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Kikuchi(10) **Pub. No.: US 2001/0040567 A1**(43) **Pub. Date: Nov. 15, 2001**(54) **ACTIVE MATRIX LIQUID CRYSTAL
DISPLAY DEVICE****Publication Classification**(51) **Int. Cl.⁷** **G09G 5/00**(52) **U.S. Cl.** **345/211**(75) **Inventor: Koji Kikuchi, Miyagi-ken (JP)**

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BRINKS HOFER GILSON & LIONE**P.O. BOX 10395****CHICAGO, IL 60610 (US)**(57) **ABSTRACT**(73) **Assignee: Alps Electric Co., Ltd.**(21) **Appl. No.: 09/849,850**(22) **Filed: May 4, 2001**(30) **Foreign Application Priority Data**

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An active matrix liquid crystal display device includes a thin film transistor (TFT) array substrate and a counter electrode substrate with a liquid crystal layer held therebetween. On a surface of the counter electrode substrate adjacent to the liquid crystal layer, a plurality of counter electrodes are formed perpendicular to gate lines on the TFT array substrate. Each of the counter electrodes faces at least one column of pixel electrodes connected to drain electrodes of the TFTs.

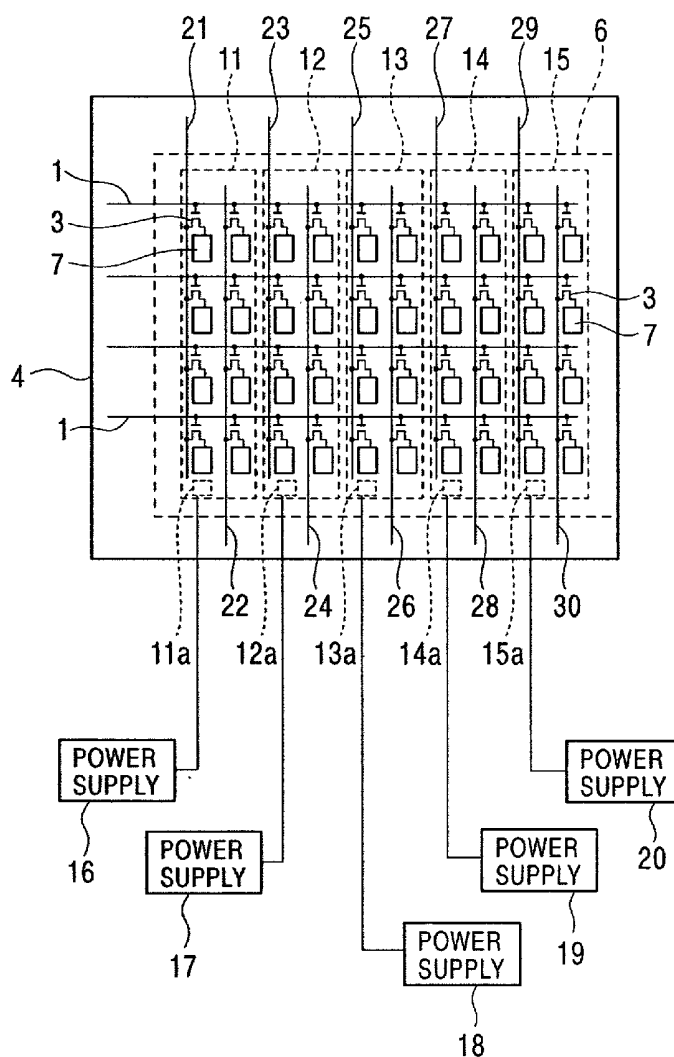


