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(54) **TOUCH PANEL HAVING SENSING SPACERS**  
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(22) Filed: **Nov. 28, 2008**

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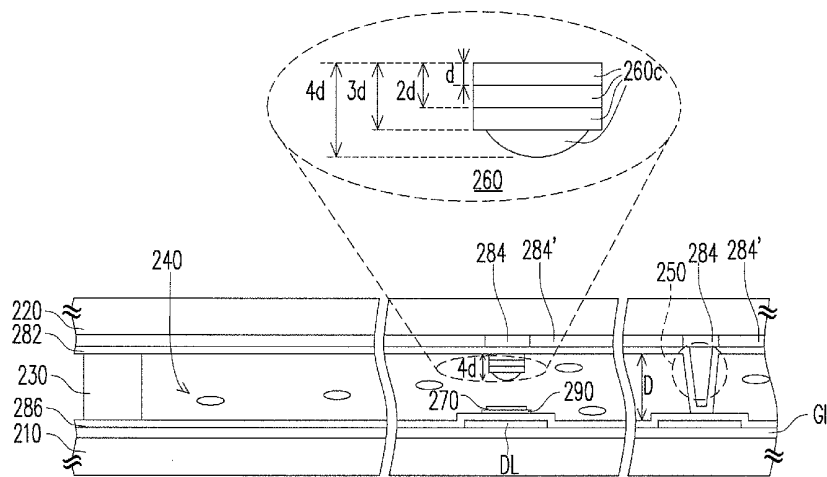
(57) **ABSTRACT**

(51) **Int. Cl.**  
**G02F 1/1335** (2006.01)  
**G02F 1/00** (2006.01)  
**G02B 5/20** (2006.01)  
(52) **U.S. Cl.** ..... **349/12**; 349/106; 349/155; 430/7; 345/173  
(58) **Field of Classification Search** ..... 430/7; 349/153, 155, 106, 110  
See application file for complete search history.

A touch panel including a first substrate, a second substrate, a sealant, a liquid crystal layer, a main spacer, a first sensing spacer, a second sensing spacer, a first opposite electrode and a second opposite electrode is provided. The first substrate has a central area and a peripheral area. The second substrate is disposed opposite to the first substrate. The first sensing spacer is disposed on the central area and between the first and the second substrates. The second sensing spacer is disposed on the peripheral area and between the first and the second substrates. There's a first sensing gap between the first sensing spacer and the first opposite electrode disposed corresponding to the first sensing spacer. There's a second sensing gap between the second sensing spacer and the second opposite electrode disposed corresponding to the second sensing spacer. The first sensing gap is larger than the second sensing gap.

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**15 Claims, 6 Drawing Sheets**



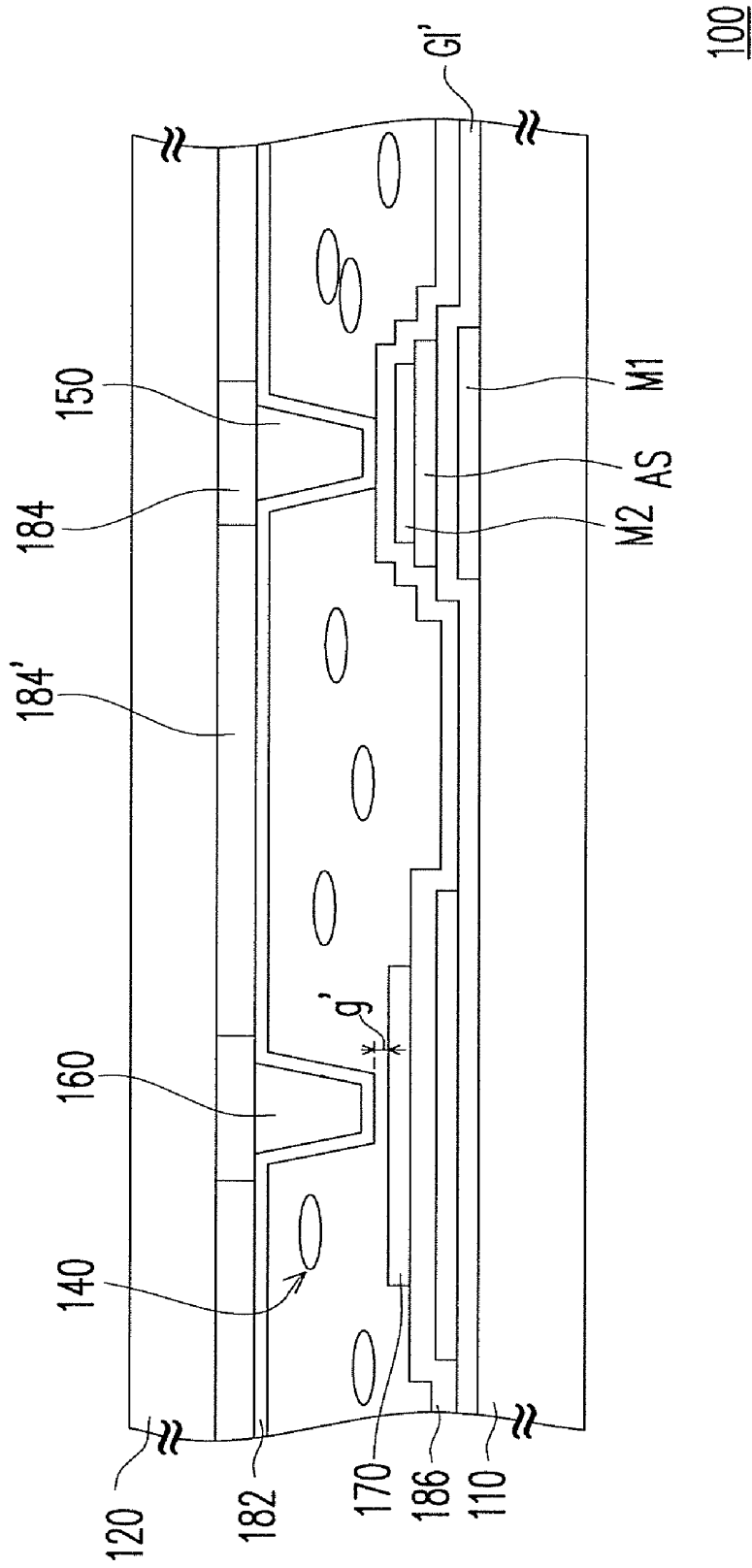


FIG. 1A (PRIOR ART)

