode 13, it is possible to control the disorder in alignment of the liquid crystals around the contact hole 12a. As a result, display quality can be improved.

[0113] The present invention is not limited to the desc ription of the embodiments above, but may be altered by a skilled person within the scope of the claims.

Industrial Applicability

[0114] The present invention is effective as a technique for improving display quality of an MVA liquid crystal display device and for reducing an implementation cost. In particular, the present invention is effective specifically in a liquid crystal display device provided in middle-size mobile products such as in-vehicle products, photo frames, IAs (Industrial Applianc), and PCs (Personal Computers).

Reference Signs List

[0115]

1	data line
2	scanning line
3	storage capacitance line
4	storage capacitance counter electrode
5	switching element
5a	drain electrode
6	storage capacitance formation section
10	array substrate
11	insulating substrate
12	interlayer insulating film
13	picture element electrode
13a	cut section
13b	cutout section
14	polarizer
17	shield electrode
18	shield electrode connecting electrode
19	shield electrode
20	counter substrate
21	insulating substrate
22	common electrode
23	polarizer
24	protrusion
30	liquid crystal layer
110	array substrate
D1	proximity distance
D2	proximity distance
D3	overlap amount
D4	distance

Claims

1. A multi-domain vertical alignment liquid crystal display device in which the region of each picture element is divided into a plurality of domains and the liquid crystal molecules are aligned in directions that are different in respective domains, wherein the multi-domain liquid crystal display device comprises an array substrate (10, 110, 210, 310) comprising:

an insulating substrate (11);
a plurality of scanning lines (2) on the insulating substrate (11);
a plurality of data lines (1) each disposed so as to intersect the plurality of scanning lines (2) on the insulating substrate (11), each intersection of a data line (1) with a scanning line (2) being associated with a respective picture element region;
a picture element electrode (13) formed in each picture element region, the picture element electrodes (13) being each formed in a substantially rectangular shape, each picture element electrode (13) being connected, via a respective switching element (5), to a corresponding scanning line (2) and a corresponding data line (1), the picture element electrodes (13) each having a long side disposed along the direction in which the plurality of scanning lines (2) extend and a short side disposed along the direction in which the plurality of data lines (1) extend, and a cutout section (13b) formed by a V-shaped cutout and serving as liquid crystal alignment dividing means, 20 **characterized in that**
each picture element electrode (13) has two cut sections (13a) formed by two cut corners, the cutout section (13b) being formed separate from the cut corners, the corner cut sections (13a) also serving as liquid crystal alignment dividing means, and
each picture element electrode (13) is formed so as to cover at least a part of a scanning line (2) associated with the driving of a directly adjacent picture element electrode (13) of the same picture element column, wherein, in each picture element region, the array substrate (10, 110, 210, 310) further comprises
a shield electrode (17, 19) formed in cross-sectional view between the respective picture element electrode (13) and a scanning line (2) associated with the driving of an adjacent picture element electrode (13) of the same picture element column, said shield electrode (17, 19) shielding the respective picture element electrode (13) from an electric field originating from said scanning line (2) associated with the driving of said adjacent picture element electrode (13) of the same picture element column, wherein
the shield electrode (17, 19) is connected to the drain electrode (5a) of the respective switching element (5) of the picture element via a connecting electrode (18); and
the connecting electrode (18) is provided so as to overlap the bent section of the respective V-shaped cutout section (13b) in plan view.

2. The multi-domain vertical alignment liquid crystal display device as set forth in claim 1, wherein:

the cut sections (13a) are formed at two adjacent corners of each of the picture element electrodes (13).

3. The multi-domain vertical alignment liquid crystal display device as set forth in claim 1, wherein:

a slit (13c) is formed at an edge section of each cutout section (13b), the slit being formed along a direction substantially orthogonal to the direction in which liquid crystals are aligned.

4. The multi-domain vertical alignment liquid crystal display device as set forth in claim 1, wherein:

when the cutout section (13b) of the picture element electrode (13) is formed on the scanning line (2) associated with the driving of the adjacent picture element electrode (13), the shield electrode (19) is disposed along the shape of the cutout section (13b).

5. The multi-domain vertical alignment liquid crystal display device as set forth in claim 1, wherein:

when the cut sections (13a) of each of the picture element electrodes (13) are formed at two adjacent corners along the corresponding scanning line (2), the length (L2) of each of the cut sections (13a) in the direction in which the plurality of data lines (1) extend is 14 μm or more.

6. The multi-domain vertical alignment liquid crystal display device as set forth in claim 1, further comprising:

a storage capacitance line (3) formed in a layer where the plurality of scanning lines (2) are formed; and
a storage capacitance counter electrode (4) formed in a layer where the plurality of data lines (1) are formed, the storage capacitance counter electrode (4) being connected to a drain electrode (5a) of the switching element

(5),
the storage capacitance line (3) and the storage capacitance counter electrode (4) being formed so as to overlap with each other via an insulating film.

7. The multi-domain vertical alignment liquid crystal display device as set forth in any one of claims 1 to 6, comprising a liquid crystal panel including liquid crystals sandwiched between a counter substrate (20) and the array substrate (10, 110, 210, 310).

8. The multi-domain vertical alignment liquid crystal display device as set forth in claim 7, wherein:

a plurality of contact holes (12a) is formed through an interlayer insulating film (12) of the array substrate (10, 110, 210, 310) for electrically connecting each of the picture element electrodes (13) with a drain electrode (5a) of the corresponding switching element (5), wherein
the counter substrate (20) is provided with a protrusion (24) serving as alignment dividing means; and wherein, when viewed in plan view, the distance between the protrusion (24) and the contact hole (12a) is shorter than the distance between the contact hole (12a) and the cutout section (13b) formed in the picture element electrode (13).

9. An electronic device comprising the multi-domain vertical alignment liquid crystal display device as set forth in any one of claims 1 to 6.

Patentansprüche

1. Flüssigkristallanzeige mit vertikaler Ausrichtung in mehreren Bereichen (MVA LCD), in welcher das Gebiet jedes Bildelementes in eine Vielzahl von Bereichen geteilt ist und die Flüssigkristallmoleküle ausgerichtet sind in Richtungen, welche in den entsprechenden Bereichen unterschiedlich sind, wobei die Flüssigkristallanzeige mit vertikaler Ausrichtung in mehreren Bereichen ein Matrixsubstrat (10, 110, 210, 310) umfasst, welches umfasst:

ein isolierendes Substrat (11);
eine Vielzahl von Abtastzeilen (2) an dem isolierenden Substrat (11);
eine Vielzahl von Datenzeilen (1), die jeweils so angeordnet sind, dass diese die Vielzahl der Abtastzeilen (2) an dem isolierenden Substrat (11) schneiden, wobei jeder Schnitt einer Datenzeile (1) mit einer Abtastzeile (2) mit einem entsprechenden Bildelementbereich verknüpft ist;
eine Bildelementelektrode (13), welche in jedem Bildelementbereich ausgebildet ist, wobei die Bildelementelektroden (13) jeweils in einer im Wesentlichen rechteckigen Form ausgebildet sind, wobei jede Bildelementelektrode (13) über ein entsprechendes Schaltelement (5) mit einer korrespondierenden Abtastzeile (2) und einer korrespondierendem Datenzeile (1) verbunden ist,
wobei die Bildelementelektroden (13) jeweils eine Längsseite haben, welche entlang der Richtung, in der sich die Vielzahl von Abtastzeilen (2) erstrecken, angeordnet sind und eine kurze Seite angeordnet entlang der Richtung, in der sich die Vielzahl von Datenzeilen (1) erstrecken, und ein ausgeschnittener Bereich (13b), welcher durch einen V-förmigen Ausschnitt gebildet wird und als Mittel zur Teilung der Flüssigkristallausrichtung dient,
dadurch gekennzeichnet, dass
jede Bildelementelektrode (13) zwei ausgeschnittene Bereiche (13a), gebildet durch zwei abgeschnittene Ecken, aufweist, wobei der ausgeschnittene Bereich (13b) separat von den abgeschnittenen Ecken geformt ist, wobei die ausgeschnittenen Eckbereiche (13a) ebenfalls als Mittel zur Teilung der Flüssigkristallausrichtung dienen und die Bildelementelektrode (13) so ausgebildet ist, dass diese wenigstens einen Teil einer Abtastzelle (2) bedeckt, welche assoziiert ist mit der Ansteuerung einer direkt benachbart gelegenen Bildelementelektrode (13) der gleichen Bildelementspalte, wobei das Matrixsubstrat (10, 110, 210, 310) in jedem Bildelementbereich des Weiteren eine Abschirmungselektrode (17, 19) umfasst, welche in einer Schnittansicht ausgebildet ist zwischen der entsprechenden Bildelementelektrode (13) und einer Abtastzeile (2), welche assoziiert ist mit der Ansteuerung einer benachbarten Bildelementelektrode (13) der gleichen Bildelementspalte, wobei besagte Abschirmelektrode (17, 19) die entsprechende Bildelementelektrode (13) von einem elektrischen Feld abschirmt, welches von besagter Abtastzeile (2), welche assoziiert ist mit der Ansteuerung der besagten benachbarten Bildelektrode (13) der gleichen Bildelementspalte, herrührt, wobei die Abschirmelektrode (17, 19) über eine Verbindungselektrode (18) mit der Drainelektrode (5a) des entsprechenden Schaltelements (5) des Bildelementes verbunden ist und

die Verbindungselektrode (18) so angeordnet ist, dass diese den gebogenen Bereich des entsprechenden V-förmigen Ausschnittbereichs (13b) in der Draufsicht überdeckt.

2. Flüssigkristallanzeige mit vertikaler Ausrichtung in mehreren Bereichen nach Anspruch 1, wobei:

die ausgeschnittenen Bereiche (13a) an zwei benachbarten Ecken jeder der Bildelementelektroden (13) gebildet sind.

3. Flüssigkristallanzeige mit vertikaler Ausrichtung in mehreren Bereichen nach Anspruch 1, wobei:

ein Schlitz (13c) an einem Eckbereich jedes ausgeschnittenen Bereichs (13b) ausgebildet ist, wobei der Schlitz entlang einer Richtung im Wesentlichen orthogonal zu der Richtung, in welcher die Flüssigkristalle ausgerichtet sind, ausgebildet ist.

4. Flüssigkristallanzeige mit vertikaler Ausrichtung in mehreren Bereichen nach Anspruch 1, wobei:

der ausgeschnittene Bereich (13b) der Bildelementelektrode (13) ausgebildet ist an der Abtastzeile (2), welche assoziiert ist mit dem Ansteuern der benachbarten Bildelementelektrode (13), wobei die Abschirmungselektrode (19) angeordnet ist entlang der Kontur des ausgeschnittenen Bereichs (13b).

5. Flüssigkristallanzeige mit vertikaler Ausrichtung in mehreren Bereichen nach Anspruch 1, wobei:

wenn die ausgeschnittenen Bereiche (13a) jeder der Bildelementelektroden (13) an zwei benachbarten Ecken entlang der entsprechenden Abtastzeile (2) gebildet werden, die Länge (L2) jeder der ausgeschnittenen Bereiche (13a) in der Richtung, in der die Vielzahl der Datenzeilen (1) sich erstreckt, 14 μm oder mehr beträgt.

6. Flüssigkristallanzeige mit vertikaler Ausrichtung in mehreren Bereichen nach Anspruch 1, weiter umfassend:

eine Speicher-Kapazitäts-Zeile (3), ausgebildet in einer Schicht, in der die Vielzahl von Abtastzeilen (2) gebildet sind und eine Speicher-Kapazitäts-Gegenelektrode (4), ausgebildet in einer Schicht, in der die Vielzahl von Datenzeilen (1) gebildet sind, wobei die Speicher-Kapazitäts-Gegenelektrode (4) verbunden ist mit einer Drainelektrode (5a) des Schaltelements (5), wobei die Speicher-Kapazitäts-Zeile (3) und die Speicher-Kapazitäts-Gegenelektrode (4) so ausgebildet sind, dass diese sich jeweils über einen Isolierfilm überlappen.

7. Flüssigkristallanzeige mit vertikaler Ausrichtung in mehreren Bereichen nach einem der Ansprüche 1 bis 6, umfassend ein Flüssigkristallpanel umfassend Flüssigkristalle, welche eingefasst sind zwischen einem Gegensubstrat (20) und dem Matrixsubstrat (10, 110, 210, 310).

8. Flüssigkristallanzeige mit vertikaler Ausrichtung in mehreren Bereichen nach Anspruch 7, wobei
eine Vielzahl von Kontaktlöchern (12a) durch einen Zwischenlagenisolationsfilm (12) des Matrixsubstrats (10, 110, 210, 310) zur elektrischen Verbindung einer jeden der Bildelementelektroden (13) mit einer Drainelektrode (5a) des korrespondierenden Schaltelements (5) gebildet ist, wobei
das Gegensubstrat (20) versehen ist mit einem Vorsprung (24), welcher als Ausrichtungsteilungsmittel dient und wobei in einer Draufsicht die Distanz zwischen dem Vorsprung (24) und dem Kontaktloch (12a) geringer ist als die Distanz zwischen dem Kontaktloch (12a) und dem in der Bildelementelektrode (13) ausgebildeten ausgeschnittenen Bereich (13b).

9. Elektronisches Gerät umfassend die Flüssigkristallanzeige mit vertikaler Ausrichtung in mehreren Bereichen nach einem der Ansprüche 1 bis 6.