FIG. 2

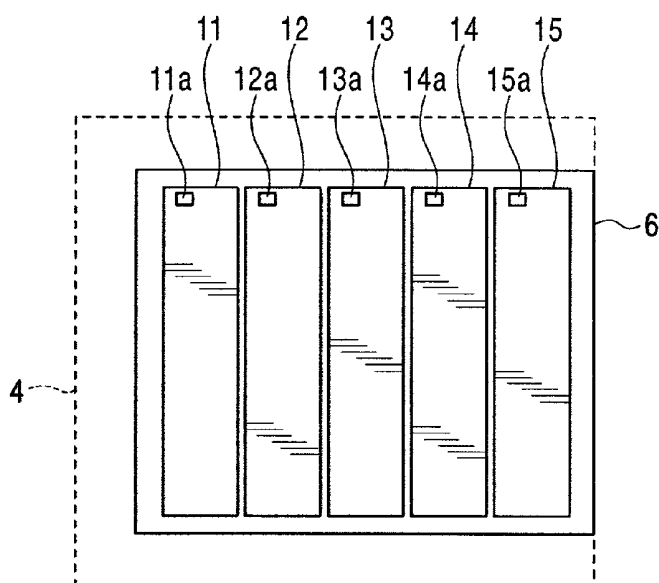


FIG. 3

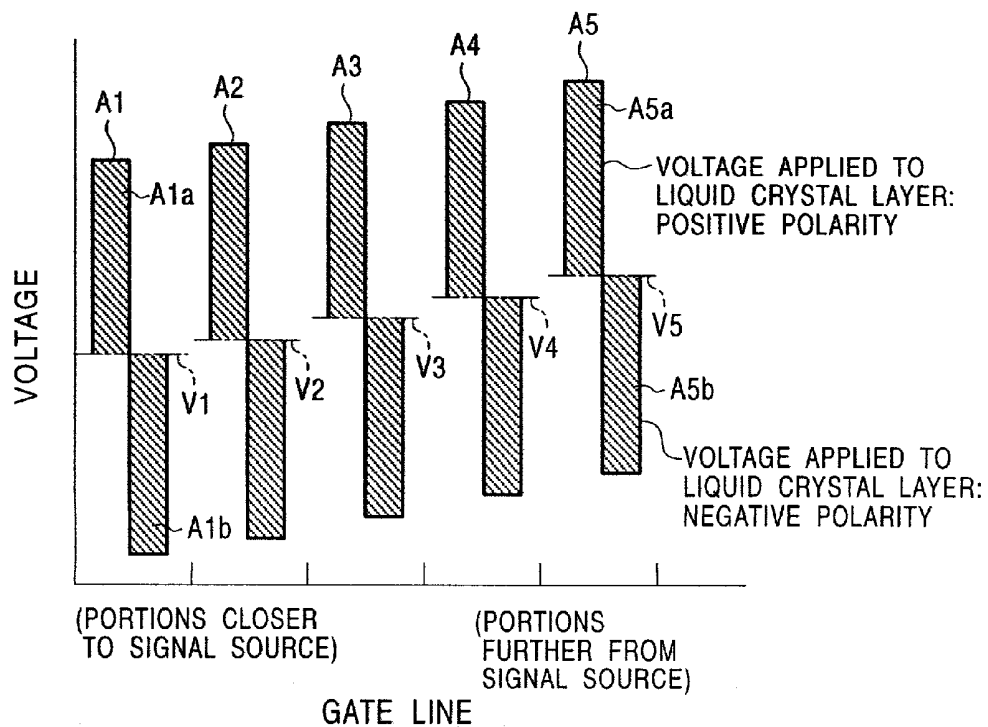


FIG. 4

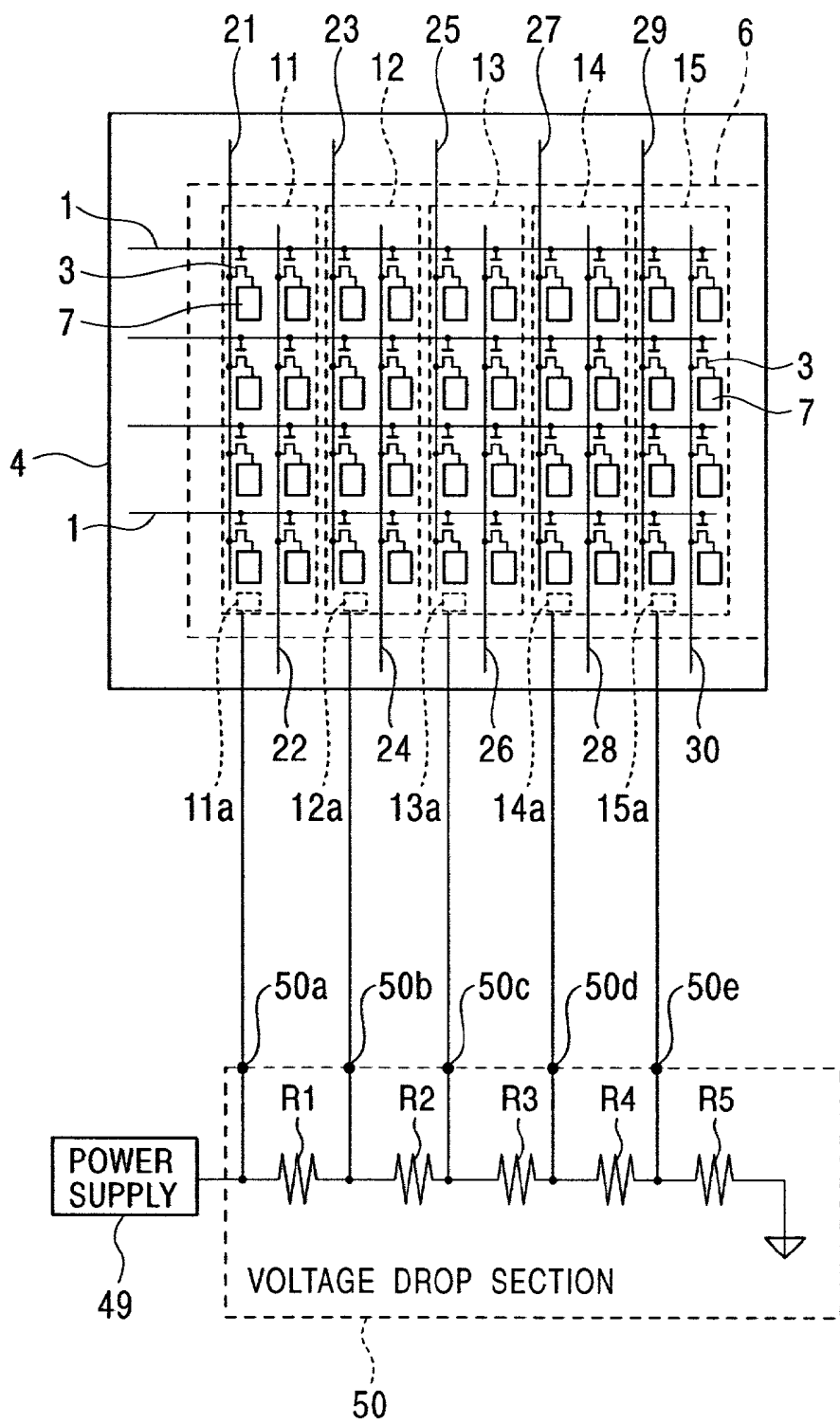


FIG. 5
PRIOR ART

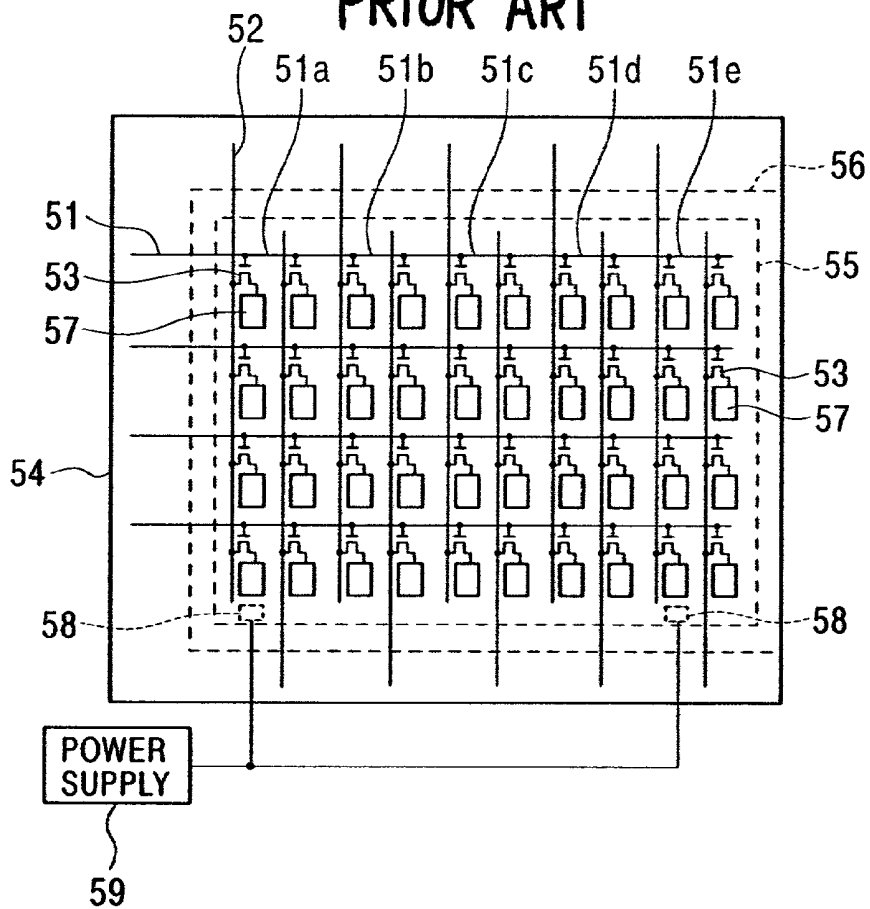


FIG. 6
PRIOR ART

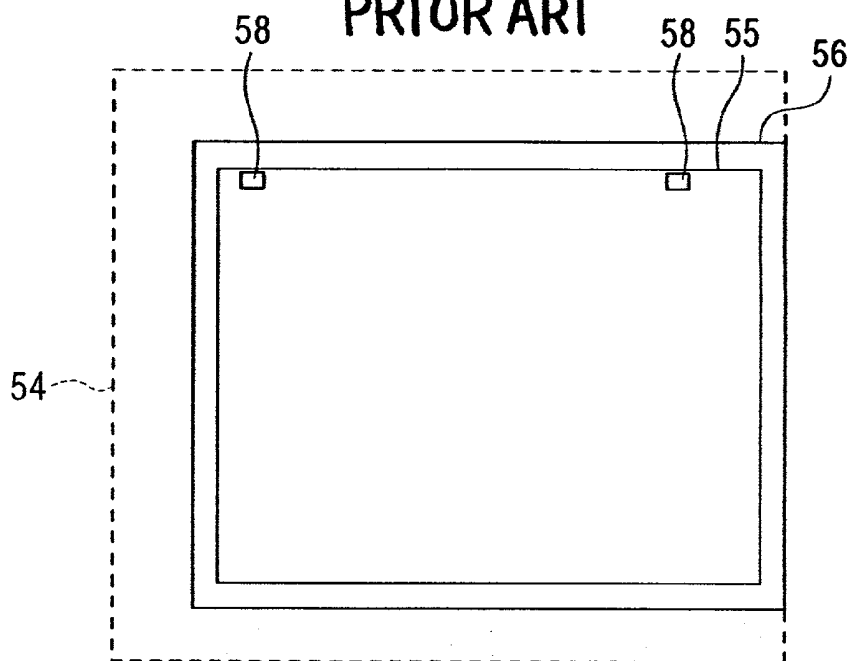


FIG. 7
PRIOR ART

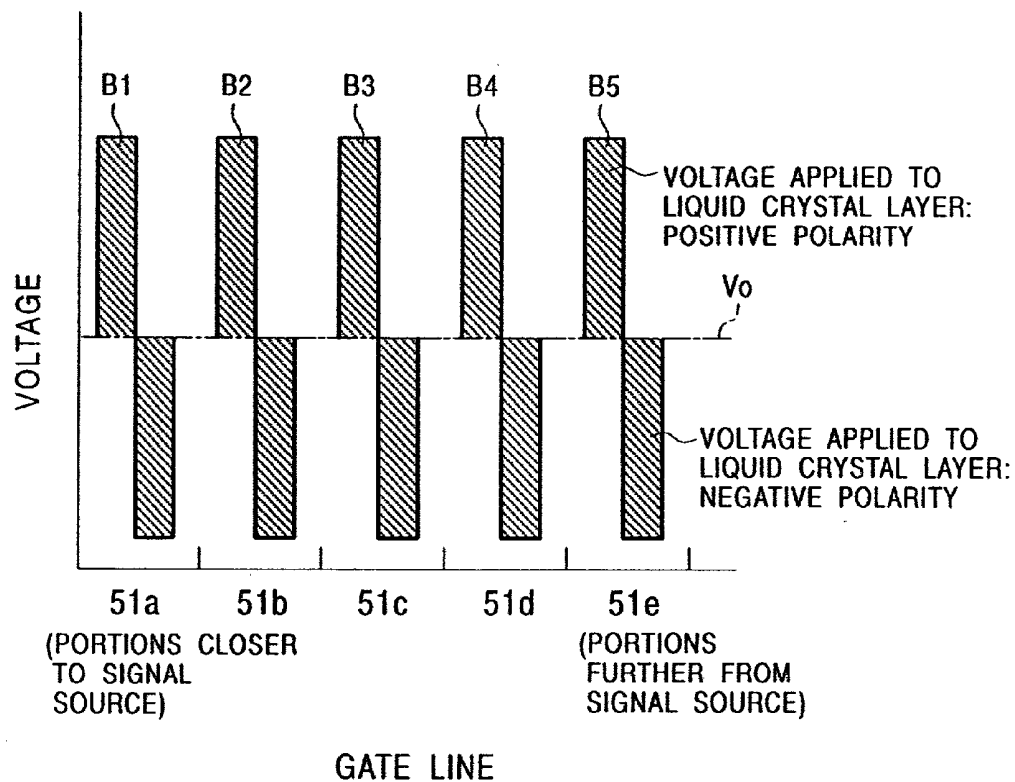
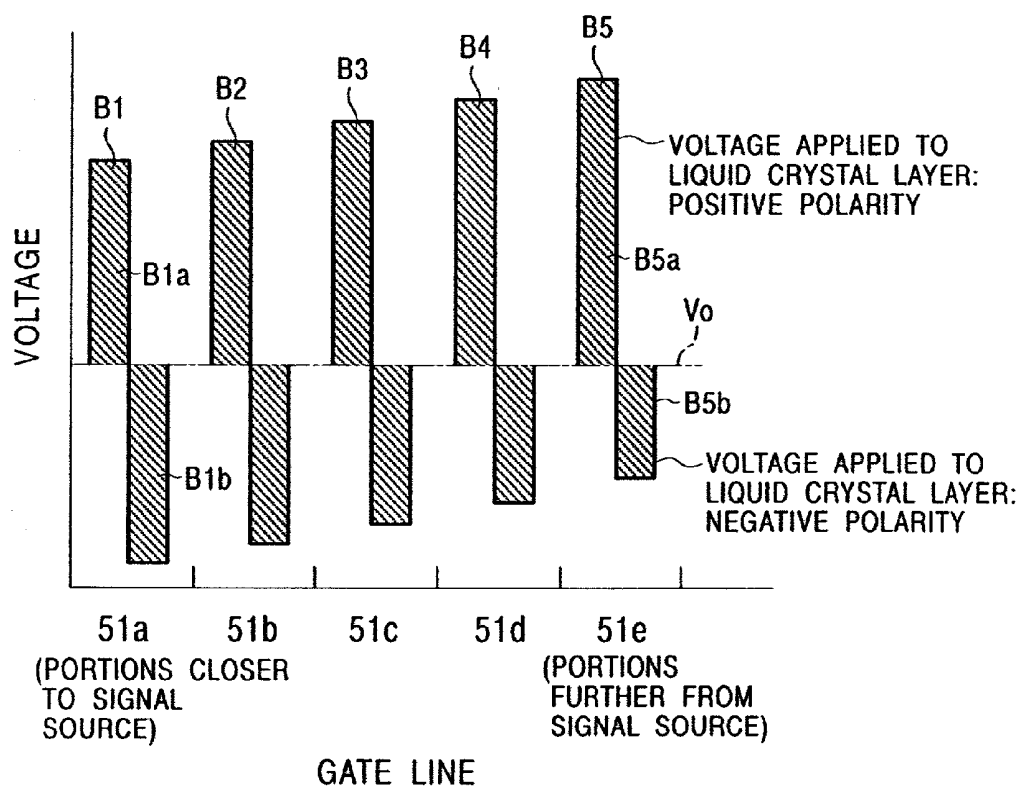