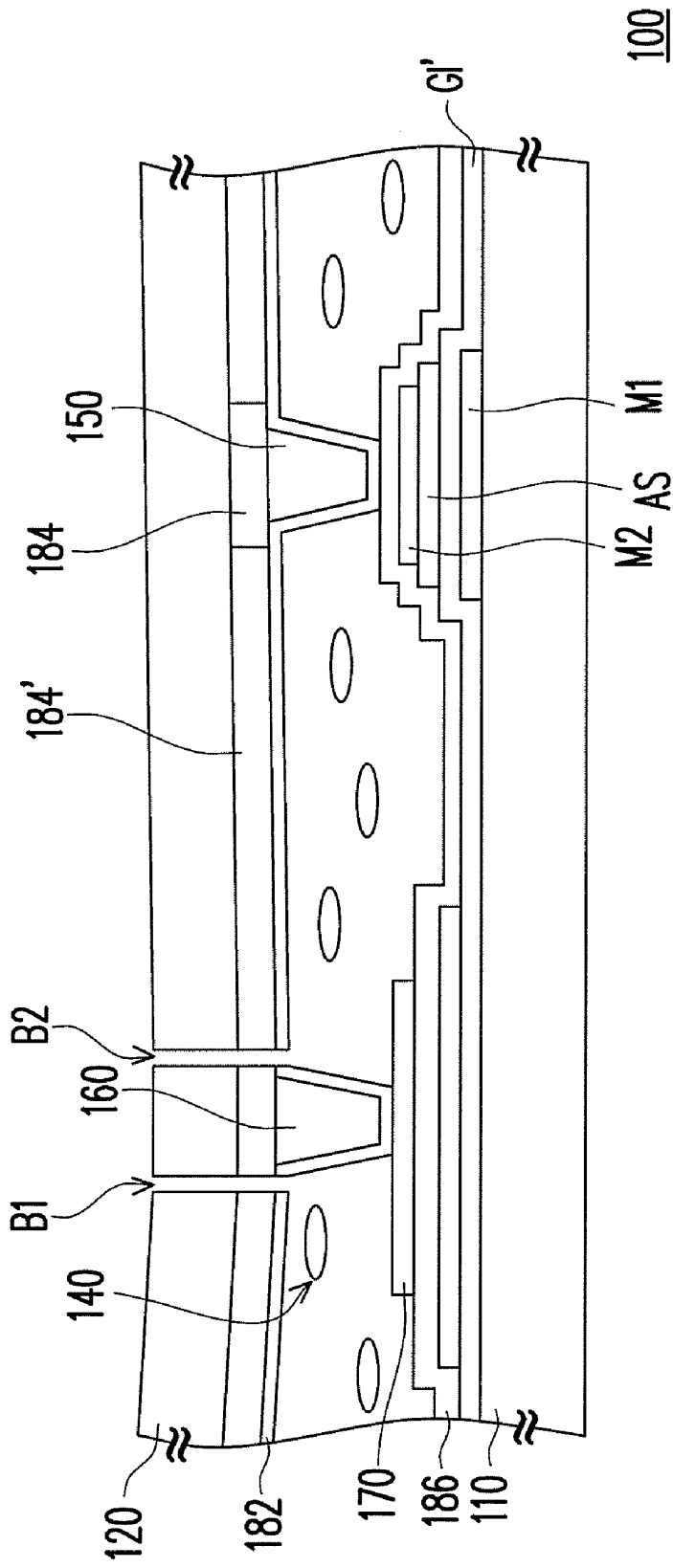


FIG. 1B (PRIOR ART)

