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(54) LIQUID CRYSTAL DISPLAY APPARATUS AND TERMINAL EQUIPMENT

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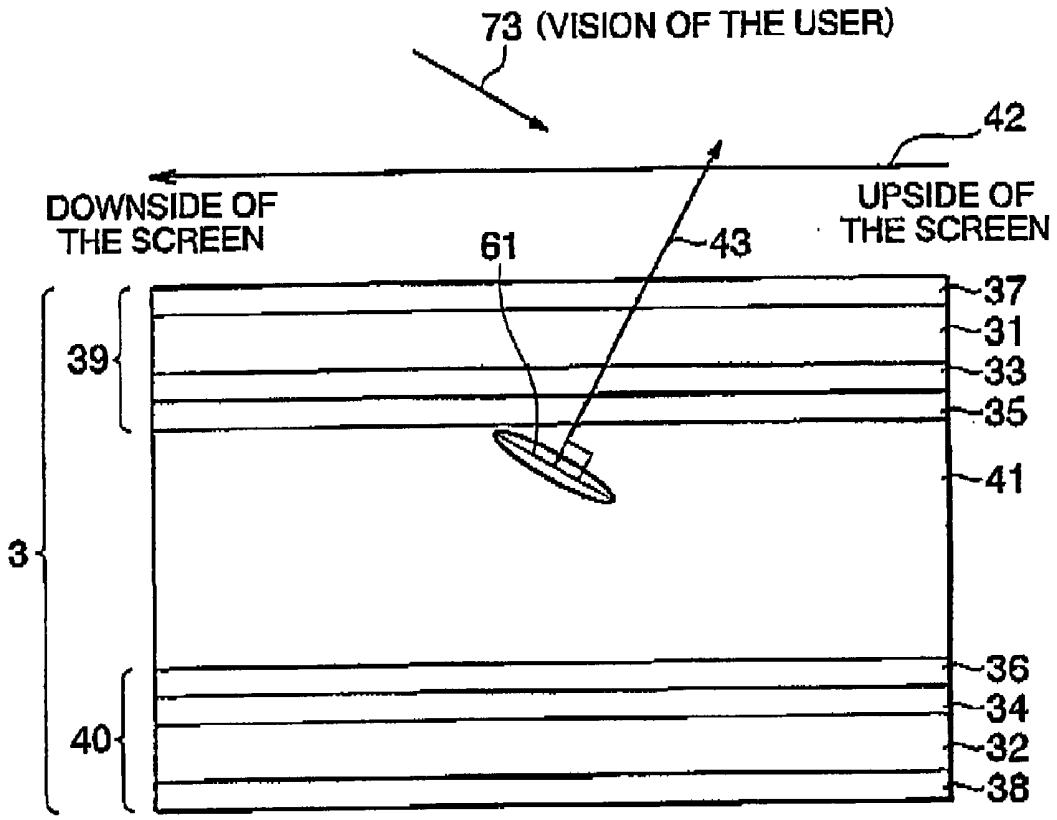
(57) ABSTRACT

A liquid crystal display apparatus includes an upper substrate having a first alignment layer and a first polarization plate. A lower substrate has a second alignment layer and a second polarization plate. A liquid crystal material is sandwiched between the upper substrate and the lower substrate. The first polarizing plate is arranged such that an up-and-down direction of a screen in the liquid crystal display apparatus becomes its first polarization-axis direction. The second polarizing plate is arranged such that its second polarization-axis direction becomes rectangular for the first polarization-axis direction. The first alignment layer is aligned by rubbing-treatment in the first polarization-axis direction. The second alignment layer is aligned by rubbing-treatment in the second polarization-axis direction.