FIG. 8
PRIOR ART



ACTIVE MATRIX LIQUID CRYSTAL DISPLAY DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention generally relates to active matrix liquid crystal display devices, and more particularly to a configuration in which counter electrodes face pixel electrodes with a liquid crystal layer therebetween.

[0003] 2. Description of the Related Art

[0004] Typically, a liquid crystal display device includes a TFT array substrate **54**, as shown in **FIG. 5**, having thin film transistors and pixel electrodes, and a counter electrode substrate **56**, as shown in **FIG. 6**, having counter electrodes facing the pixel electrodes, with a liquid crystal layer (not shown) being held therebetween.

[0005] The TFT array substrate **54** includes a plurality of gate lines **51**, a plurality of data lines **52**, a plurality of thin film transistors **53** formed in the vicinity of intersections of the gate lines **51** and the data lines **52**, and pixel electrodes **57** individually connected to the plurality of thin film transistors **53**.

[0006] On the other hand, the counter electrode substrate **56** facing the TFT array substrate **54** simply includes a single counter electrode **55** common to all the pixel electrodes **57**.

[0007] A signal voltage from the data lines **52** is applied to the pixel electrodes **57** formed on the TFT array substrate **54** via the thin film transistors **53**. A power supply **59** is connected to the counter electrode **55** formed on the counter electrode substrate **56** through a plurality of connector terminals **58**. Although two connector terminals **58** are shown in **FIG. 5**, at least one connector terminal **58** is required, and the connector terminal **58** may be disposed at any location. This allows a liquid crystal layer (not shown) to be driven by using a voltage difference between the pixel electrodes **57** and the common electrode **55**.

[0008] In the above-mentioned liquid crystal display device, a voltage applied to the counter electrode **55** is selected to be V_0 so that positive voltages and negative voltages are applied to the liquid crystal layer in a symmetric manner, as illustrated in **FIG. 7**, in order to avoid a flicker or display failure which results from the sticking phenomenon (image retention) when the liquid crystal display device is driven.