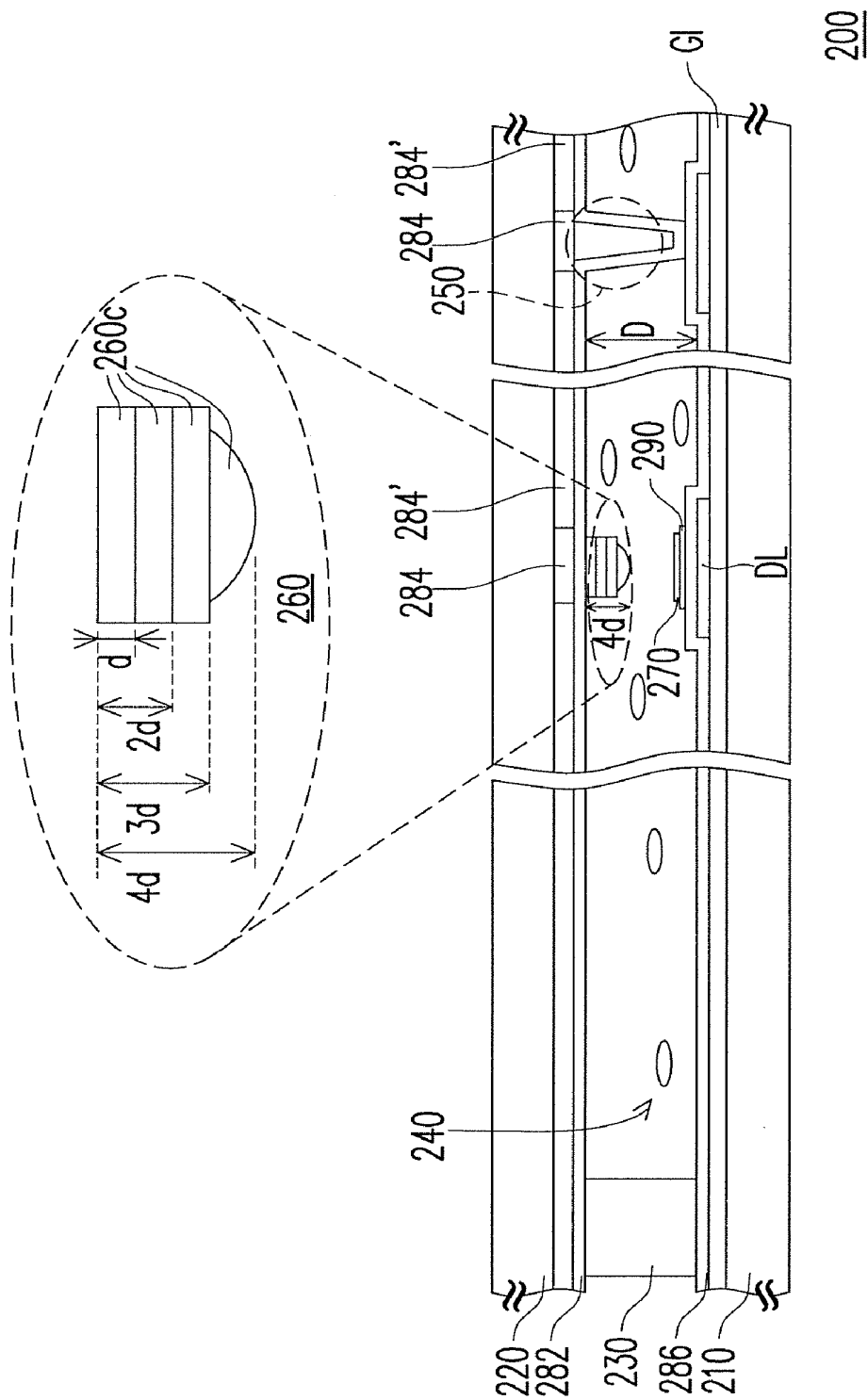


FIG. 2A

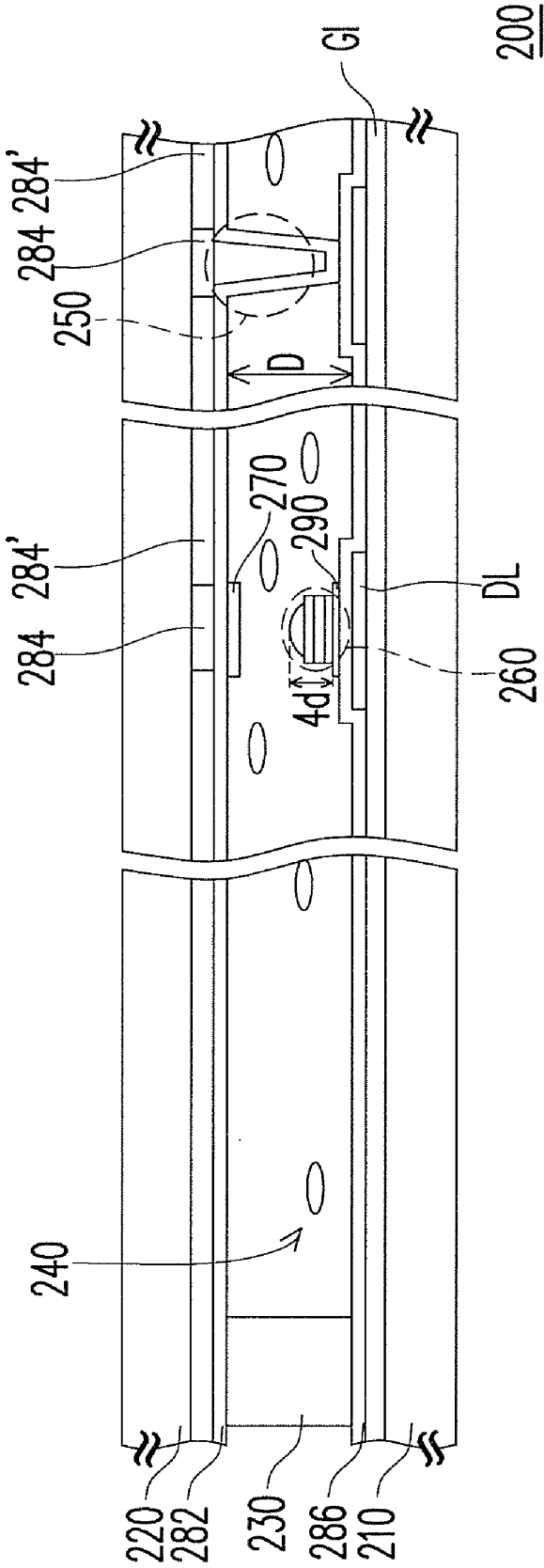


FIG. 2B

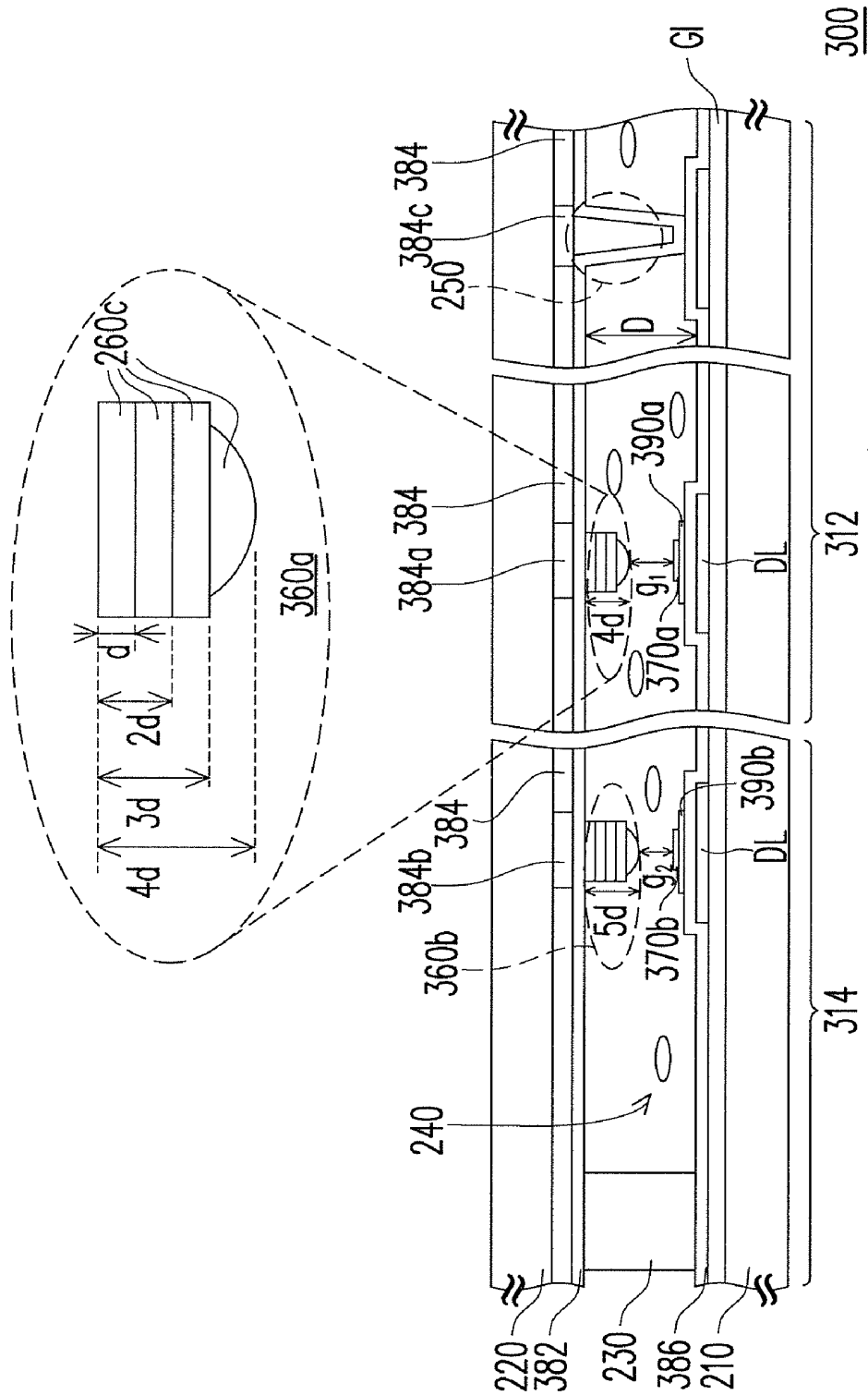


FIG. 3A

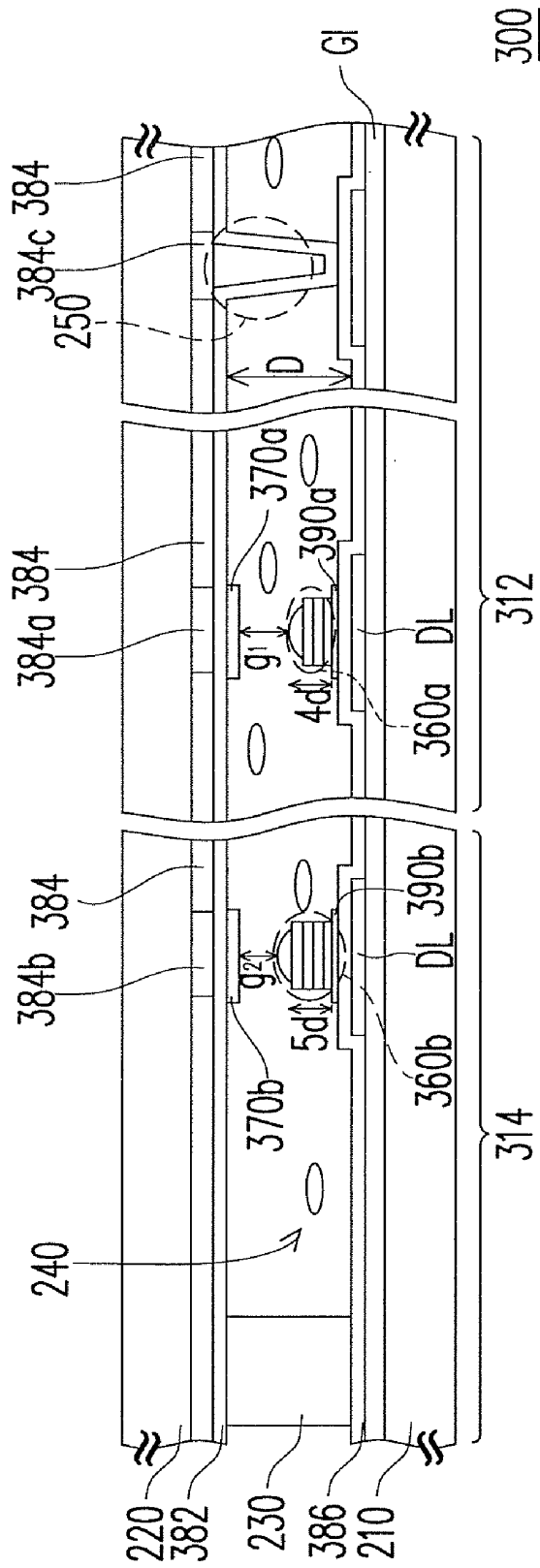


FIG. 3B

## TOUCH PANEL HAVING SENSING SPACERS

## CROSS-REFERENCE TO RELATED APPLICATION

This application claims the priority benefit of Taiwan application serial no. 97132792, filed on Aug. 27, 2008. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

The present invention relates to a display panel, and particularly relates to a touch panel.

## 2. Description of Related Art

At present, a display is one of the most popular among various consumers' optoelectronic products. As display technology advances, the use of displays is making our life more convenient than ever. Hence, the design of touch panels, especially, has become the representative of convenience. By directly touching the display frame, a user may utilize various functions of the touch panel, which simplifies the complexity of operating the touch panel.

Generally speaking, touch panels are categorized into two types, plug-in type and built-in type, according to the structures thereof. A built-in type product is usually thinner and lighter than a plug-in type product. Hence, built-in type touch panels are commonly applied in all kinds of portable electronic devices.