Revendications

1. Dispositif d'affichage à cristaux liquides à alignement vertical et domaines multiples, dans lequel la zone de chaque élément d'image est divisée en plusieurs domaines, et les molécules de cristaux liquides sont alignées dans des directions qui sont différentes dans les domaines respectifs, étant précisé que le dispositif d'affichage à cristaux liquides et domaines multiples comprend un substrat de matrice (10, 110, 310, 310) comprenant :

un substrat isolant (11) ;
plusieurs lignes de balayage (2) sur le substrat isolant (11) ;
plusieurs lignes de données (1) disposées chacune de manière à couper les lignes de balayage (2) sur le substrat isolant (11), chaque intersection d'une ligne de données (1) et d'une ligne de balayage (2) étant associée à une zone d'élément d'image respective ;
une électrode d'élément d'image (13) formée dans chaque zone d'élément d'image, les électrodes d'élément d'image (13) présentant chacune une forme globalement rectangulaire, chaque électrode d'élément d'image (13) étant reliée par l'intermédiaire d'un élément de commutation respectif (5) à une ligne de balayage (2) correspondante et à une ligne de données (1) correspondante,
les électrodes d'élément d'image (13) comportant chacune un côté long disposé le long de la direction dans laquelle s'étendent les lignes de balayage (2), et un côté court disposé le long de la direction dans laquelle s'étendent les lignes de données (1), ainsi qu'une section découpée (13b) qui est formée par une découpe en V et qui sert de moyen de division d'alignement de cristaux liquides,
caractérisé en ce que
chaque électrode d'élément d'image (13) comporte deux sections coupées (13a) formées par deux coins coupés, la section découpée (13b) étant formée séparément des coins coupés, les sections coupées d'angle (13a) servant elles aussi de moyen de division d'alignement de cristaux liquides, et
chaque électrode d'élément d'image (13) est formée de manière à couvrir une partie au moins d'une ligne de balayage (2) associée à l'entraînement d'une électrode d'élément d'image directement voisine (13) de la même colonne d'éléments d'image, étant précisé que dans chaque zone d'élément d'image, le substrat de matrice (10, 110, 210, 310) comprend par ailleurs
une électrode de protection (17, 19) formée, vue en coupe transversale, entre l'électrode d'élément d'image (13) respectif et une ligne de balayage (2) associée à l'entraînement d'une électrode d'élément d'image voisin (13) de la même colonne d'éléments d'image, ladite électrode de protection (17, 19) protégeant l'électrode d'élément d'image (13) respective d'un champ électrique provenant de la ligne de balayage (2) associée à l'entraînement de l'électrode d'élément d'image voisine (13) de la même colonne d'éléments d'image,
étant précisé que l'électrode de protection (17, 19) est reliée à l'électrode de drain (5a) de l'élément de commutation (5) respectif de l'élément d'image par l'intermédiaire d'une électrode de liaison (18) ; et
que l'électrode de liaison (18) est disposée de manière à empiéter sur la section coudée de la section découpée en V (13b) respective, vue en plan.

2. Dispositif d'affichage à cristaux liquides à alignement vertical et domaines multiples tel qu'il est présenté dans la revendication 1, étant précisé que :

les sections coupées (13a) sont formées à deux coins, voisins, de chacune des électrodes d'élément d'image (13).

3. Dispositif d'affichage à cristaux liquides à alignement vertical et domaines multiples tel qu'il est présenté dans la revendication 1, étant précisé :

qu'une fente (13c) est formée sur une section d'arête de chaque section découpée (13b), la fente étant formée le long d'une direction globalement orthogonale par rapport à la direction dans laquelle les cristaux liquides sont alignés.

4. Dispositif d'affichage à cristaux liquides à alignement vertical et domaines multiples tel qu'il est présenté dans la revendication 1, étant précisé que :

quand la section découpée (13b) de l'électrode d'élément d'image (13) est formée sur la ligne de balayage (2) associée à l'entraînement de l'électrode d'élément d'image (13) voisin, l'électrode de protection (19) est disposée le long de la forme de la section découpée (13b).

5. Dispositif d'affichage à cristaux liquides à alignement vertical et domaines multiples tel qu'il est présenté dans la revendication 1, étant précisé que :

quand les sections coupées (13a) de chacune des électrodes d'élément d'image (13) sont formées à deux coins voisins, le long de la ligne de balayage (2) correspondante, la longueur (L2) de chacune des sections coupées (13a) dans la direction dans laquelle s'étendent les lignes de données (1) est de 14 μm ou plus.

6. Dispositif d'affichage à cristaux liquides à alignement vertical et domaines multiples tel qu'il est présenté dans la revendication 1, comprenant également :

une ligne de capacité de stockage (3) formée dans une couche où sont formées les lignes de balayage (2) ; et une contre-électrode de capacité de mémoire (4) formée dans une couche où sont formées les lignes de données (1), la contre-électrode de capacité de mémoire (4) étant reliée à une électrode de drain (5a) de l'élément de commutation (5),
la ligne de capacité de stockage (3) et la contre-électrode de capacité de stockage (4) étant formées de manière à empiéter l'une sur l'autre par l'intermédiaire d'un film isolant.

7. Dispositif d'affichage à cristaux liquides à alignement vertical et domaines multiples tel qu'il est présenté dans l'une quelconque des revendications 1 à 6, comprenant un panneau à cristaux liquides contenant des cristaux liquides placés en sandwich entre un contre-substrat (20) et le substrat de matrice (10, 110, 210, 310).

8. Dispositif d'affichage à cristaux liquides à alignement vertical et domaines multiples tel qu'il est présenté dans la revendication 7, étant précisé que :

plusieurs trous de contact (12a) sont formés dans un film isolant intercalaire (12) du substrat de matrice (10, 110, 210, 310) pour la liaison électrique entre chacune des électrodes d'élément d'image (13) et une électrode de drain (5a) de l'élément de commutation (5) correspondant, étant précisé que le contre-substrat (20) est pourvu d'une saillie (24) qui sert de moyen de division d'alignement ; et
que, vue en plan, la distance entre la saillie (24) et le trou de contact (12a) est plus courte que la distance entre le trou de contact (12a) et la section découpée (13b) formée dans l'électrode d'élément d'image (13).

9. Dispositif électronique comprenant le dispositif d'affichage à cristaux liquides à alignement vertical et domaines multiples tel qu'il est présenté dans l'une quelconque des revendications 1 à 6.