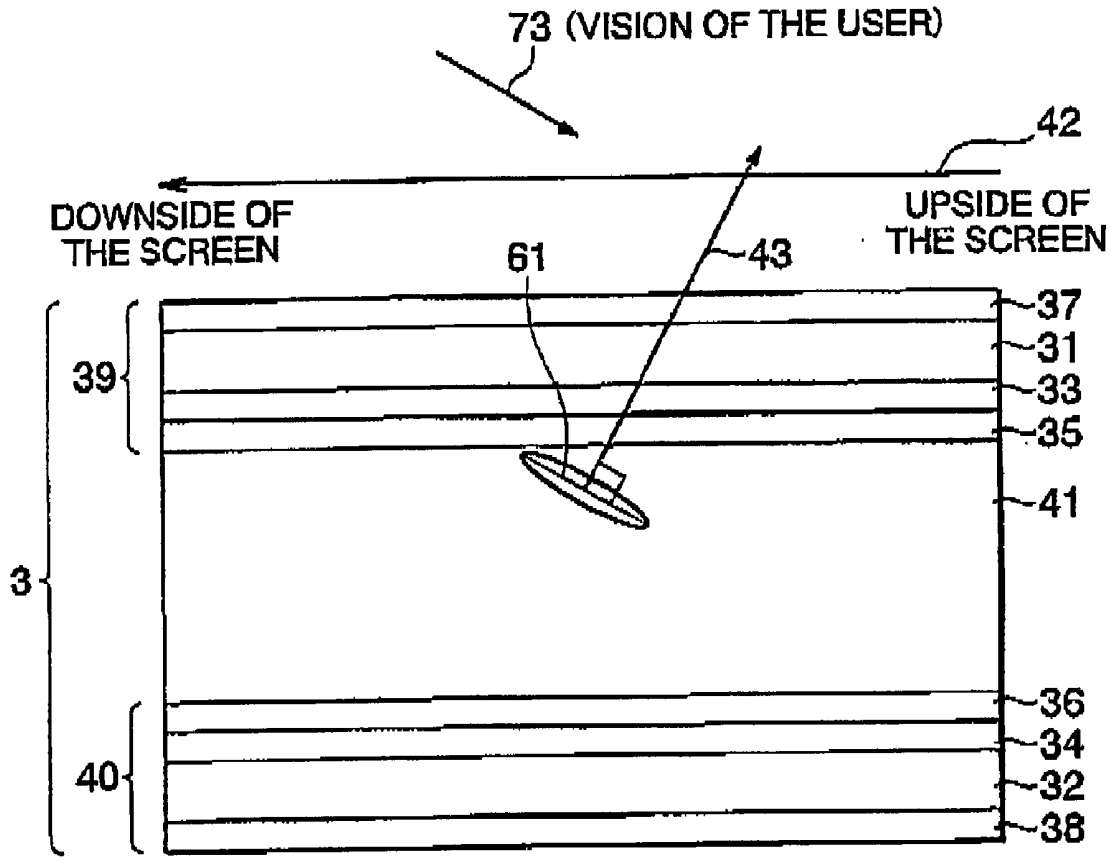

73 (VISION OF THE USER)
42
DOWNSIDE OF THE SCREEN
UPSIDE OF THE SCREEN
61
43
37
31
33
35
39
41
3
36
34
32
40
38

FIG. 1

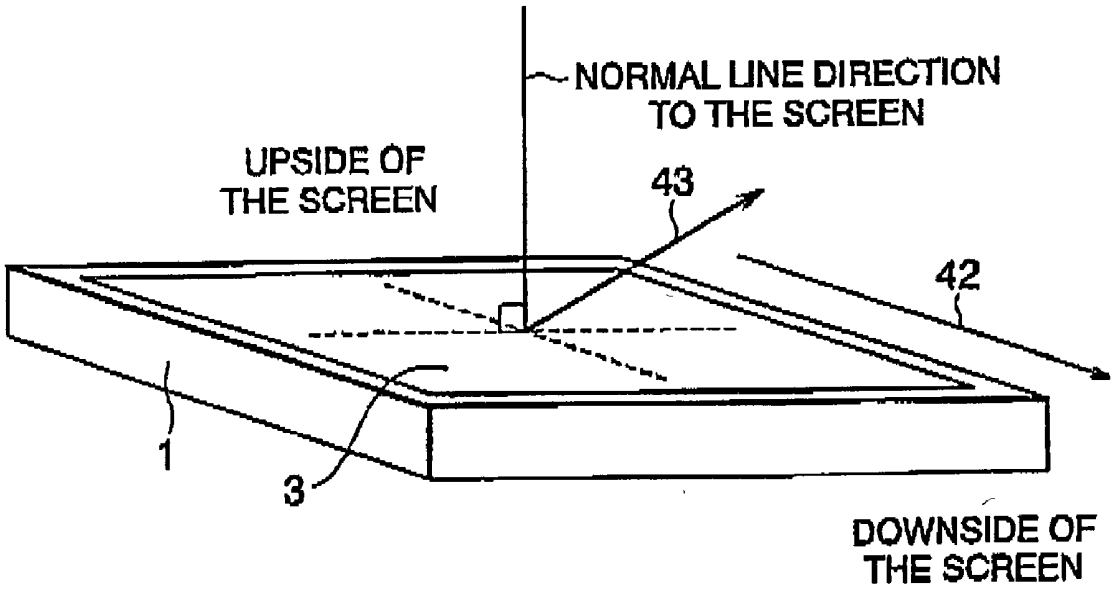

NORMAL LINE DIRECTION TO THE SCREEN
UPSIDE OF THE SCREEN
43
42
1
3
DOWNSIDE OF THE SCREEN