FIG. 1A is a cross-sectional view illustrating a portion of a conventional built-in touch panel. Referring to FIG. 1A, a built-in touch panel 100 includes a first substrate 110, a second substrate 120, a liquid crystal layer 140, a main spacer 150, a sensing spacer 160, an opposite electrode 170, a transparent conductive layer 182, a shielding layer 184, a plurality of color filter layers 184', a protective layer 186, a first metal layer M1, a gate insulating layer GI', an amorphous silicon layer AS, and a second metal layer M2.

The second substrate 120 is disposed opposite to the first substrate 110. The liquid crystal layer 140 and the main spacer 150 are arranged between the first substrate 110 and the second substrate 120. The sensing spacer 160 is disposed on the second substrate 120. The opposite electrode 170 is arranged on the first substrate 110 and corresponds to the sensing spacer 160, wherein the opposite electrode 170 is disposed on the protective layer 186 and contacts the protective layer 186. The transparent conductive layer 182 is disposed on the second substrate 120 and covers the main spacer 150 and the sensing spacer 160.

Generally speaking, the main spacer 150 and the sensing spacer 160 are formed by performing a photomask process, so as to simultaneously complete the fabrication of the main spacer 150 and the sensing spacer 160. However, because of the limitation of the photolithography process, the discrepancy between the height of the sensing spacer 160 and the height of the main spacer 150 is small or none.

Referring to FIG. 1A, when the built-in touch panel 100 is not touched, the shortest distance between the transparent conductive layer 182 covering the sensing spacer 160 and the opposite electrode 170 is a sensing gap  $g'$ . When the user touches the built-in touch panel 100, an electrical change is generated by the contact of the transparent conductive layer 182 covering the sensing spacer 160 and the opposite electrode 170. Thereby, the built-in touch panel 100 determines the area touched by the user.

In the conventional built-in touch panel 100, the sensing gap  $g'$  remains the same or almost the same in every area. When the user touches an area having lower sensitivity, the user needs to apply larger stress so that the transparent conductive layer 182 on the sensing spacer 160 may contact the opposite electrode 170, i.e. to make the sensing gap  $g'$  become 0. However, the transparent conductive layer 182 may be broken if the user applies excessive stress to the built-in touch panel 100, as indicated by the breaking position B1 and B2 in FIG. 1B.

## SUMMARY OF THE INVENTION

The present invention provides a touch panel having sensing spacers of various heights disposed therein for enhancing the touch sensitivity of a low-sensitive area in the touch panel.

The present invention further provides a touch panel comprising sensing gaps of various sizes for enhancing the touch sensitivity of a low-sensitive area in the touch panel.

The present invention further provides a touch panel using an organic conductive material to fabricate a sensing spacer for varying the height of the sensing spacer and the size of a sensing gap.

The present invention provides a touch panel including a first substrate, a second substrate, a sealant, a liquid crystal layer, a main spacer, a first sensing spacer, a second sensing spacer, a first opposite electrode, and a second opposite electrode. The first substrate has a central area and a peripheral area, and the second substrate is disposed opposite to the first substrate. The sealant is disposed on the peripheral area for bonding the first and the second substrates. The liquid crystal layer, the main spacer, the first sensing spacer, and the second sensing spacer are arranged between the first and the second substrates. The first sensing spacer is disposed on the central area, and the second sensing spacer is disposed on the peripheral area. A first sensing gap is arranged between the first sensing spacer and the first opposite electrode disposed corresponding to the first sensing spacer. A second sensing gap is arranged between the second sensing spacer and the second opposite electrode disposed corresponding to the second sensing spacer. The first sensing gap is larger than the second sensing gap.

The present invention further provides a touch panel including a first substrate, a second substrate, a sealant, a liquid crystal layer, a main spacer, a first sensing spacer, and a second sensing spacer. The first substrate has a central area and a peripheral area, and the second substrate is disposed opposite to the first substrate. The sealant is disposed on the peripheral area for bonding the first and the second substrates. The liquid crystal layer, the main spacer, the first sensing spacer, and the second sensing spacer are arranged between the first and the second substrates. The first sensing spacer is disposed on the central area and the second sensing spacer is disposed on the peripheral area. The second sensing spacer is higher than the first sensing spacer.

The present invention further provides a touch panel including a first substrate, a second substrate, a sealant, a liquid crystal layer, a main spacer, and a sensing spacer. The second substrate is disposed opposite to the first substrate. The sealant is used for bonding the first and the second substrates. The liquid crystal layer and the main spacer are disposed between the first substrate and the second substrate. The sensing spacer is disposed on the first substrate or the second substrate, and may be formed by multiple organic conductive layers.



In an embodiment of the present invention, at least one of the first sensing spacer and the second sensing spacer is formed by multiple organic conductive layers.

In an embodiment of the present invention, at least one of the first opposite electrode and the second opposite electrode is formed by multiple organic conductive layers.

In an embodiment of the present invention, the first sensing gap or the second sensing gap ranges from 0.3  $\mu\text{m}$  to 0.8  $\mu\text{m}$ .

In an embodiment of the present invention, at least one of the first sensing spacer and the second sensing spacer has a spherical top or a blunt top.

In an embodiment of the present invention, the first sensing spacer and the second sensing spacer are disposed on a transparent conductive layer and contact the transparent conductive layer.

In an embodiment of the present invention, the touch panel further comprises a first shielding layer, a second shielding layer, and a third shielding layer disposed on the second substrate. In an embodiment, the first shielding layer, the second shielding layer, and the third shielding layer are arranged corresponding to the first sensing spacer, the second sensing spacer, and the main spacer respectively.

In an embodiment of the present invention, the touch panel further comprises a protective layer and a plurality of transparent electrodes. The protective layer disposed on the first substrate and the transparent electrodes disposed on the protective layer are arranged to correspond to the first sensing spacer and the second sensing spacer respectively. In a preferable embodiment, the first opposite electrode and the second opposite electrode are separately disposed on the transparent electrodes.