FIG. 1

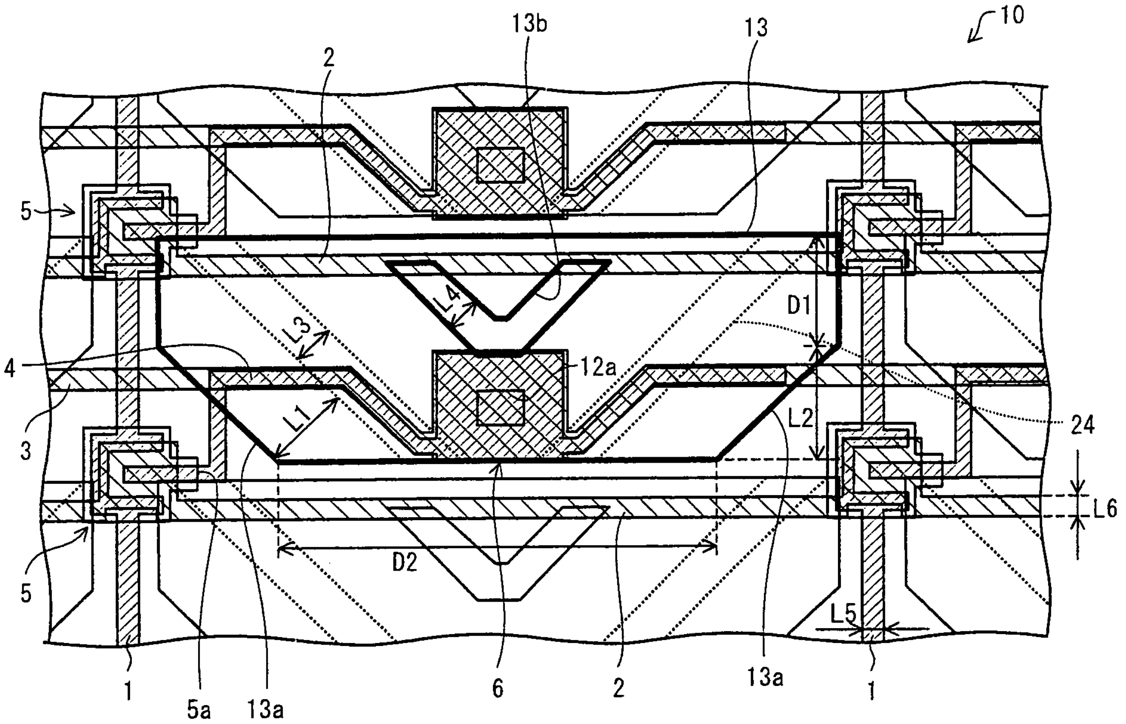

10
13b
13
2
5
D1
L3
L4
4
12a
3
L1
L2
24
5
L6
D2
L5
1
5a
13a
6
2
13a
1

FIG. 2

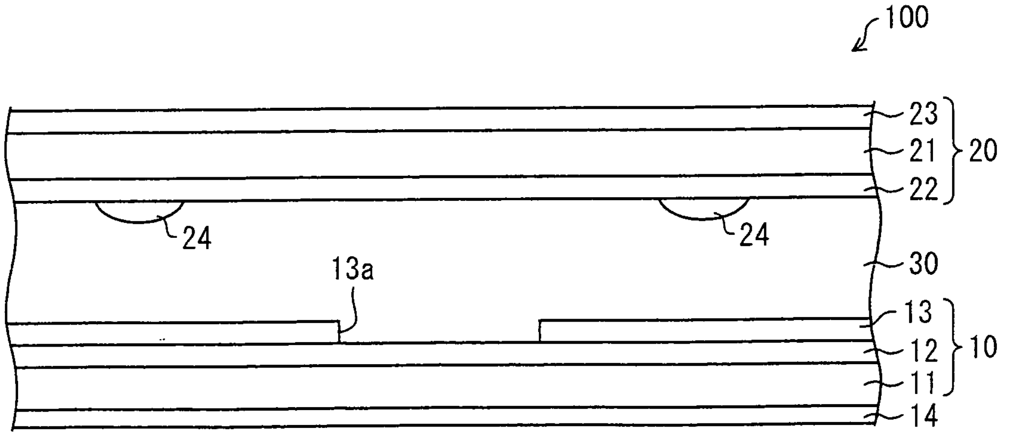

100
23
21
20
22
24
24
30
13a
13
12
10
11
14

FIG. 3

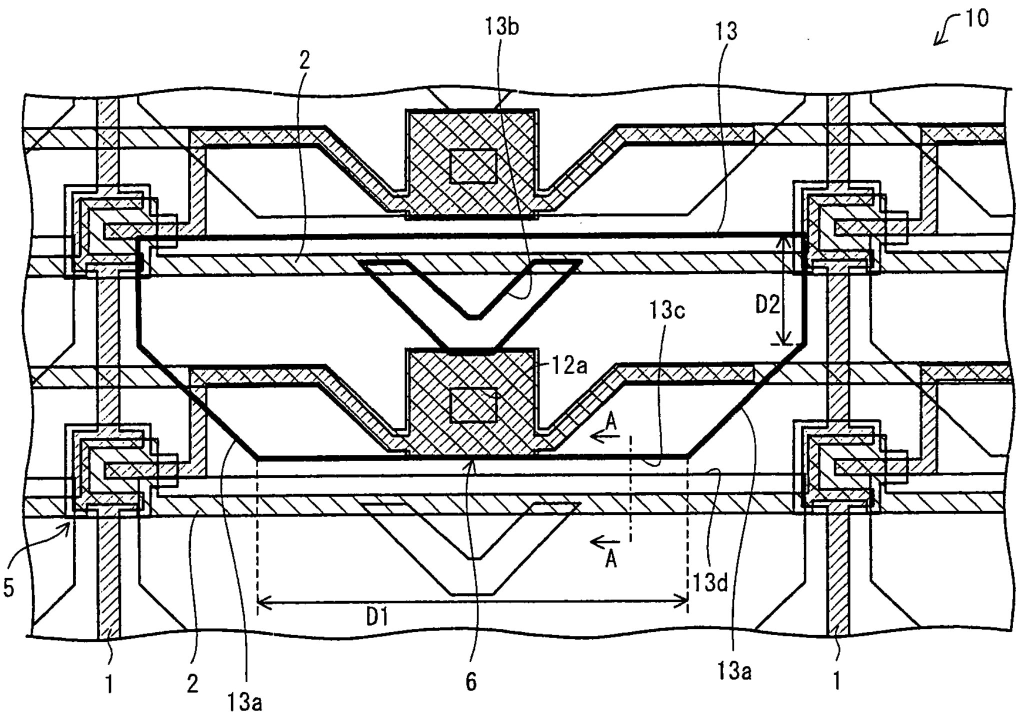

10
13b
13
2
13c
D2
12a
A
A
13d
5
D1
1
2
13a
6
13a
1

FIG. 4

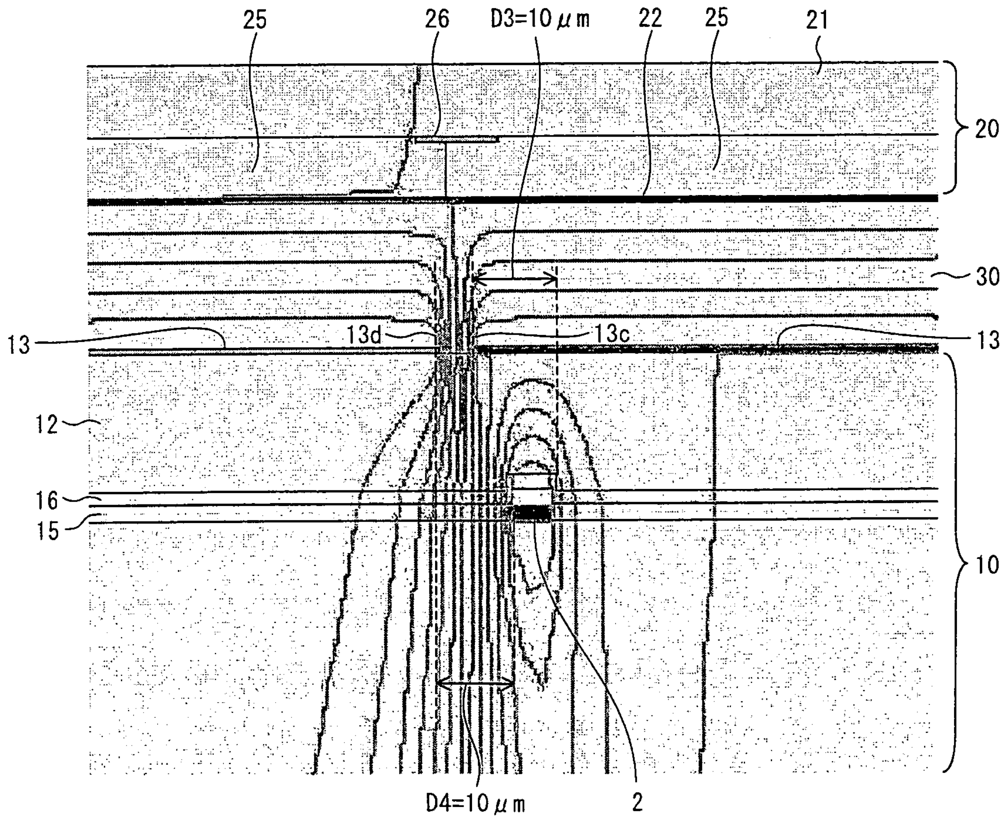

