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(54) **LIQUID CRYSTAL DISPLAY PANEL USED IN CURVED DISPLAY DEVICE AND CURVED DISPLAY DEVICE**

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G02F 1/1335 (2006.01)

G02F 1/1368 (2006.01)

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(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0110022 A1* 5/2010 Chen G06F 3/0414 345/173

2011/0228190 A1 9/2011 Yang et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 104155809 A 11/2014

CN 104298015 A 1/2015

(Continued)

OTHER PUBLICATIONS

Office Action dated Jul. 27, 2017, by the State Intellectual Property Office of the People's Republic of China in corresponding Chinese Patent Application No. 201510645400.2 (6 pages).

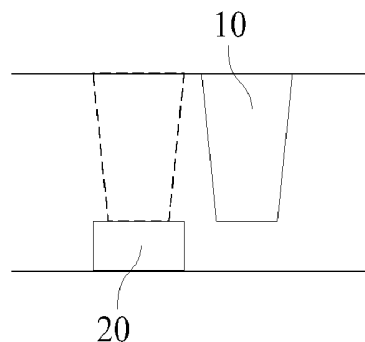
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Primary Examiner — Thoi V Duong

(57) **ABSTRACT**

Provided is a liquid crystal display panel used in a curved display device and the curved display device. This belongs to the field of display technologies, and solves the technical problem of inferior display caused by inhomogeneous cell thickness that would easily occur to an existing curved display device. The liquid crystal display panel includes: an upper substrate provided with a plurality of spacers thereon; and a lower substrate provided with a plurality of bosses thereon, in one-to-one correspondence with the plurality of spacers. At least one of the plurality of spacers has a distance to a central axis of the liquid crystal display panel shorter than a distance from its corresponding boss to the central axis of the liquid crystal display panel. The liquid crystal

(Continued)



display panel can be used in large-sized curved display devices such as liquid crystal display televisions.

14 Claims, 2 Drawing Sheets

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2012/0138653	A1	6/2012	Kim et al.	
2015/0370116	A1	12/2015	Chae et al.	
2016/0109743	A1	4/2016	Wu	
2016/0349561	A1*	12/2016	Shiina	G02F 1/13394
2016/0377900	A1	12/2016	Qu	
2017/0160577	A1	6/2017	Tang	

FOREIGN PATENT DOCUMENTS

CN	104914607	A	9/2015
CN	104932153	A	9/2015
JP	2004-77860	A	3/2004
KR	10-2010-0021021	A	2/2010
KR	10-1552902	B1	9/2015
TW	201133430	A	10/2011

OTHER PUBLICATIONS

Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority (Forms PCT/ISA/210, PCT/ISA/220, and PCT/ISA/237) dated Jul. 15, 2016, by the State Intellectual Property Office of People's Republic of China Patent Office in corresponding International Application No. PCT/CN2015/092368. (12 pages).