In an embodiment of the present invention, a material of the organic conductive layer may be selected from a group of poly(3,4-ethylene dioxythiophene)/poly(styrene sulfonate) (PEDOT/PSS), polyaniline, polypyrrole, polythiophene, polyacetylene, polyphenyl, polyfuran, polyselenophene, isothianaphthene, polyphenylsulfide, polystyrene, polythienylstyrene, polynaphthalene, polyanthracene, polypyrene, polyazulene, phthalocyanine, pentacene, hemicyanine dye, and 3,4-polyethylene dioxythiophene (PEDT), but the present invention is not limited thereto.

According to the present invention, the sensing spacers in the touch panel may be fabricated by performing an inkjet process, so as to vary the heights of different sensing spacers simultaneously. Moreover, the present invention may apply the sensing spacers of different heights to overcome the problem that the peripheral area of the touch panel has lower touch sensitivity. From another aspect, the touch sensitivity of the peripheral area in the touch panel may also be enhanced by forming sensing gaps of different sizes. By the means mentioned above, the present invention not only helps to improve the low touch sensitivity of the peripheral area in the touch panel but also prevents the breaking of the transparent conductive layer caused by excessive stress from the user.

To make the above features and advantages of the present invention more comprehensible, several embodiments accompanied with drawings are described in detail as follows.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. 1A is a cross-sectional view illustrating a portion of a conventional built-in touch panel.

FIG. 1B is a cross-sectional view illustrating a portion of the built-in touch panel in FIG. 1A damaged by excessive stress.

FIG. 2A is a cross-sectional view illustrating a portion of a touch panel in the first embodiment of the present invention.

FIG. 2B is a cross-sectional view illustrating a portion of a touch panel in the second embodiment of the present invention.

FIG. 3A is a cross-sectional view illustrating a portion of a touch panel in the third embodiment of the present invention.

FIG. 3B is a cross-sectional view illustrating a portion of a touch panel in the fourth embodiment of the present invention.

#### DESCRIPTION OF EMBODIMENTS

FIG. 2A is a cross-sectional view illustrating a portion of a touch panel in the first embodiment of the present invention. Referring to FIG. 2A, a touch panel 200 of the embodiment includes a first substrate 210, a second substrate 220, a sealant 230, a liquid crystal layer 240, a main spacer 250, a sensing spacer 260, a transparent electrode 290, and an opposite electrode 270.

A pixel array is disposed on the first substrate 210, wherein the pixel array includes a plurality of active elements, a plurality of scanning lines, a plurality of data lines DL, and a plurality of pixel electrodes. In order to facilitate the illustration of the embodiment, only one data line DL is illustrated in FIG. 2A and the other elements are omitted. Persons with ordinary skill in the art should understand the actual positions and functions of the omitted elements. Hence, the details thereof are not described here. As shown in FIG. 2A, the data line DL is disposed above a gate insulating layer GI. The second substrate 220 is disposed opposite to the first substrate 210. The sealant 230 is used for bonding the first substrate 210 and the second substrate 220. The liquid crystal layer 240 and the main spacer 250 are disposed between the first substrate 210 and the second substrate 220. The sensing spacer 260 is arranged on the second substrate 220.

According to a preferable embodiment, the opposite electrode 270 and the transparent electrode 290 are disposed on the first substrate 210 and arranged corresponding to the sensing spacer 260, as shown in FIG. 2A. The opposite electrode 270 is above the data line DL and the gate insulating layer GI, and the transparent electrode 290 is arranged between the opposite electrode 270 and the data line DL, but the present invention is not limited thereto. Any designer may dispose the opposite electrode 270 above the scanning lines (not shown) or other suitable elements, or dispose the opposite electrode 270 between the transparent electrode 290 and the data line DL, the scanning lines, or other elements to meet the requirements of products.

In a preferable embodiment, the transparent electrode 290 and the opposite electrode 270 are electrically connected for transmitting an electrical change or a sensing signal generated by a contact of the sensing spacer 260 and the opposite electrode 270 caused by a user touching the touch panel 200. In addition, the designer may vary a pattern of the opposite electrode 270 per the requirements of products to substitute for the functions of the transparent electrode 290, and further simplify the fabricating process.

Referring to FIG. 2A, a transparent conductive layer 282 is disposed on the second substrate 220, and the sensing spacer 260 is disposed on the transparent conductive layer 282 and contacts the transparent conductive layer 282. In a preferable

embodiment, shielding layer **284** are disposed on the second substrate **220** and arranged corresponding to the sensing spacer **260** and the main spacer **250** respectively. Moreover, pluralities of color filter layers **284'** are disposed on the second substrate **220**. The color filter layers **284'** and the shielding layer **284** are arranged alternately. Further, a protective layer **286** is disposed on the first substrate **210**, and the opposite electrode **270** is disposed on the protective layer **286** and contacts the protective layer **286** or the transparent electrode **290** on the protective layer **286**.

As shown in FIG. 2A, the transparent conductive layer **282** may be electrically connected with the sensing spacer **260** and electrically insulated from the opposite electrode **270** when not operating. When the user touches the touch panel **200**, an electrical change is generated by a contact of the sensing spacer **260** and the opposite electrode **270**. Thereby, the touch panel **200** determines the area touched by the user. In brief, the sensing spacer **260** and the opposite electrode **270** are respectively disposed on the second substrate **220** and the first substrate **210** to correspond to each other, so as to sense the touched area in the touch panel **200**.

The sensing spacer **260** may be formed by multiple organic conductive layers **260c**. The organic conductive layers **260c** are usually formed by a conductive material having softer texture for easing a force which occurs when the sensing spacer **260** contacts the opposite electrode **270**.

According to a preferable embodiment, a material of the organic conductive layers **260c** may be selected from a group of poly(3,4-ethylene dioxythiophene)/poly(styrene sulfonate) (PEDOT/PSS), polyaniline, polypyrrole, polythiophene, polyacetylene, polyphenyl, polyfuran, polyselephene, isothianaphthene, polyphenylsulfide, polystyrene, polythienylstyrene, polynaphthalene, polyanthracene, polypyrene, polyazulene, phthalocyanine, pentacene, hemicyanine dye, and 3,4-polyethylene dioxythiophene (PEDT), but the present invention is not limited thereto.