25
26
D3=10 μm
22
25
21
20
30
13
13d
13c
13
12
16
15
10
D4=10 μm
2

FIG. 5

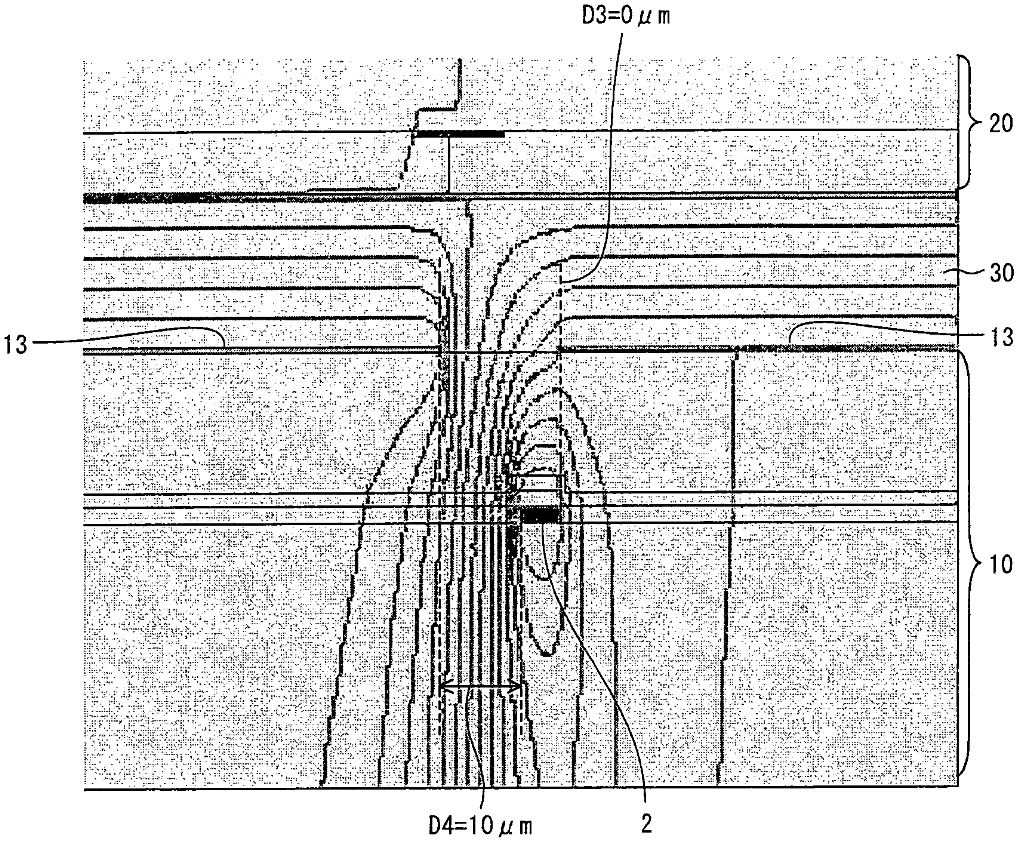


FIG. 6

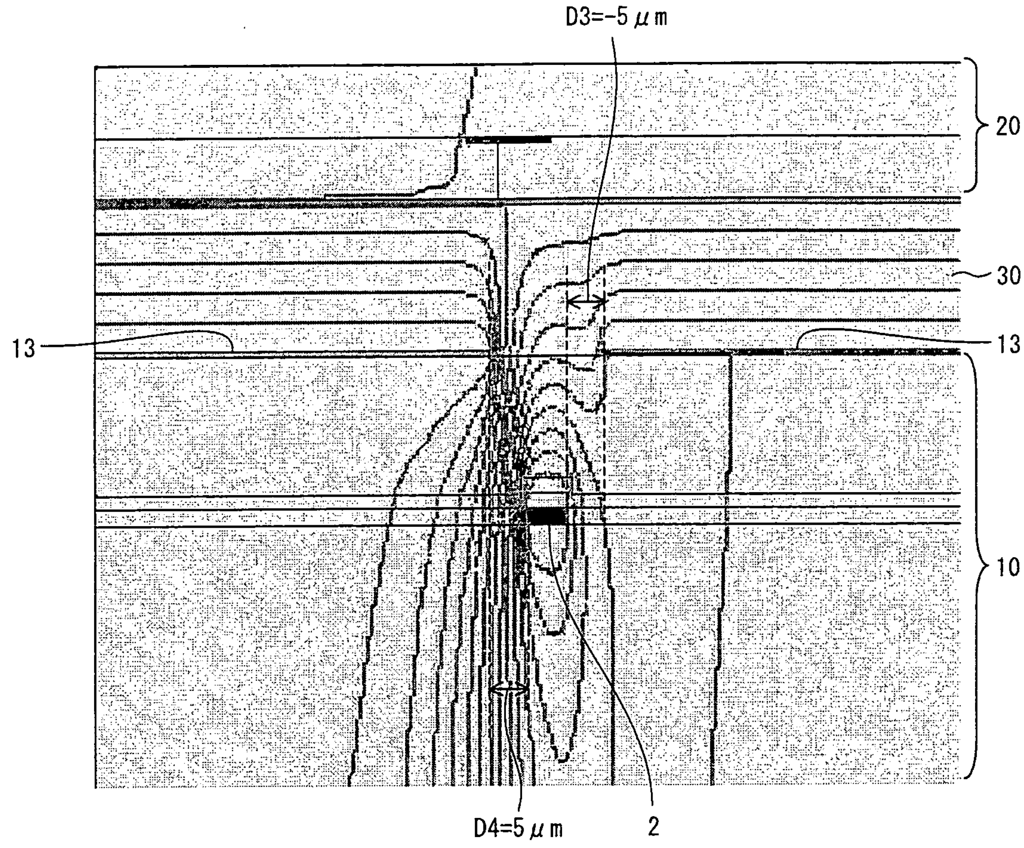


FIG. 7

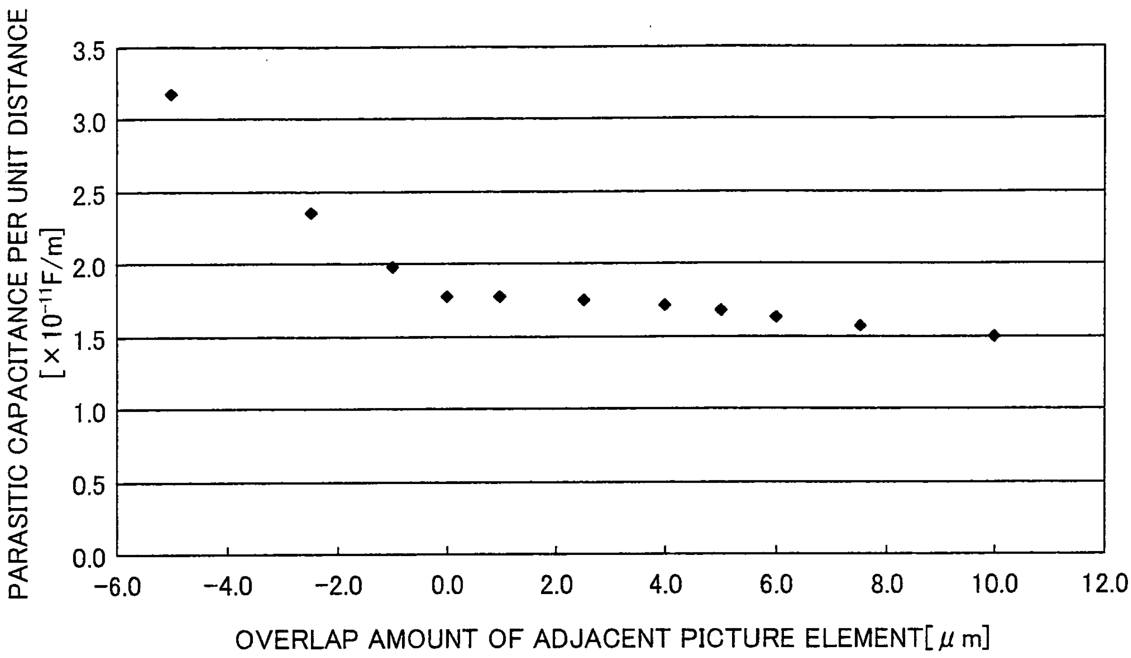

PARASITIC CAPACITANCE PER UNIT DISTANCE [×10⁻¹¹F/m]
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−6.0
−4.0