[0009] Recently, the demand for such a liquid crystal display device with high definition display has been increasing. As a result, the number of intersections between the gate lines **51** and the data lines **52**, and the number of thin film transistors **53** connected to the gate lines **51** are drastically being increased. The gate lines **51** exhibit parasitic capacitance at locations such as at the intersections with the data lines **52** and the gate electrodes of the thin film transistors **53** in the vicinity of the intersections.

[0010] Therefore, as the desire for higher definition display increases, such capacitance in the gate lines **51** is increased, thus increasing signal delay in the gate lines **51**.

[0011] When a signal delay occurs in the gate lines **51**, the signal waveform of the gate electrodes becomes rounded,

and the thin film transistors **53** suffer from the leakage of charge at the timing when they are turned off.

[0012] The leakage of charge at the thin film transistors **53** is greater at portions further from gate signal sources. Hence, the further the thin film transistors are from the gate signal sources, the greater the leakage becomes.

[0013] Accordingly, the amount of variation in voltage applied to the pixel electrodes **57**, which depends upon the leakage of charge at the thin film transistors **53**, is also increased at portions of the gate lines **51** that are further from the gate signal sources. Portions **51a**, **51b**, **51c**, **51d**, and **51e** of each of the gate lines **51** shown in **FIG. 5** extend further from the gate signal source, in the order stated.

[0014] When the amount of variation in voltage applied to the pixel electrodes **57** differs depending upon a distance in the gate lines **51** from the gate signal sources, voltages applied to the liquid crystal layer, as indicated by **B1** to **B5** in **FIG. 8**, are increased at portions of the gate lines **51** that are further from the gate signal sources in a manner such that $|B1a|$ to $|B1b|$, . . . , $(|B5a|$ to $|B5b|)$. Thus, the applied voltage has less symmetrical polarity.

[0015] Less symmetrical polarity may result in problems of flicker or display failure which results from the sticking phenomenon.

SUMMARY OF THE INVENTION

[0016] Accordingly, it is an object of the present invention to provide an active matrix liquid crystal display device in which no flicker or sticking of images occurs on a display screen when a signal delay in gate lines causes voltages applied to pixels at portions of the gate lines that are closer to and further from signal sources to differ.

[0017] To this end, the present invention provides an active matrix liquid crystal display device including a pair of substrates facing each other with a liquid crystal layer held therebetween. On a surface of one of the substrates adjacent to the liquid crystal layer, there are formed a plurality of gate lines and a plurality of data lines intersecting to form a matrix; thin film transistors in the vicinity of intersections of the gate lines and the data lines, the thin film transistors having gate electrodes connected to the gate lines and source electrodes connected to the data lines; and pixel electrodes connected to the drain electrodes of the thin film transistors. On a surface of the other substrate adjacent to the liquid crystal layer, there are formed a plurality of counter electrodes in the direction perpendicular to the gate lines on the one substrate. Each of the counter electrodes faces at least one column of the pixel electrodes.

[0018] Therefore, a voltage is applied at different magnitudes to the plurality of counter electrodes depending upon a distance in the gate lines from signal sources. This prevents a flicker or sticking of images from occurring on a display screen when the amount of variation in voltages applied to the pixel electrodes at portions of the gate lines that are closer to and further from the signal sources differs.

[0019] Preferably, the plurality of counter electrodes are connected to power supplies for supplying different voltages, so that the voltages applied to the counter electrodes may be independently set.

[0020] Preferably, the plurality of counter electrodes are respectively connected to a plurality of output terminals of a voltage controller connected to a signal power supply to generate different magnitudes of voltage, so that the number of power supplies required may be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Some illustrative embodiments of the present invention will be described with reference to the drawings, in which:

[0022] FIG. 1 is an exploded view showing a main portion of an active matrix liquid crystal display device according to a first embodiment of the present invention;

[0023] FIG. 2 is an exploded view showing another main portion of the active matrix liquid crystal display device shown in FIG. 1;

[0024] FIG. 3 is a graph showing the operation of the active matrix liquid crystal display device shown in FIG. 1;

[0025] FIG. 4 is an exploded view showing a main portion of an active matrix liquid crystal display device according to a second embodiment of the present invention;

[0026] FIG. 5 is an exploded view showing a main portion of a conventional liquid crystal display device;

[0027] FIG. 6 is an exploded view showing another main portion of the liquid crystal display device shown in FIG. 5;

[0028] FIG. 7 is a graph showing an operation of the liquid crystal display device shown in FIG. 5; and

[0029] FIG. 8 is a graph showing another operation of the liquid crystal display device shown in FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] FIGS. 1 and 2 are exploded views showing main portions of an active matrix liquid crystal display device according to a first embodiment of the present invention.