* cited by examiner

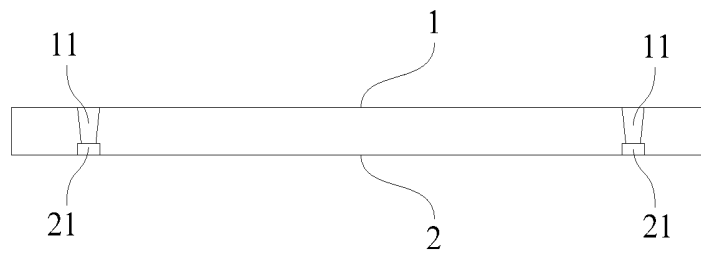


Fig. 1
Prior Art

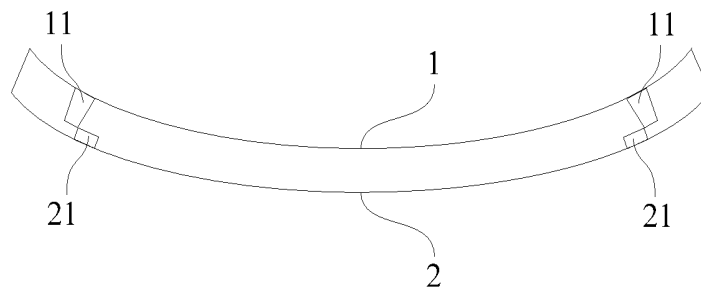


Fig. 2
Prior Art

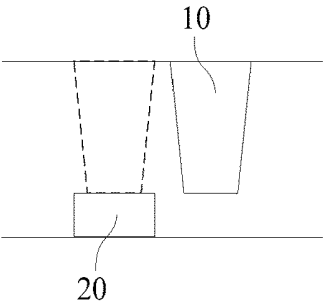


Fig. 3a

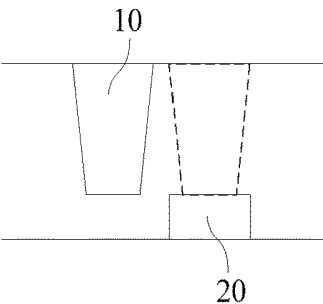


Fig. 3b

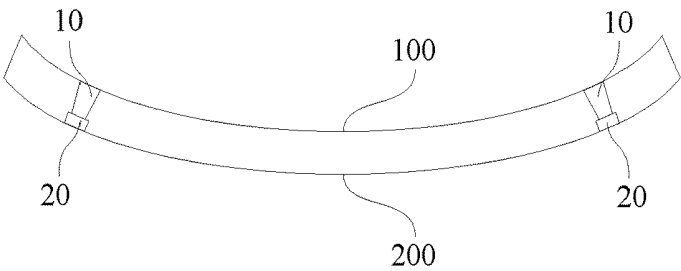


Fig. 4

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LIQUID CRYSTAL DISPLAY PANEL USED IN CURVED DISPLAY DEVICE AND CURVED DISPLAY DEVICE

The present application claims the priority of Chinese patent application CN 201510645400.2, entitled "Liquid crystal display panel used in curved display device and curved display device" and filed on Oct. 8, 2015, the entirety of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present disclosure relates to the field of display technologies, and in particular, to a liquid crystal display panel used in a curved display device and the curved display device.

BACKGROUND OF THE INVENTION

A curved display device, with a curved screen, can more exactly restore human eyes' true visual perception, due to its ability to achieve equal distances from different pixels on the screen to the human eyes. Therefore, the curved display device is more competitive than a conventional flat panel display device.

The curved display device can be manufactured through the following steps. A planar array substrate and a planar color filter substrate are first manufactured, followed by alignment and assembling therebetween, to form a planar liquid crystal display panel. The planar liquid crystal display panel is then bent, to form an internally concave curved liquid crystal display panel. As shown in FIG. 1, a color filter substrate **1** is provided thereon with a plurality of columnar spacers **11**, and an array substrate **2** is correspondingly provided thereon with a plurality of bosses **21**. After the color filter substrate **1** and the array substrate **2** are aligned and assembled, an end of each of the spacers **11** can abut against a corresponding boss **21**, so as to function as a support. The liquid crystal display panel can thus maintain a certain thickness.

However, after the planar liquid crystal display panel is bent, the color filter substrate **1** and the array substrate **2** will move with respect to each other. And such relative movement will have different directions at different positions in the liquid crystal display panel. As illustrated in FIG. 2, at a left side of the liquid crystal display panel, the color filter substrate **1** moves left with respect to the array substrate **2**; while at a right side of the liquid crystal display panel, the color filter substrate **1** moves right with respect to the array substrate **2**. This also causes dislocation between the spacer **11** and its corresponding boss **21**, such that the end of the spacer **11** will not be able to abut against its corresponding boss **21**. As a result, the technical problem of inferior display would arise due to inhomogeneous cell thickness of the liquid crystal display panel.

SUMMARY OF THE INVENTION

The present disclosure aims to provide a liquid crystal display panel used in a curved display device and the curved display device, so as to solve the technical problem of inferior display caused by inhomogeneous cell thickness that easily occurs to an existing curved display device.