−2.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
OVERLAP AMOUNT OF ADJACENT PICTURE ELEMENT[μm]

FIG. 8

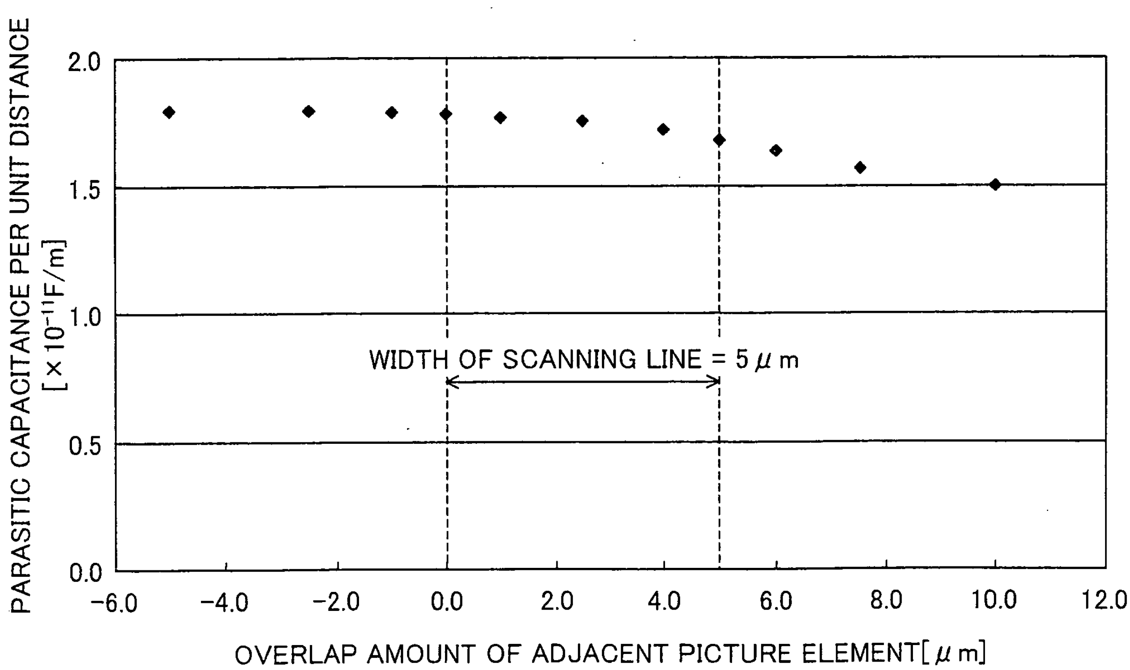

PARASITIC CAPACITANCE PER UNIT DISTANCE [×10⁻¹¹F/m]
2.0
1.5
1.0
0.5
0.0
WIDTH OF SCANNING LINE = 5μm
−6.0
−4.0
−2.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
OVERLAP AMOUNT OF ADJACENT PICTURE ELEMENT[μm]