[0031] Referring to FIGS. 1 and 2, the liquid crystal display device includes a TFT array substrate 4 and a counter electrode substrate 6 facing each other with a liquid crystal layer (not shown) held therebetween. The TFT array substrate 4 includes a plurality of gate lines 1, a plurality of data lines 21, 22, 23, 24, 25, 26, 27, 28, 29, and 30, a plurality of thin film transistors 3 formed in the vicinity of intersections between the gate lines 1 and the data lines 21 to 30, and pixel electrodes 7 individually connected to the thin film transistors 3. The counter electrode substrate 6 contains counter electrodes 11, 12, 13, 14, and 15 which face columns of the pixel electrodes 7 defined by the data lines 21 and 22, 23 and 24, 25 and 26, 27 and 28, and 29 and 30, respectively.

[0032] A signal voltage is applied to the pixel electrodes 7 formed on the TFT array substrate 4 from the associated data lines 21 to 30 via the thin film transistors 3. The plurality of counter electrodes 11, 12, 13, 14, and 15 formed on the counter electrode substrate 6 are supplied different voltages from power supplies 16, 17, 18, 19, and 20 via connector terminals 11a, 12a, 13a, 14a, and 15a, respectively.

[0033] As shown in FIG. 3, the voltages applied to the counter electrodes 11, 12, 13, 14, and 15 are selected to be

V1, V2, V3, V4, and V5 for columns of the pixel electrodes 7 depending upon a distance in the gate lines 1 from signal sources so that positive voltages and negative voltages are applied to the liquid crystal layer in a symmetric manner such that $(|A1a|=|A1b|)$, $\dots$, $(|A5a|=|A5b|)$.

[0034] Therefore, even though a signal delay in the gate lines 1 causes voltages applied to the pixel electrodes 7 at portions of the gate lines 1 that are closer to and further from the signal sources to differ, positive voltages and negative voltages are applied to the liquid crystal layer in a symmetric manner. This avoids a flicker or display failure which results from the sticking phenomenon when the present display device is driven.

[0035] While five divided counter electrodes, i.e., the counter electrodes 11, 12, 13, 14, and 15 are employed in the first embodiment shown in FIGS. 1 and 2, the number of divided counter electrodes is not limited to this number. The larger the number of divided counter electrodes, the more symmetric the positive and negative voltages applied to the liquid crystal layer.

[0036] This feature would be more remarkably exhibited in high definition display of the SVGA class or higher.

[0037] A liquid crystal display device according to a second embodiment of the present invention is described with reference to FIG. 4. The liquid crystal display device according to the second embodiment is different from that of the first embodiment in that the counter electrodes 11, 12, 13, 14, and 15 are supplied with different magnitudes of voltage through output terminals 50a, 50b, 50c, 50d, and 50e of a voltage drop section 50 coupled to a single power supply 49 to generate different fractional voltages.

[0038] In the liquid crystal display device according to the second embodiment, the same reference numerals are assigned to the same elements as those of the liquid crystal display device of the first embodiment shown in FIG. 4, and a description thereof is thus omitted.

[0039] The plurality of counter electrodes 11, 12, 13, 14, and 15 formed on the counter electrode substrate 6 of the liquid crystal display device shown in FIG. 4 are electrically connected to the output terminals 50a, 50b, 50c, 50d, and 50e of the voltage drop section 50 via the connector terminals 11a, 12a, 13a, 14a, and 15a, respectively.

[0040] The voltage drop section 50 having one end connected to the power supply 49 and the other end connected to the ground includes resistors R1, R2, R3, R4, and R5 connected in series. Although the other end of the voltage drop section 50 is connected to the ground in FIG. 4, it may be connected to any other terminal with a voltage.

[0041] The voltages applied to the plurality of counter electrodes 11, 12, 13, 14, and 15 from the power supply 49 are set to have different magnitudes in the voltage drop section 50. In FIG. 4, the plurality of resistors R1, R2, R3, R4, and R5 are used to generate a voltage drop having different magnitudes. The resistance values of the resistors R1, R2, R3, R4, and R5 are selected for V1, V2, V3, V4, and V5 and for the associated columns of pixel electrodes 7 depending upon a distance in the gate lines 1 from signal sources so that positive voltages and negative voltages are applied to the liquid crystal layer in a symmetric manner, as in FIG. 3.

[0042] Therefore, the desired voltage is applied to the plurality of counter electrodes 11, 12, 13, 14, and 15 in order to avoid a flicker or display failure which results from the sticking phenomenon when the present liquid crystal display device is driven, allowing the liquid crystal display device to be driven using voltage differences between the pixel electrodes 7 and the plurality of counter electrodes 11, 12, 13, 14, and 15.