FIG. 2

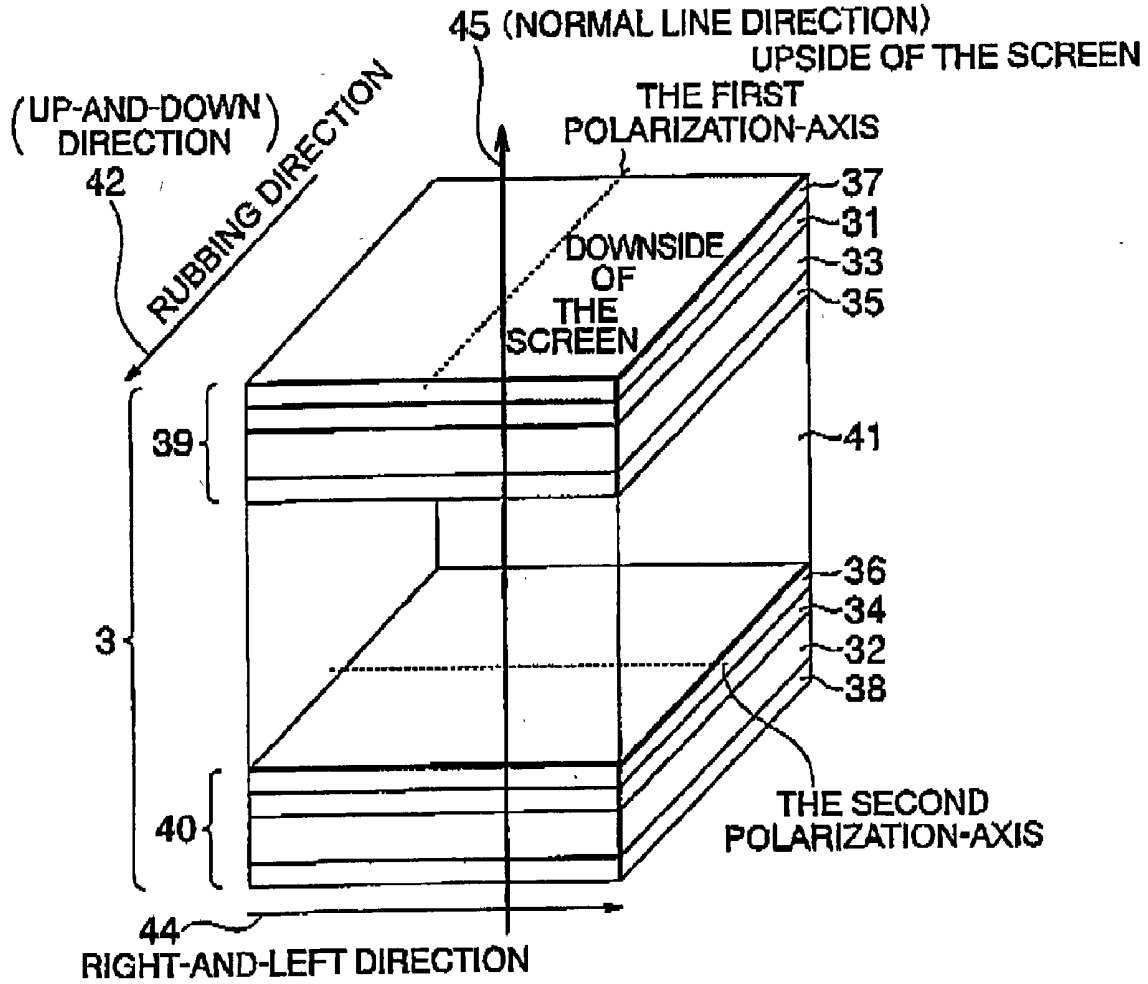

45 (NORMAL LINE DIRECTION)
UPSIDE OF THE SCREEN
THE FIRST POLARIZATION-AXIS
(UP-AND-DOWN DIRECTION)
42
RUBBING DIRECTION
37
31
33
35
DOWNSIDE OF THE SCREEN
39
41
3
36
34
32
38
40
THE SECOND POLARIZATION-AXIS
44
RIGHT-AND-LEFT DIRECTION