The present disclosure provides a liquid crystal display panel used in a curved display device, comprising:

an upper substrate provided with a plurality of spacers thereon; and

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a lower substrate provided with a plurality of bosses thereon, in one-to-one correspondence with the plurality of spacers,

wherein at least one of the plurality of spacers has a distance to a central axis of the liquid crystal display panel shorter than a distance from its corresponding boss to the central axis of the liquid crystal display panel.

Preferably, a difference between a distance from any one of the plurality of spacers to the central axis of the liquid crystal display panel and a distance from a corresponding boss to the central axis of the liquid crystal panel is smaller than 20 μm .

Further, said difference in distance gradually increases in a direction from a center to either end of the liquid crystal display panel.

Further, the upper substrate is further provided thereon with a plurality of auxiliary spacers.

Preferably, the number of the auxiliary spacers is 8 to 12 times that of the spacers.

Further, the upper substrate is a color filter substrate, and the lower substrate is an array substrate.

Preferably, the plurality of bosses is arranged at positions where thin film transistors are located.

The present disclosure further provides a curved display device, comprising a curved liquid crystal display panel formed by the above liquid crystal display panel after being bent.

The present disclosure brings about the following beneficial effects. According to the liquid crystal display panel provided in the present disclosure, the spacers arranged on the upper substrate are configured as having smaller distances to the central axis than their corresponding bosses arranged on the lower substrate. After the liquid crystal display panel is bent, due to relative movement between the upper substrate and the lower substrate, the spacers can be accurately aligned with their corresponding bosses, such that an end of each of the spacers can exactly abut against its corresponding boss. This can maintain a constant cell thickness of the bent liquid crystal display panel, and prevent the technical problem of inferior display that would be otherwise caused by inhomogeneous cell thickness.

Other features and advantages of the present disclosure will be further explained in the following description, and partly become self-evident therefrom, or be understood through implementing the present disclosure. The objectives and advantages of the present disclosure will be achieved through the structure specifically pointed out in the description, claims, and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to explicitly illustrate the technical solution of the embodiments of the present disclosure, the embodiments will be described in combination with accompanying drawings, in which:

FIG. 1 schematically shows a liquid crystal display panel before being bent in an existing curved display device;

FIG. 2 schematically shows the liquid crystal display panel after being bent in the existing curved display device;

FIGS. 3a and 3b schematically show spacers and bosses of a liquid crystal display panel provided in an embodiment of the present disclosure at a left side and a right side, respectively; and

FIG. 4 schematically shows the liquid crystal display panel after being bent as provided in the embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The present disclosure will be explained in details with reference to the embodiments and the accompanying drawings, whereby it can be fully understood how to solve the technical problem by the technical means according to the present disclosure and achieve the technical effects thereof, and thus the technical solution according to the present disclosure can be implemented. It is important to note that as long as there is no structural conflict, all the technical features mentioned in all the embodiments may be combined together in any manner, and the technical solutions obtained in this manner all fall within the scope of the present disclosure.

According to an embodiment of the present disclosure, a liquid crystal display panel used in a curved display device is provided, mainly comprising an upper substrate and a lower substrate. In the present embodiment, constitution of a most commonly seen liquid crystal display panel will be referred to as an example for detailed explanations. That is, the upper substrate is a color filter substrate, and the lower substrate is an array substrate, and liquid crystals are filled between the color filter substrate and the array substrate.

In the present embodiment, the color filter substrate is provided thereon with a plurality of spacers, and the array substrate is provided thereon with a plurality of bosses, in one-to-one correspondence with the plurality of spacers. These bosses constitute highest positions of multiple layer structures of the array substrate. In one preferred embodiment, the bosses can be arranged at positions where thin film transistors are located. As the layer structure at the positions where the thin film transistors are located is usually most complex, such positions typically form highest positions of the array substrate.

At least one of the plurality of spacers has a distance to a central axis of the liquid crystal display panel shorter than a distance from its corresponding boss to the central axis of the liquid crystal display panel. That is, the spacer is nearer to the central axis than its corresponding boss.