Because the sensing spacer **260** is formed by the organic conductive material having softer texture, an ink-jet process may be applied to sequentially form the sensing spacer **260** on the second substrate **220**. In addition, through controlling the volume and times of jetting the organic conductive material in each ink-jet process, the height of the sensing spacer **260** may be controlled to reach a predetermined value or fall within a predetermined range.

As shown in FIG. 2A, a first ink-jet process is performed on the second substrate **220** to form one organic conductive layer **260c** having a height *d*. Then, a second ink-jet process is performed to form another organic conductive layer having the height *d*. Thus, the height is *2d* in total. Accordingly, after four times of the ink-jet process, four organic conductive layers **260c** having a total height of *4d* are formed. In this embodiment, the sensing spacer **260** is formed by the four organic conductive layers **260c**, and the height of the sensing spacer **260** is *4d*.

In practice, the organic conductive layers **260c** are not restricted to four layers. The designer may vary the volume and times of jetting the organic conductive material during the ink-jet process based on the requirements of products, so as to control the number and height of the organic conductive layers **260c**. Moreover, other fabricating methods or ink-jet controlling processes may also be used to form the sensing spacer **260** as long as the shape or height of the sensing spacer **260** can be controlled. Persons with ordinary skill in the art may adjust the height of the organic conductive layer **260c** formed in each ink-jet process according to their requirements.

According to a preferable embodiment, the aforesaid material of the organic conductive layers **260c** and the aforesaid ink-jet process may be combined to fabricate the opposite electrode **270**, so that the height of the opposite electrode **270** may meet the requirements of design, but the present invention is not limited thereto. Generally speaking, the opposite electrode **270** may be a single-layer conductive layer which may be formed by an inorganic conductive material. The present invention is not limited to the aforesaid material of the organic conductive layers **260c**.

The sensing spacer **260** may also be disposed on the first substrate **210**, and the opposite electrode **270** may be disposed on the second substrate **220** to correspond to the sensing spacer **260**, wherein the sensing spacer **260** is formed by the organic conductive material, as shown in FIG. 2B.

FIG. 2B is a cross-sectional view illustrating a portion of a touch panel in the second embodiment of the present invention. Referring to FIG. 2B, the sensing spacer **260** is disposed above the protective layer **286** and the transparent electrode **290**, and electrically contacts the transparent electrode **290**. Additionally, the opposite electrode **270** or the transparent electrode **290** may also be formed by the inorganic conductive material instead of the organic conductive material. The organic conductive material has been described in the above, and thus the details thereof are omitted here.

In this embodiment, the use of the organic conductive material may be combined with the ink-jet process or other fabricating processes to fabricate the sensing spacer **260**. Thereby, the height of the sensing spacer **260** may be easily varied. Moreover, the use of the organic conductive material may also be combined with the ink-jet process or other fabricating processes to form the opposite electrode **270**, so as to further adjust the height of the opposite electrode **270**.

FIG. 3A is a cross-sectional view illustrating a portion of a touch panel in the third embodiment of the present invention. Referring to FIG. 3A, a touch panel **300** of this embodiment includes the first substrate **210**, the second substrate **220**, the sealant **230**, the liquid crystal layer **240**, the main spacer **250**, a first sensing spacer **360a**, a second sensing spacer **360b**, a first opposite electrode **370a**, a second opposite electrode **370b**, a transparent conductive layer **382**, a first shielding layer **384a**, a second shielding layer **384b**, a third shielding layer **384c**, a first transparent electrode **390a**, a second transparent electrode **390b**, and a protective layer **386**.

The first substrate **210** has a central area **312** and a peripheral area **314**. Further, a pixel array is disposed on the first substrate **210**, wherein the pixel array includes a plurality of active elements, a plurality of scanning lines, a plurality of data lines DL, and a plurality of pixel electrodes. To facilitate the illustration, only the data lines DL are shown in FIG. 3A and other elements are omitted. Persons having ordinary skill in the art should understand the actual positions and functions of the omitted elements. Hence, the details thereof are not described here. As shown in FIG. 3A, the data lines DL are arranged above the gate insulating layer GI.

The second substrate **220** is disposed opposite to the first substrate **210**. The sealant **230** is disposed on the peripheral area **314** for bonding the first substrate **210** and the second substrate **220**. The liquid crystal layer **240**, the main spacer **250**, the first sensing spacer **360a**, and the second sensing spacer **360b** are all arranged between the first substrate **210** and the second substrate **220**.

In this embodiment, the first sensing spacer **360a** and the second sensing spacer **360b** are disposed on the second substrate **220**, wherein the first sensing spacer **360a** and the main spacer **250** are arranged in the central area **312**, and the second sensing spacer **360b** is arranged in the peripheral area **314**.

The first opposite electrode **370a** and the first transparent electrode **390a** are disposed on the central area **312** of the first substrate **210** and correspond to the first sensing spacer **360a**. The second opposite electrode **370b** and the second transparent electrode **390b** are disposed on the peripheral area **314** of the first substrate **210** and correspond to the second sensing spacer **360b**, wherein the peripheral area **314** usually surrounds the central area **312**.

The first opposite electrode **370a**, the first transparent electrode **390a**, the second opposite electrode **370b**, and the second transparent electrode **390b** are all disposed above the data lines DL and the gate insulating layer GI. The first transparent electrode **390a** and the second transparent electrode **390b** are respectively disposed between the first opposite electrode **370a** and the second opposite electrode **370b** and the corresponding data lines DL. However, the designer may dispose the first opposite electrode **370a** and the second opposite electrode **370b** above the scanning lines (not shown) or other suitable elements, or alternatively dispose the first opposite electrode **370a** and the second opposite electrode **370b** between the first transparent electrode **390a** and the second transparent electrode **390b** and the data lines DL, the scanning lines, or other elements to meet the requirements of products.