FIG. 3

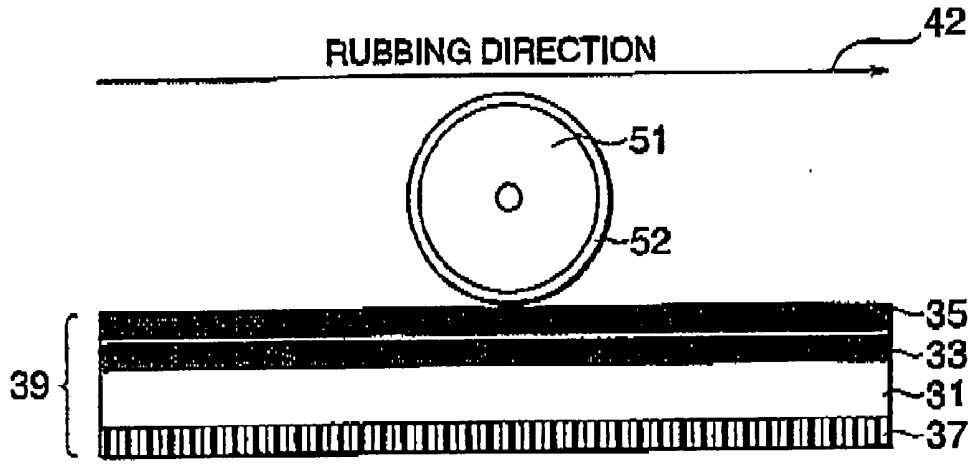

42
RUBBING DIRECTION
51
52
35
33
31
37
39

FIG. 4

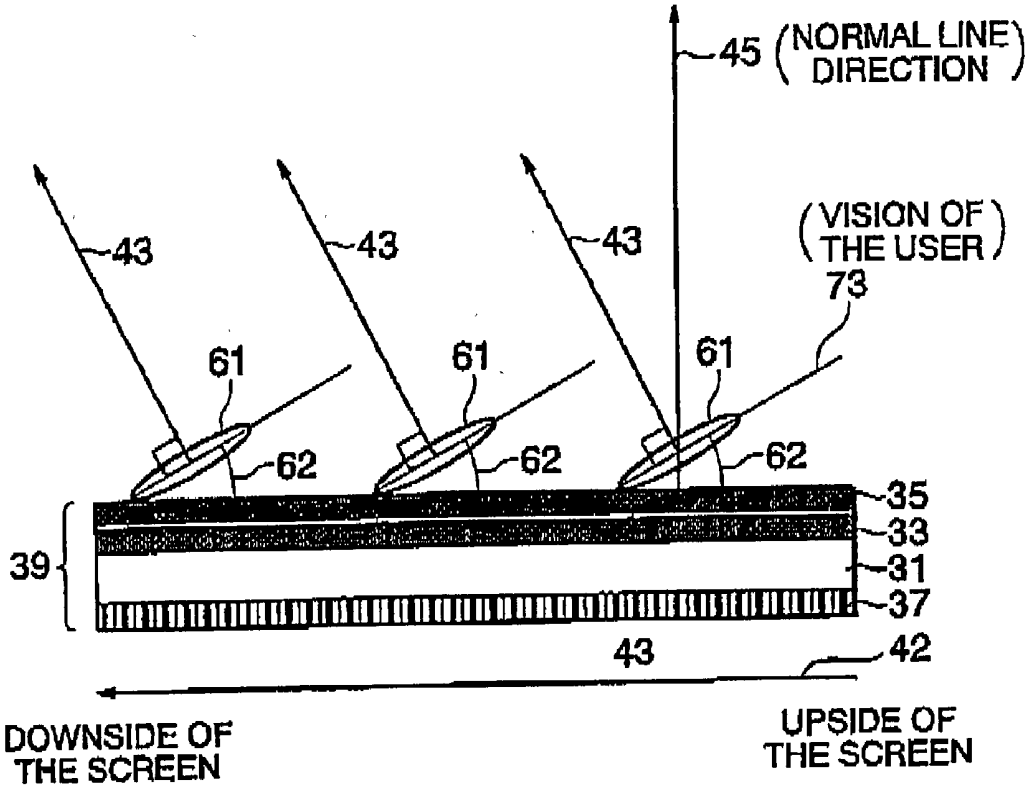

45 (NORMAL LINE DIRECTION)
(VISION OF THE USER)
73
43
43
43
61
61
61
62
62
62
35
33
31
37
39
43
42
DOWNSIDE OF THE SCREEN
UPSIDE OF THE SCREEN

FIG. 5

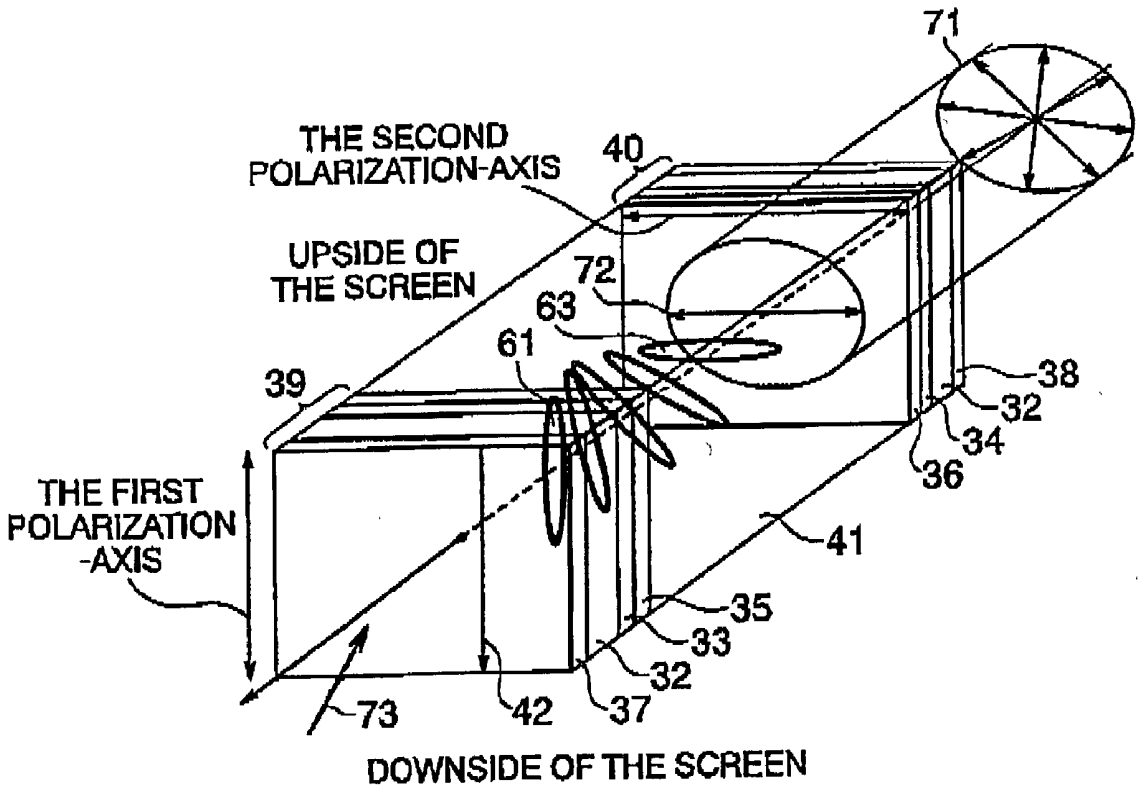

71
THE SECOND POLARIZATION-AXIS
40
UPSIDE OF THE SCREEN
72
63
61
39
38
32
34
36
THE FIRST POLARIZATION -AXIS
41
35
33
32
73
42
37
DOWNSIDE OF THE SCREEN