As depicted in FIG. 3a, at a left side of the liquid crystal display panel, a spacer 10 deflects right with respect to its corresponding boss 20. And as shown in FIG. 3b, at a right side of the liquid crystal display panel, the spacer 10 deflects left with respect to its corresponding boss 20.

A difference between a distance from any one of the plurality of spacers 10 to the central axis of the liquid crystal display panel and a distance from a corresponding boss 20 to the central axis of the liquid crystal panel is smaller than 20 μm . Generally, such a difference in distance can be selected as several microns or a dozen microns. A specific value of the difference in distance should be accurately measured and calculated as per actual parameters of the liquid crystal display panel, such as sizes and curvature thereof.

Further, in a direction from a center to either end of the liquid crystal display panel, said difference in distance gradually increases. That is, the distance between the spacer 10 and its corresponding boss 20 gradually increases. As FIG. 4 shows, after the liquid crystal display panel is bent, the degree of dislocation between a color filter substrate 100 and an array substrate 200 increases towards two ends of the liquid crystal display panel. Therefore, at the two ends of the liquid crystal display panel, the distance from the spacer 10 to its corresponding boss 20 is increased accordingly. Thus, after the liquid crystal display panel is bent, all the spacers 10 can be accurately aligned with their corresponding bosses

20, such that an end of the spacer 10 can precisely abut against its corresponding boss 20. As a result, the liquid crystal display panel can be maintained with a constant cell thickness after being bent, thereby preventing the technical problem of inferior display that would be otherwise caused by inhomogeneous cell thickness.

It should be noted that, in a center region of the liquid crystal display panel, i.e., in the vicinity of the central axis of the liquid crystal display panel, only a small degree of or even no relative displacement occurs between the spacer and its corresponding boss after the liquid crystal display panel is bent. Therefore, in the center region of the liquid crystal display panel, the distance from the spacer to the central axis can be equal to that from its corresponding boss to the central axis. That is, it can be unnecessary to deflect the spacer toward the central axis.

Of course, where a relatively strict accuracy is required in cell thickness of the liquid crystal display panel, the spacers can all be deflected, such that the spacers will be all closer to the central axis than their corresponding bosses.

Further, the color filter substrate 100 in the present embodiment is further provided thereon with a plurality of auxiliary spacers (not shown in the drawings). The spacers 10 which are deflected toward the central axis as described above can be termed main spacers as well. The number of the auxiliary spacers is 8 to 12 times that of the main spacers.

After the color filter substrate and the array substrate are aligned and assembled with each other, typically, only the main spacers will be in contact with their corresponding bosses provided on the array substrate, so as to support the bosses and maintain the cell thickness formed between the color filter substrate and the array substrate constant. The auxiliary spacers will not be in contact with the array substrate. Only after the color filter substrate is under external pressure, will the auxiliary spacers come into contact with the array substrate, so as to function as an auxiliary support.

According to another embodiment of the present disclosure, a curved display device is further provided, comprising a curved liquid crystal display panel formed after the liquid crystal display panel as provided in the above embodiment of the present disclosure is bent. The curved display device generally refers to a large-sized liquid crystal display television, specifically as large as 49 inches, 55 inches, or even larger.

As the curved display device according to the embodiment of the present disclosure comprises all the technical features of the liquid crystal display panel provided in the above embodiment, it can solve the same technical problems and bring about the same technical effects.

While the embodiments of the present disclosure are described above, the description should not be construed as limitations of the present disclosure, but merely as embodiments for readily understanding the present disclosure. Any one skilled in the art, within the spirit and scope of the present disclosure, can make amendments or modification to the implementing forms and details of the embodiments. Hence, the scope of the present disclosure should be subject to the scope defined in the claims.

The invention claimed is:

1. A liquid crystal display panel used in a curved display device, comprising:

- an upper substrate provided with a plurality of spacers thereon; and
- a lower substrate provided with a plurality of bosses thereon, in one-to-one correspondence with the plurality of spacers,

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wherein, before the liquid crystal display panel is bent for the curved display device, at least one of the plurality of spacers has a distance to a central axis of the liquid crystal display panel shorter than a distance from its corresponding boss to the central axis of the liquid crystal display panel; and after the liquid crystal display panel is bent for the curved display device, an end of each of the spacers exactly abuts against its corresponding boss, and each of the spacers is located at an intermediate portion of its corresponding boss.