FIG. 9

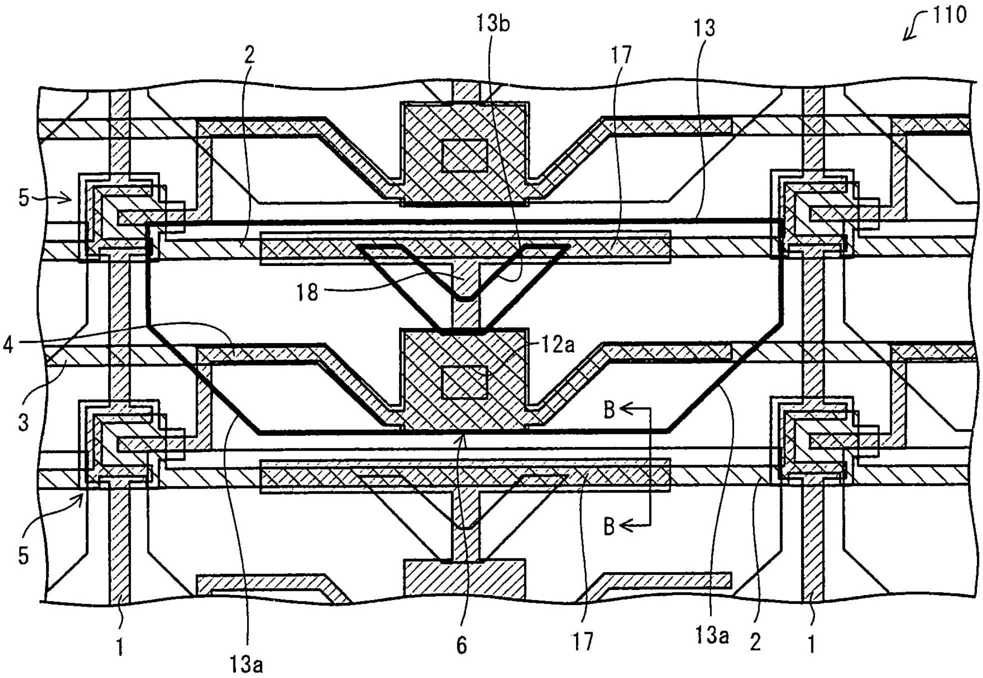

110
13b
13
2
17
5
18
4
12a
3
B
5
1
13a
6
17
13a
2
1

FIG. 10

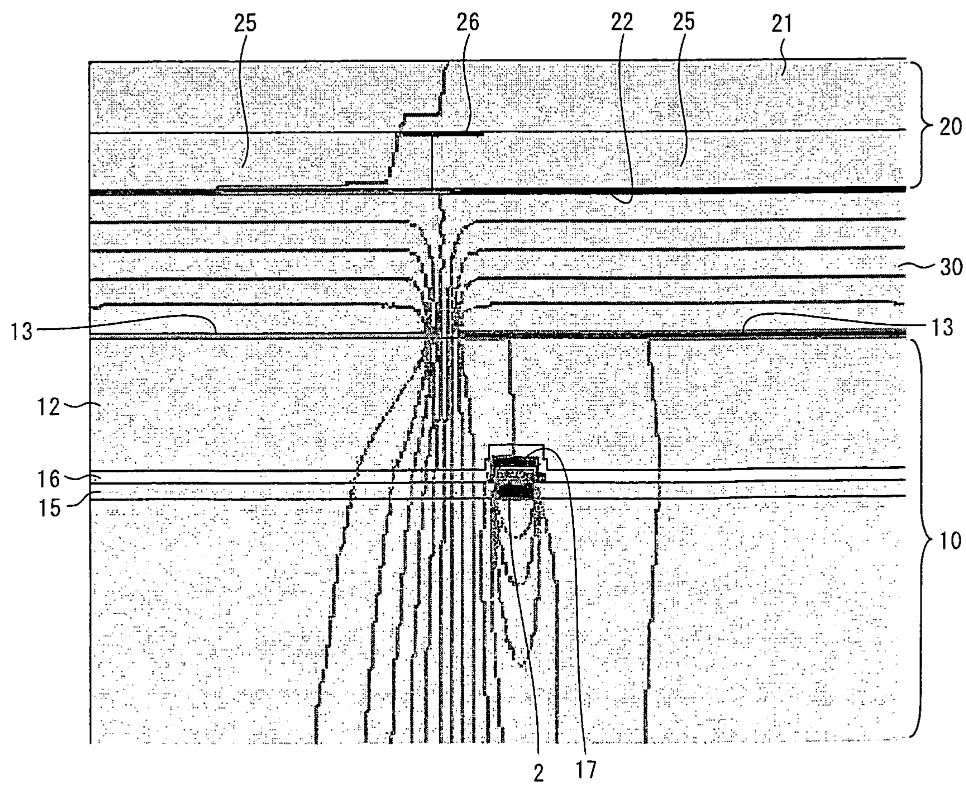

25
26
22
25
21
20
30
13
13
12
16
15
10
2
17

FIG. 11

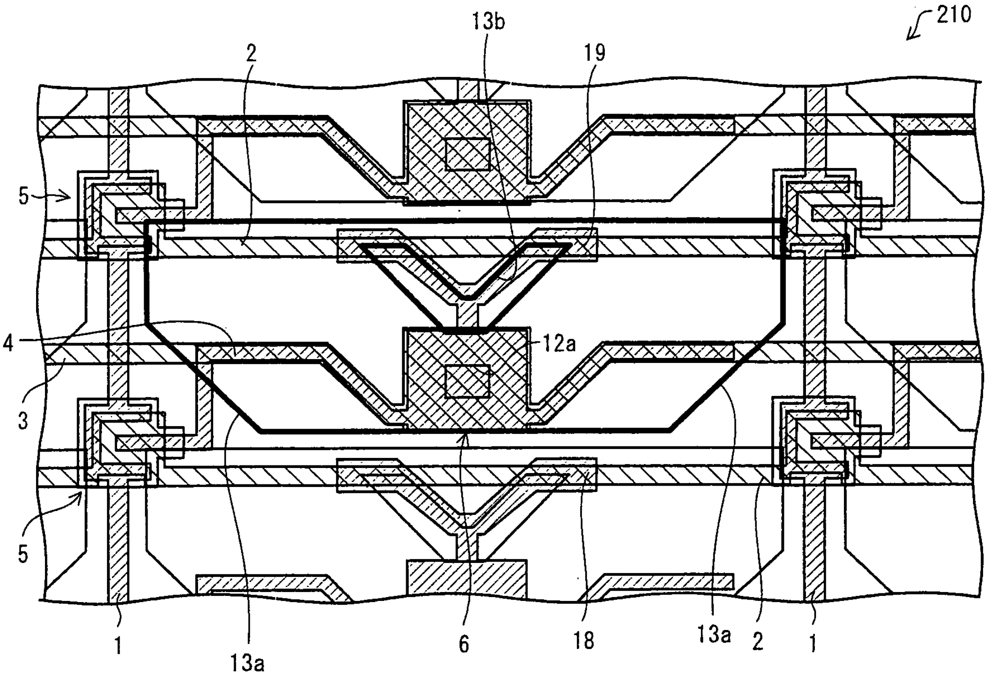

13b
210
2
19
5
4
12a
3
5
5
1
13a
6
18
13a
2
1

FIG. 12

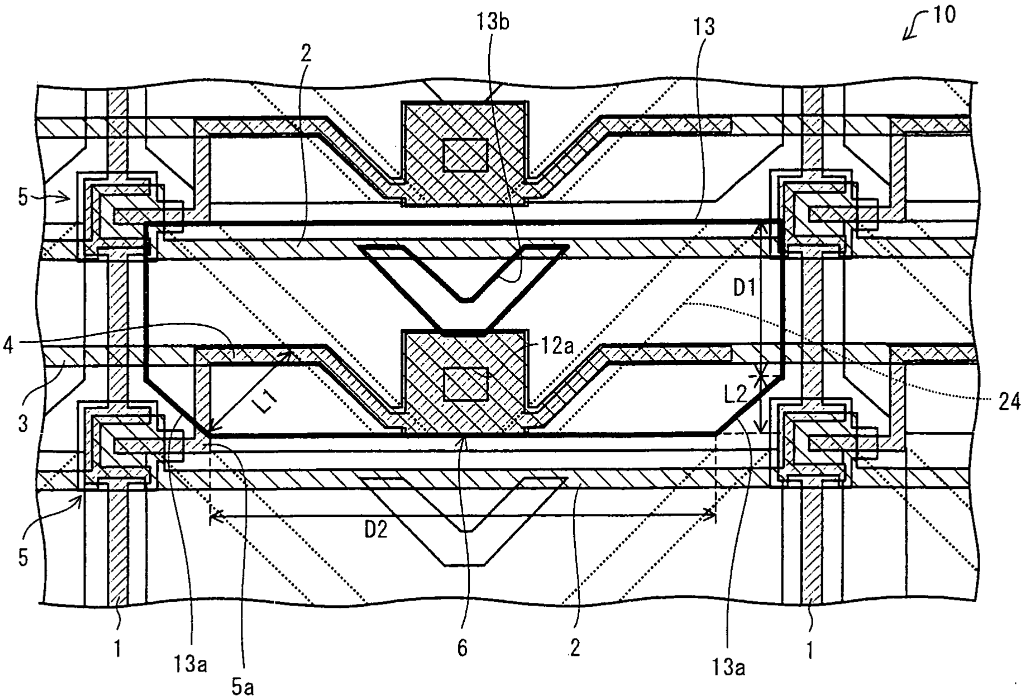

13b
13
10
2
5
D1
4
12a
L1
L2
24
3
5
D2
5
1
13a
5a
6
2
13a
1

FIG. 13

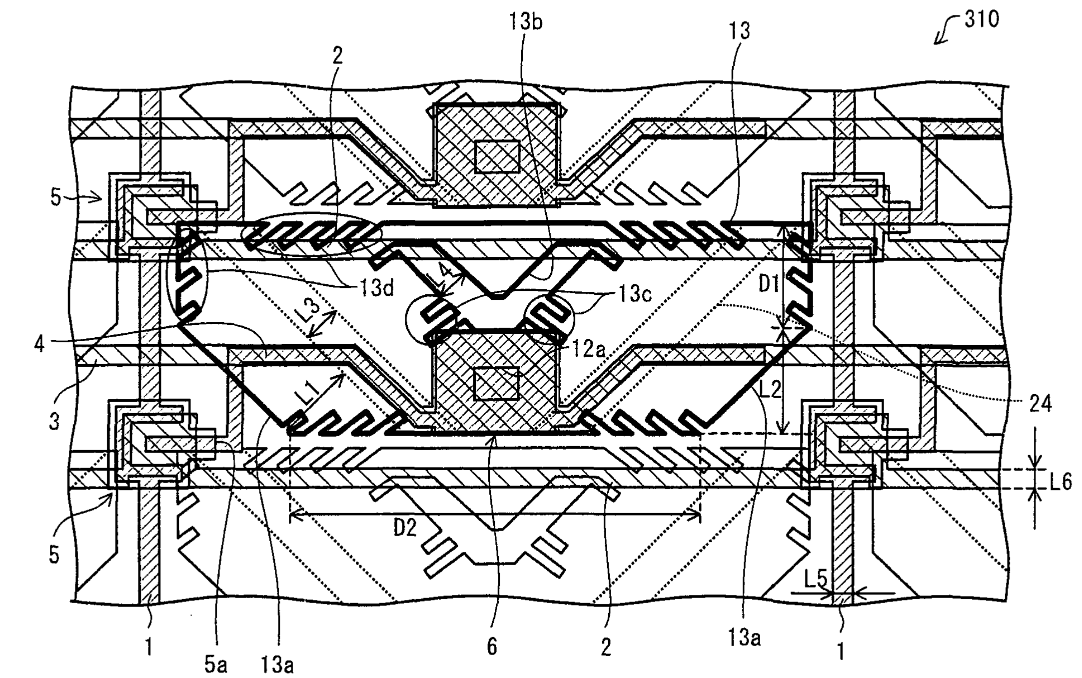
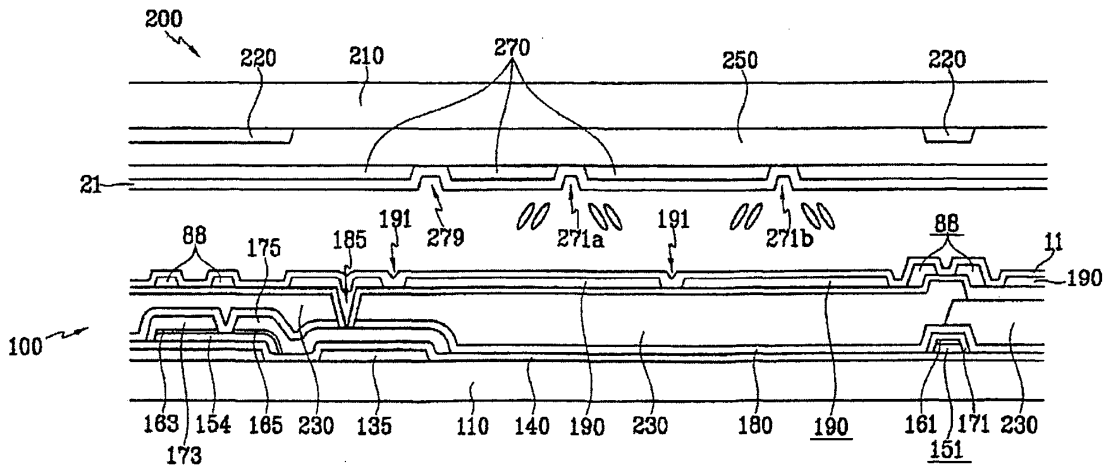

310
13b
13
2
5
13d
13c
D1
L4
L3
12a
4
3
24
L1
L2
L6
5
D2
5
L5
1
5a
13a
6
2
13a
1

FIG. 14


200
220
210
270
250
220
21
279
271a
191
271b
88
175
185
191
88
11
190
100
163
154
165
230
135
110
140
190
230
180
190
161
171
230
173
151

REFERENCES CITED IN THE DESCRIPTION

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- US 2004227888 A1 **[0010]**
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- US 2007171320 A1 **[0013]**