FIG. 6

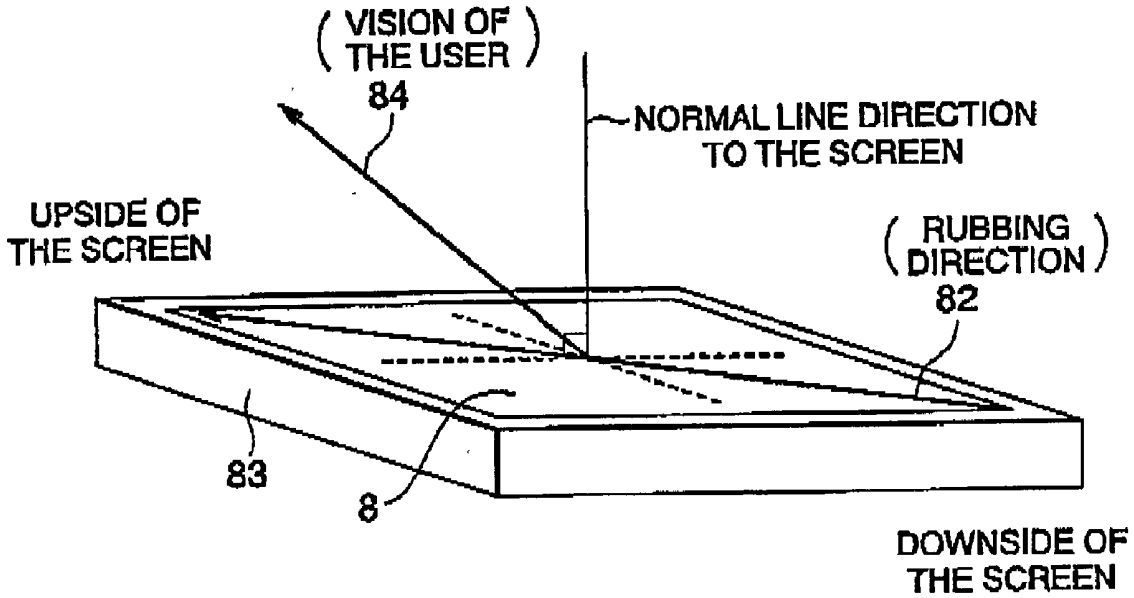

(VISION OF THE USER)
84
NORMAL LINE DIRECTION TO THE SCREEN
UPSIDE OF THE SCREEN
(RUBBING DIRECTION)
82
83
8
DOWNSIDE OF THE SCREEN

FIG. 7

LIQUID CRYSTAL DISPLAY APPARATUS AND TERMINAL EQUIPMENT

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a liquid crystal display apparatus and a terminal equipment for improving the visibility.

[0002] A liquid crystal display (LCD) panels and methods which can provide increased viewing angle over conventional display is disclosed in U.S. Pat. No. 5,856,857.

[0003] Now, the conventional display panel will be described hereinbelow. A panel for a liquid crystal display (LCD) includes a substrate having a plurality of pixel areas defined thereon. A first alignment layer is formed on the substrate, the first alignment layer providing a first pretilt angle for a liquid crystal material. A plurality of second alignment regions is formed on the first alignment layer and are separated from each other with a predetermined spaces between them, the second alignment regions providing a second pretilt angle for the liquid crystal material, respective second alignment regions being separated by a portion of the first alignment layer such that a respective pixel area is covered by the first alignment region and partially covered by a second alignment region. Portions of the first alignment layer and the second alignment regions covering respective adjacent pixel areas have grooves formed therein which are substantially alignment along respective first and second directions. The first and second directions preferably are perpendicular. The pixel areas may be rectangular, and the portion of a respective pixel area covered by a second alignment region may include approximately one-half of the pixel area. The approximately one-half of the pixel area may include a rectangular portion of the pixel area. Preferably, the second pretilt angle is greater than the first pretilt angle.

[0004] In the conventional terminal equipment, the liquid crystal display apparatus has been employed in the note type computer and the liquid crystal monitor. For examples in the note type computer, the center of the screen is below the object of the vision of an user (viewing direction) for the screen. Therefore, the viewing direction is above the normal line direction to the screen.

[0005] However, the above conventional terminal equipment has been found to have the following problems. When the liquid crystal display apparatus employed in the note type computer and the liquid crystal monitor is used in front of the screen and in the viewing direction except for the viewing direction above the normal line direction to the screen, the viewing angle direction is above the normal line direction to match the vision of the user in front of the screen. This results in the deterioration in the visibility.

SUMMARY OF THE INVENTION

[0006] In light of foregoing, it is an object of the present invention to solve the problems (drawbacks) of the prior art as described above and to provide a liquid crystal display apparatus and a terminal equipment for improving the visibility.

[0007] In particular, according to the present invention, A liquid crystal display apparatus includes an upper substrate having a first alignment layer and a first polarization plate. A lower substrate has a second alignment layer and a second polarization plate. A liquid crystal material is sandwiched between the upper substrate and the lower substrate. The first polarizing plate is arranged such that an up-and-down direction of a screen in the liquid crystal display apparatus becomes its first polarization-axis direction. The second polarizing plate is arranged such that its second polarization-axis direction becomes rectangular for the first polarization-axis direction. The first alignment layer is aligned by rubbing-treatment in the first polarization-axis direction. The second alignment layer is aligned by rubbing-treatment in the second polarization-axis direction.

[0008] A second liquid crystal molecules in contact with the interface of the second alignment layer are aligned in the second polarization-axis direction.

[0009] A polarized light emitted from the lower substrate is transmitted from the lower substrate to the upper substrate while oscillating in a longer axis direction of the second liquid crystal molecules.

[0010] A first liquid crystal molecules in contact with the interface of the first alignment layer are aligned such that the first alignment directions of the first liquid crystal molecules are twisted by 90° for the second aligning directions of the first liquid crystal molecules.

[0011] The first liquid crystal molecules moves spirally such that a longer axis thereof are twisted by 90° for the second aligning directions In the liquid crystal material.

[0012] The first polarization-axis direction, a rubbing treatment direction, and a polarized light oscillating direction are parallel.

[0013] The first liquid crystal molecules are arranged with a pretilt angle for the rubbing treatment direction kept.

[0014] When the first liquid crystal molecules is raised depending on the pretilt angle, an oscillation of the polarized light becomes to the maximum value at a part in a direction perpendicular to the longer axis direction of the first liquid crystal molecules, the direction being a viewing direction of the liquid crystal display apparatus.