2. The liquid crystal display panel according to claim 1, wherein a difference between a distance from any one of the plurality of spacers to the central axis of the liquid crystal display panel and a distance from a corresponding boss to the central axis of the liquid crystal panel is smaller than 20 μm .

3. The liquid crystal display panel according to claim 2, wherein said difference in distance gradually increases in a direction from a center to either end of the liquid crystal display panel.

4. The liquid crystal display panel according to claim 1, wherein the upper substrate is further provided thereon with a plurality of auxiliary spacers.

5. The liquid crystal display panel according to claim 4, wherein the number of the auxiliary spacers is 8 to 12 times that of the spacers.

6. The liquid crystal display panel according to claim 1, wherein the upper substrate is a color filter substrate, and the lower substrate is an array substrate.

7. The liquid crystal display panel according to claim 6, wherein the plurality of bosses is arranged at positions where thin film transistors are located.

8. A curved display device, comprising a curved liquid crystal display panel formed by a liquid crystal display panel after being bent,

wherein the liquid crystal display panel comprises:
an upper substrate provided with a plurality of spacers thereon; and

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a lower substrate provided with a plurality of bosses thereon, in one-to-one correspondence with the plurality of spacers,

wherein, before the liquid crystal display panel is bent for being used in the curved display device, at least one of the plurality of spacers has a distance to a central axis of the liquid crystal display panel shorter than a distance from its corresponding boss to the central axis of the liquid crystal display panel; and after the liquid crystal display panel is bent for being used in the curved display device, an end of each of the spacers exactly abuts against its corresponding boss, and each of the spacers is located at an intermediate portion of its corresponding boss.

9. The curved display device according to claim 8, wherein a difference between a distance from any one of the plurality of spacers to the central axis of the liquid crystal display panel and a distance from a corresponding boss to the central axis of the liquid crystal panel is smaller than 20 μm .

10. The curved display device according to claim 9, wherein said difference in distance gradually increases in a direction from a center to either end of the liquid crystal display panel.

11. The curved display device according to claim 8, wherein the upper substrate is further provided thereon with a plurality of auxiliary spacers.

12. The curved display device according to claim 11, wherein the number of the auxiliary spacers is 8 to 12 times that of the spacers.

13. The curved display device according to claim 8, wherein the upper substrate is a color filter substrate, and the lower substrate is an array substrate.

14. The curved display device according to claim 13, wherein the plurality of bosses is arranged at positions where thin film transistors are located.

* * * * *

专利名称(译)	用于弯曲显示装置和弯曲显示装置的液晶显示板		
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[标]申请(专利权)人(译)	深圳市华星光电技术有限公司		
申请(专利权)人(译)	深圳中星光电科技有限公司		
当前申请(专利权)人(译)	深圳市中国星光电科技有限公司.		
[标]发明人	LIU SIYANG WANG ZUI		
发明人	LIU, SIYANG WANG, ZUI		
IPC分类号	G02F1/1339 G02F1/1368 G02F1/1335		
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优先权	201510645400.2 2015-10-08 CN		
其他公开文献	US20180136503A1		
外部链接	Espacenet		

摘要(译)

提供一种用于弯曲显示装置和弯曲显示装置的液晶显示面板。这属于显示技术领域，并且解决了由现有的弯曲显示装置容易发生的不均匀的单元厚度引起的劣质显示的技术问题。液晶显示面板包括：上基板，其上设置有多多个间隔物；以及在其上设置有多多个凸台的下基板，与多个间隔件一一对应。多个间隔物中的至少一个与液晶显示面板的中心轴的距离比从其对应的凸起到液晶显示面板的中心轴的距离短。液晶显示面板可用于大型曲面显示装置，例如液晶显示电视。