- JP 2005134889 A **[0014]**

专利名称(译)	多域垂直配向液晶显示装置和电子设备		
公开(公告)号	EP2397890B1	公开(公告)日	2015-07-01
申请号	EP2009840025	申请日	2009-10-08
[标]申请(专利权)人(译)	夏普株式会社		
申请(专利权)人(译)	夏普株式会社		
当前申请(专利权)人(译)	夏普株式会社		
[标]发明人	YOSHIDA MASAHIRO HORIUCHI SATOSHI YAMADA TAKAHARU HISADA YUHKO ITOH RYOHKI		
发明人	YOSHIDA, MASAHIRO HORIUCHI, SATOSHI YAMADA, TAKAHARU HISADA, YUHKO ITOH, RYOHKI		
IPC分类号	G02F1/1343 G02F1/1337 G02F1/1368 G02F1/139		
CPC分类号	G02F1/134309 G02F1/133707 G02F1/136213 G02F1/1393 G02F2001/13606 G02F2201/40		
优先权	2009031789 2009-02-13 JP		
其他公开文献	EP2397890A4 EP2397890A1		
外部链接	Espacenet		

摘要(译)

本发明的阵列基板（10）包括：绝缘基板;绝缘基板上的多条扫描线（2）;多条数据线（1），每条数据线设置成与绝缘基板上的多条扫描线（2）交叉;每个像素电极（13）形成为大致矩形形状，每个像素电极（13）通过开关元件（5）连接到相应的扫描线（2）和相应的数据线（1），每个像素电极（13）具有沿着多条扫描线（2）延伸的方向设置的长边和沿着多条数据线（1）延伸的方向设置的短边，每个像素电极（13）具有通过切割每个像素电极的两个角形成的切割部分（13a），切割部分形成为用作对准分割装置。这使得关于MVA液晶显示装置可以通过确保每个像素中的足够的孔径比来容易地确保足够的工艺产量以及改善显示质量。

FIG. 1

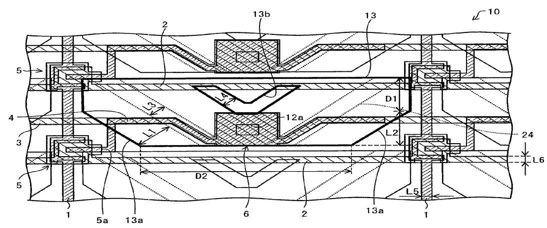

FIG. 2