[0015] A liquid crystal display apparatus includes an upper substrate having a first alignment layer and a first polarization plate. A lower substrate has a second alignment layer and a second polarization plate. A liquid crystal material is sandwiched between the upper substrate and the lower substrate. The first polarizing plate is arranged such that a direction from lower right to upper left of a screen in the liquid crystal display becomes its first polarization-axis direction. The second polarizing plate is arranged such that its second polarization-axis direction becomes rectangular for the first polarization-axis direction. The first alignment layer is aligned by rubbing-treatment in the first polarization-axis direction. The second alignment layer is aligned by rubbing-treatment in the second polarization-axis direction.

[0016] A terminal equipment equipped with a liquid crystal display apparatus include an upper substrate having a first alignment layer and a first polarization plate. A lower substrate having a second alignment layer and a second polarization plate. A liquid crystal material is sandwiched between the upper substrate and the lower substrate. The first polarizing plate is arranged such that an up-and-down direction of a screen in the liquid crystal display apparatus becomes its first polarization-axis direction. The second

polarizing plate is arranged such that its second polarization-axis direction becomes rectangular for the first polarization-axis direction. The first alignment layer is aligned by rubbing-treatment in the first polarization-axis direction. The second alignment layer is aligned by rubbing-treatment in the second polarization-axis direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] **FIG. 1** is a block diagram showing one preferred embodiment of a liquid crystal display apparatus in accordance with the present invention;

[0018] **FIG. 2** is an external perspective view showing one preferred embodiment of a terminal equipment equipped with the liquid crystal display apparatus in accordance with the present invention;

[0019] **FIG. 3** is a block diagram showing one preferred embodiment of an liquid crystal display apparatus in accordance with the present invention;

[0020] **FIG. 4** shows the rubbing-treatment process by use of the rubbing-treatment apparatus rubbing a first alignment layer formed in an upper substrate of the liquid crystal display equipped with the terminal equipment according to the present invention;

[0021] **FIG. 5** is a diagram illustrating the operation of a liquid crystal display apparatus in **FIG. 1**;

[0022] **FIG. 6** is a diagram illustrating the operation of a liquid crystal display apparatus in **FIG. 1**; and

[0023] **FIG. 7** is an external perspective view showing another preferred embodiment of a terminal equipment equipped with the liquid crystal display apparatus in accordance with the present invention;

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] An embodiment of the present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be through and complete, and will fully convey the scope of the invention to those skilled in the art.

[0025] Referring to **FIG. 1, a** liquid crystal display **3** is used in case the vision of the user (indicated by **73** in **FIG. 6**) is below the normal line direction to the screen, and is equipped with a terminal equipment **1**.

[0026] The liquid crystal display **3** comprises an upper substrate **39** and a lower substrate **40**. The upper substrate **39** has an upper glass substrate **31**, a transparent electrode **33**, a first alignment layer **35**, and a first polarizing plate **37**. The lower substrate **40** has a lower glass substrate **32**, a transparent electrode **34**, a second alignment layer **36**, and a second polarizing plate **38**. A liquid crystal material **41** is sandwiched between the upper substrate **39** and the lower substrate **40**. The voltage is applied to the upper glass substrate **31** and the lower glass substrate **32** by the transparent electrode **33** and **34**, so that the alignment of the liquid crystal material **41** is controlled. The first alignment layer **35** and the second alignment layer **36** perform so as to keep the alignment of the liquid crystal material **41** in initial condition during the no voltage application.

[0027] The image produced by the alignment-control for the liquid crystal material **41** transmits and intercepts incident light from the lower substrate **40**. Then, a user see downward the upper substrate **39** identify the image.

[0028] Referring to **FIG. 3**, the first polarizing plate **37** is arranged such that an up-and-down direction (indicated by the arrows **42** of **FIG. 3**) of the liquid crystal display **3** becomes its first polarization-axis direction of the first polarizing plate **37**. The second polarizing plate **38** is arranged such that its second polarization-axis direction becomes rectangular for the first polarization-axis direction, for example a right-and-left direction (indicated by the arrows **44** of **FIG. 3**) of the liquid crystal display **3** becomes its second polarization-axis direction of the second polarizing plate **38**.

[0029] The first alignment layer **35** formed in the upper substrate **39** is performed an, alignment-treatment by rubbing-treatment in the first polarization-axis direction, that is, an up-and-down direction of a screen. Similarly, the second alignment layer **36** formed in the lower substrate **40** is performed an alignment-treatment by rubbing-treatment in the second polarization-axis direction, that is, the right-and-left direction (indicated by the arrows **44** of **FIG. 3**) of a screen.

[0030] A liquid crystal material sandwiched between the upper substrate **39** and the lower substrate **40**, and is closely fixed therein, by laminating two sheet of substrates such that each of first and second polarization-axis direction is rectangular each other and first polarization-axis direction becomes the up-and-down direction of a screen (indicated by the arrows **42** of **FIG. 3**), the up-and-down direction being the alignment direction by rubbing-treatment.

[0031] A direction of incident light in the liquid crystal display **3** becomes a direction from the lower substrate **40** to the upper substrate **39**.