[0043] Although the present invention has been described through illustrations of its preferred forms, it is to be understood that the described embodiments are only illustrative and various changes and modifications may be imparted thereto without departing from the scope of the present invention which is limited solely by the appended claims.

What is claimed is:

1. An active matrix liquid crystal display device comprising a pair of substrates facing each other with a liquid crystal layer held therebetween, one of the substrates including:

a plurality of gate lines and a plurality of data lines intersecting to form a matrix;

thin film transistors in a vicinity of intersections of the gate lines and the data lines, the thin film transistors having drain electrodes, gate electrodes connected to the gate lines and source electrodes connected to the data lines; and

pixel electrodes connected to the drain electrodes of the thin film transistors, wherein the gate lines, the data lines, the thin film transistors, and the pixel electrodes are formed on a surface of the one substrate adjacent to the liquid crystal layer,

the other substrate including, on a surface thereof adjacent to the liquid crystal layer, a plurality of counter electrodes formed in a direction perpendicular to the gate lines on the one substrate, each of the counter electrodes facing at least one column of the pixel electrodes.

2. An active matrix liquid crystal display device according to claim 1, wherein the plurality of counter electrodes are respectively connected to power supplies that supply different voltages to each counter electrode.

3. An active matrix liquid crystal display device according to claim 1, wherein the plurality of counter electrodes are respectively connected to a plurality of output terminals of a voltage controller, the voltage controller being connected to a power supply and generating voltages of different magnitudes at different output terminals of the plurality of output terminals.

4. An active matrix liquid crystal display device according to claim 1, wherein a magnitude of a voltage applied to a

particular counter electrode decreases as the thin film transistors opposing the counter electrode increase in distance from a source of signals to the gate lines.

5. An active matrix liquid crystal display device according to claim 1, wherein a magnitude of a voltage applied to the liquid crystal layer disposed between a particular thin film transistor and a particular counter electrode is independent of a position of the particular thin film transistor.

6. An active matrix liquid crystal display device according to claim 1, wherein voltages applied to the liquid crystal layer disposed between a particular thin film transistor and a particular counter electrode have a symmetric magnitude and alternate polarity.

7. A method of reducing flicker of images in active matrix liquid crystal display device, the method comprising:

providing a plurality of gate lines and a plurality of data lines intersecting to form a matrix, thin film transistors in a vicinity of the intersections, the thin film transistors having drain electrodes, gate electrodes connected to the gate lines and source electrodes connected to the data lines, and pixel electrodes connected to the drain electrodes; and

providing a plurality of counter electrodes formed in a direction perpendicular to the gate lines with liquid crystal therebetween, each of the counter electrodes facing at least one column of the pixel electrodes.

8. The method according to claim 7, further comprising supplying different voltages to each counter electrode.

9. The method according to claim 7, further comprising supplying the different voltages via a plurality of power supplies.

10. The method according to claim 7, further comprising supplying the different voltages via a single power supply.

11. The method according to claim 7, further comprising decreasing magnitudes of voltages applied to the counter electrodes as a distance of the corresponding thin film transistors increase from a source of signals to the respective gate lines.

12. The method according to claim 7, further comprising applying a magnitude of a voltage to the liquid crystal layer disposed between a particular thin film transistor and a particular counter electrode independent of a position of the particular thin film transistor.

13. The method according to claim 7, further comprising applying voltages of symmetric magnitude and alternating polarity to the liquid crystal layer disposed between a particular thin film transistor and a particular counter electrode.

* * * * *

专利名称(译)	有源矩阵液晶显示装置		
公开(公告)号	US20010040567A1	公开(公告)日	2001-11-15
申请号	US09/849850	申请日	2001-05-04
[标]申请(专利权)人(译)	阿尔卑斯电气株式会社		
申请(专利权)人(译)	ALPS ELECTRIC CO. , LTD.		
当前申请(专利权)人(译)	ALPS ELECTRIC CO. , LTD.		
[标]发明人	KIKUCHI KOJI		
发明人	KIKUCHI, KOJI		
IPC分类号	G02F1/1343 G02F1/133 G09F9/30 G09G3/20 G09G3/36 G09G5/00		
CPC分类号	G09G3/3655 G09G2320/0204 G09G2320/0223 G09G2320/0247 G09G2320/0257		
优先权	2000143410 2000-05-11 JP		
其他公开文献	US6621479		
外部链接	Espacenet USPTO		

摘要(译)

一种有源矩阵液晶显示装置，包括薄膜晶体管（TFT）阵列基板和对电极基板，其间夹有液晶层。在对电极基板的与液晶层相邻的表面上，垂直于TFT阵列基板上的栅极线形成多个对电极。每个对电极面对至少一列像素电极，其连接到TFT的漏电极。