[0032] Next, the alignment direction by rubbing-treatment and the alignment direction of the liquid crystal material **41** according to an embodiment of the present invention will be described with reference to **FIG. 4**. **FIG. 4** shows the rubbing-treatment process by use of the rubbing-treatment apparatus rubbing the first alignment layer **35** formed in the upper substrate **39** of the liquid crystal display **3** equipped with the terminal equipment according to the present invention. The rubbing-treatment apparatus has roller **51** to which the cloth is wound. When the first alignment layer **35** formed in the upper substrate **39** is rubbed by the roller **51**, the first alignment layer **35** is scratched in the direction indicated by the arrows **42** of **FIG. 3**. Similarly, when the second alignment layer **36** formed in the lower substrate **40** is rubbed by the roller **51**, the second alignment layer **36**, is scratched in the direction indicated by the arrows **42** of **FIG. 3**. Then, the upper substrate **39** and the lower substrate **40** are laminated, and sandwich the liquid crystal material therebetween, the liquid crystal material is fixed. As shown **FIG. 5**, In such a case, first liquid crystal molecules **61** which exists in contact with the interface of the first alignment layer **35** (inside the upper substrate **39** opposite to the lower substrate **40**) are aligned with a pretilt angle **62** for the laminated direction (indicated by the arrows **42** of **FIG. 3**) kept.

[0033] Next, the operation of the liquid crystal display apparatus will be described. At fast, referring to **FIGS. 5 and 6**, a viewing angle indicated by **FIG. 1** will be described.

[0034] Generally, the liquid crystal molecule is a bar-like. A polarized light is transmitted inside the liquid crystal material from the lower substrate **40** to the upper substrate **39** while oscillating in a longer axis direction of the second liquid crystal molecules. The polarized light is polarized at random. The polarized light is emitted from outside the lower substrate **40**.

[0035] Then, as shown **FIG. 6**, since the second polarizing plate **38** is laminated more outside the upper substrate **40**, its second polarization-axis direction becomes rectangular for the first polarization-axis direction. Thus, the second polarization-axis direction becomes the right-and-left direction (indicated by the arrows **44** of **FIG. 6**). The incident light **71** oscillates parallel in the second polarization-axis direction of the second polarizing plate **38** so that the incident light **71** becomes polarized light **72**. Second liquid crystal molecules **63** in contact with the interface of the second alignment layer **36** are aligned in the second polarization-axis direction of the second polarizing plate **38**, that is, in the screen right-and-left direction (indicated by the arrows **44** of **FIG. 3**) of the liquid crystal display **3**. Accordingly, the polarized light **72** is transmitted inside the liquid crystal material from the lower substrate **40** to the upper substrate **39** while oscillating in a longer axis direction of the second liquid crystal molecules **63**.

[0036] The first liquid crystal molecules **61** in contact with the interface of the first alignment layer **35** are aligned such that the first alignment directions of the first liquid crystal molecules **61** are twisted by 90° for the second aligning directions of the first liquid crystal molecules **61**. Since the first alignment layer **35** is arranged by rubbing such that its first polarization-axis direction becomes rectangular for the second polarization-axis direction in the second alignment layer **36**, a first liquid crystal molecules **61** in contact with the interface of the first alignment layer **35** are aligned such that the first alignment directions (a longer axis directions) of the first liquid crystal molecules **61** are twisted by 90° for the second aligning directions (a longer axis directions) of the second liquid crystal molecules **63**. Thus, the aligning direction of the liquid crystal molecules changes spirally from the second aligning directions to the first aligning directions. Accordingly, the polarization light oscillates to the longer axis directions of the molecules, that is, the polarization light oscillates in the longer axis directions of the liquid crystal molecules at the interface of the first alignment layer **35**. The first polarization-axis direction of the first polarizing plate **37**, the first alignment directions by rubbing, and the oscillating directions of the polarization light **72** are parallel each other. Therefore, the first polarizing plate **37** transmits the polarization light **72** and the polarization light **72** comes to the viewing direction of the user, so that a white display performs.

[0037] At this time, the first liquid crystal molecules **61** are aligned with a pretilt angle **62** for the rubbing treatment direction kept. Since the alignment-treatment performs in a direction from lower to upper of a screen in the liquid crystal display **3**, the first liquid crystal molecules **61** is arranged with a pretilt angle **62** kept in an up direction of the screen.

[0038] As shown **FIG. 5**, when the first liquid crystal molecules **61** is raised depending on the pretilt angle **62**, an oscillation of the polarized light **72** becomes to the maximum value at a part in a direction **43** perpendicular to the longer axis direction (the viewing direction of the user) **73** of the first liquid crystal molecules **61**. Therefore, the viewing direction is below the normal line direction to the screen.

[0039] When the voltage is not applied to the upper glass substrate **31** and the lower glass substrate **32** by the transparent electrode **33** and **34**, the liquid crystal material **41** aligns as described above and transmits the polarization light **72**. When the voltage is not applied to the upper glass substrate **31** and the lower glass substrate **32** by the transparent electrode **33** and **34**, the liquid crystal material **41** and the first and the second liquid crystal molecules **61** and **63** which are part thereof raise together. Therefore, a direction perpendicular to the longer axis direction of the first and the second liquid crystal molecules **61** and **63** become to the normal line direction to the screen. Accordingly, the incident light **71** and the polarization light **72** polarized by polarizing plate **38** can not be oscillated in the longer axis direction of the second liquid crystal molecules **63** in the interface of the second alignment layer **36**. As a result, the polarization light **72** does not come to the viewing direction of the user through the upper substrate **39**, so that a black display performs.

[0040] Next, another embodiment of the present invention will be described with reference to the **FIG. 7**. Referring to **FIG. 7**. the rubbing-treatment is performed to the upper substrate in the direction (indicated by the arrows **82** of **FIG. 7**) from lower right to upper left of a screen in the liquid crystal display **8**. Therefore, the liquid crystal molecules exist adjacent to the interface of the alignment layer of the upper substrate is aligned with pretilt angle kept in an upper left direction of the screen. Accordingly, the viewing direction of the liquid crystal display **8** is broad in an upper left direction for the normal line direction. Thus, the terminal equipment **83** equipped with a liquid crystal display apparatus **8** provides the amelioration in the visibility, when an user utilizes the liquid crystal monitor such that the viewing direction of the user becomes to the direction from an upper left direction to a lower right direction.

[0041] According to the present invention, the amelioration in the visibility is provided corresponding to the viewing angle of the user, since the viewing angle is set in the rubbing direction corresponding to viewing direction easy to use. Therefore, the terminal equipment **83** equipped with a liquid crystal display apparatus **8** can be applied to the board type computer and the point of sale terminal (POS terminal).

What is claimed is:

1. A liquid crystal display apparatus comprising:

an upper substrate having a first alignment layer and a first polarization plate;

a lower substrate having a second alignment layer and a second polarization plate; and

a liquid crystal material sandwiched between the upper substrate and the lower substrate;

wherein the first polarizing plate is arranged such that an up-and-down direction of a screen in the liquid crystal display apparatus becomes its first polarization-axis direction, and

wherein the second polarizing plate is arranged such that its second polarization-axis direction becomes rectangular for the first polarization-axis direction, and

wherein the first alignment layer is aligned by rubbing-treatment in the first polarization-axis direction, and

wherein the second alignment layer is aligned by rubbing-treatment in the second polarization-axis direction.

2. The liquid crystal display apparatus as claimed in claim 1, wherein:

a second liquid crystal molecules in contact with the interface of the second alignment layer are aligned in the second polarization-axis direction.

3. The liquid crystal display apparatus as claimed in claim 2, wherein:

a polarized light emitted from the lower substrate is transmitted from the lower substrate to the upper substrate while oscillating in a longer axis direction of the second liquid crystal molecules.

4. The liquid crystal display apparatus as claimed in claim 3, wherein:

a first liquid crystal molecules in contact with the interface of the first alignment layer are aligned such that the first alignment directions of the first liquid crystal molecules are twisted by 90° for the second aligning directions of the first liquid crystal molecules.

5. The liquid crystal display apparatus as claimed in claim 4, wherein:

the first liquid crystal molecules moves spirally such that a longer axis thereof are twisted by 90° for the second aligning directions in the liquid crystal material.

6. The liquid crystal display apparatus as claimed in claim 5, wherein:

the first polarization-axis direction, a rubbing treatment direction, and a polarized light oscillating direction are parallel.

7. The liquid crystal display apparatus as claimed in claim 6, wherein:

the first liquid crystal molecules are arranged with a pretilt angle for the rubbing treatment direction kept.

8. The liquid crystal display apparatus as claimed in claim 7, wherein:

when the first liquid crystal molecules is raised depending on the pretilt angle, an oscillation of the polarized light becomes to the maximum value at a part in a direction perpendicular to the longer axis direction of the first liquid crystal molecules, the direction being a viewing direction of the liquid crystal display apparatus.

9. A liquid crystal display apparatus comprising;

an upper substrate having a first alignment layer and a first polarization plate;

a lower substrate having a second alignment layer and a second polarization plate; and

a liquid crystal material sandwiched between the upper substrate and the lower substrate,

wherein the first polarizing plate is arranged such that a direction from lower right to upper left of a screen in the liquid crystal display becomes its first polarization-axis direction, and

wherein the second polarizing plate is arranged such that its second polarization-axis direction becomes rectangular for the first polarization-axis direction, and

wherein the first alignment layer is aligned by rubbing-treatment in the first polarization-axis direction, and

wherein the second alignment layer is aligned by rubbing-treatment in the second polarization-axis direction.

10. A terminal equipment equipped with a liquid crystal display apparatus comprising:

an upper substrate having a first alignment layer and a first polarization plate;

a lower substrate having a second alignment layer and a second polarization plate; and

a liquid crystal material sandwiched between the upper substrate and the lower substrate,

wherein the first polarizing plate is arranged such that an up-and-down direction of a screen in the liquid crystal display apparatus becomes its first polarization-axis direction, and

wherein the second polarizing plate is arranged such that its second polarization-axis direction becomes rectangular for the first polarization-axis direction, and

wherein the first alignment layer is aligned by rubbing-treatment in the first polarization-axis direction, and

wherein the second alignment layer is aligned by rubbing-treatment in the second polarization-axis direction.

* * * * *

专利名称(译)	液晶显示装置和终端设备		
公开(公告)号	US20030160913A1	公开(公告)日	2003-08-28
申请号	US10/305350	申请日	2002-11-27
[标]申请(专利权)人(译)	日通工株式会社		
申请(专利权)人(译)	NEC Infrontia公司		
当前申请(专利权)人(译)	NEC Infrontia公司		
[标]发明人	YAMASHITA SHUNICHI		
发明人	YAMASHITA, SHUNICHI		
IPC分类号	G02F1/1335 G02F1/1337		
CPC分类号	G02F1/133528 G02F2001/133531 G02F1/133784		
优先权	2001362767 2001-11-28 JP		
外部链接	Espacenet USPTO		

摘要(译)

一种液晶显示装置，包括具有第一取向层和第一偏振板的上基板。下基板具有第二取向层和第二偏振板。液晶材料夹在上基板和下基板之间。第一偏振板被布置成使得液晶显示装置中的屏幕的上下方向变为其第一偏振轴方向。第二偏振板被布置成使得其第二偏振轴方向对于第一偏振轴方向变为矩形。通过在第一偏振轴方向上进行摩擦处理来对准第一取向层。通过在第二偏振轴方向上进行摩擦处理来对准第二取向层。