In a preferable embodiment, the first transparent electrode **390a** and the second transparent electrode **390b** are electrically connected with the first opposite electrode **370a** and the second opposite electrode **370b** respectively for transmitting the electrical changes or sensing signals generated by the contact of the first sensing spacer **360a** and the first opposite electrode **370a** and the contact of the second sensing spacer **360b** and the second opposite electrode **370b** when the user touches the touch panel **300**. Additionally, the designer may vary the patterns of the first opposite electrode **370a** or the second opposite electrode **370b** per the requirements of products to substitute for the functions of the first transparent electrode **390a** or the second transparent electrode **390b**, and further simplify the fabricating process.

In this embodiment, the transparent conductive layer **382** is disposed on the second substrate **220**, and the first sensing spacer **360a** and the second sensing spacer **360b** are disposed on the transparent conductive layer **382** and contact the transparent conductive layer **382**. The first shielding layer **384a**, and the second shielding layer **384b**, and the third shielding layer **384c** are disposed on the second substrate **220** and correspond to the first sensing spacer **360a**, the second sensing spacer **360b**, and the main spacer **250** respectively. Furthermore, pluralities of color filter layers **384** are disposed on the second substrate **220**. The color filter layers **384** and the shielding layers **384a**, **384b**, and **384c** are arranged alternately. The protective layer **386** is disposed on the first substrate **210**. The first opposite electrode **370a** and the second opposite electrode **370b** are disposed on the protective layer **386** and contact the protective layer **386** or contact the first transparent electrode **390a** and the second transparent electrode **390b** on the protective layer **386**.

As shown in FIG. 3A, the transparent conductive layer **382** may be electrically connected with the first sensing spacer **360a** and the second sensing spacer **360b**, and respectively electrically insulated from the first opposite electrode **370a** and the second opposite electrode **370b** when not operating. When the user touches the central area **312** of the touch panel **300**, the touch panel **300** determines the touched area according to the electrical change generated by the contact of the first sensing spacer **360a** and the first opposite electrode **370a**. Similarly, when the user touches the peripheral area **314** of the touch panel **300**, the touch panel **300** determines the

touched area based on the electrical change generated by the contact of the second sensing spacer **360b** and the second opposite electrode **370b**.

The first sensing spacer **360a**, the second sensing spacer **360b**, the first opposite electrode **370a**, and the second opposite electrode **370b** may all be formed by multiple organic conductive layers **260c**. Generally speaking, the organic conductive layers **260c** usually have softer texture for reducing the force generated when the first sensing spacer **360a** contacts the first opposite electrode **370a** (or when the second sensing spacer **360b** contacts the second opposite electrode **370b**), so as to reduce the possibility and degree of damaging the transparent conductive layer **382** or other structures. The organic conductive layers **260c** may be formed by the materials described in the first embodiment, but the present invention is not limited to the use of these organic conductive materials.

In view of the above, because the first sensing spacer **360a** and the second sensing spacer **360b** are formed by the organic conductive material having softer texture, the ink-jet process may be used to form the first sensing spacer **360a** and the second sensing spacer **360b** on the second substrate **220**. As shown in FIG. 3A, the first sensing spacer **360a** may be formed by four organic conductive layers **260c**, and the second sensing spacer **360b** may be formed by five organic conductive layers **260c**. In other words, the height of the first sensing spacer **360a** is 4d and the height of the second sensing spacer **360b** is 5d. The height 5d of the second sensing spacer **360b** is larger than the height 4d of the first sensing spacer **360a**.

In practice, the organic conductive layers **260c** are not restricted to four or five layers. The designer may vary the volume and times of jetting the organic conductive material during the ink-jet process based on the requirements of products, so as to control the number and height of the organic conductive layers **260c**. Moreover, other fabricating methods or other ink-jet controlling processes may also be applied to form the first sensing spacer **360a** and the second sensing spacer **360b** as long as the shapes or heights of the first sensing spacer **360a** and the second sensing spacer **360b** can be controlled. For instance, the height of the organic conductive layer **260c** formed in each ink-jet process may also be varied.

In addition, the shape that the organic conductive material is formed on the second substrate **220** may also be adjusted by using the ink-jet process. As shown in FIG. 3A, the first sensing spacer **360a** and the second sensing spacer **360b** both have spherical tops. However, the tops of the first sensing spacer **360a** and the second sensing spacer **360b** may also be blunt tops. Herein, the spherical tops or blunt tops of the first sensing spacer **360a** and the second sensing spacer **360b** help to ease the force which occurs when the first sensing spacer **360a** contacts the first opposite electrode **370a** (or when the second sensing spacer **360b** contacts the second opposite electrode **370b**).

One or both of the first sensing spacer **360a** and the second sensing spacer **360b** may be selected to have the spherical top or the blunt top. That is to say, at least one of the first sensing spacer **360a** and the second sensing spacer **360b** has the spherical top or the blunt top. Moreover, the designer may dispose the first sensing spacer **360a** and the second sensing spacer **360b** on the second substrate **200** by performing other fabricating methods according to the requirements of products. Hence, the present invention is not limited to the use of the ink-jet process.

From another aspect, a first sensing pad  $g_1$  is arranged between the first sensing spacer **360a** and the first opposite

electrode **370a**, and a second sensing gap  $g_2$  is arranged between the second sensing spacer **360b** and the second opposite electrode **370b**. The first sensing gap  $g_1$  is correlated to the height of the first sensing spacer **360a**, and the second sensing gap  $g_2$  is correlated to the height of the second sensing spacer **360b**.

To be more specific, because the main spacer **250** may maintain a gap  $D$  between the first substrate **210** and the second substrate **220**, the first sensing gap  $g_1$  is enlarged when the height of the first sensing spacer **360a** decreases. On the contrary, the first sensing gap  $g_1$  is narrowed when the height of the first sensing spacer **360a** increases. In practice, the gap  $D$  does not remain the same in every area. Therefore, the second sensing gap  $g_2$  may also be smaller than the first sensing gap  $g_1$ .

However, the touch panel **300** has different touch sensitivities in different areas. Because the sealant **230** is disposed on the peripheral area **214**, the deformation flexibility of the peripheral area **214** is constrained by the sealant **230**. Therefore, the peripheral area **214** has lower deformation flexibility and sensitivity than that of the central area **312**. To enhance the sensitivity of the peripheral area **214**, the second sensing spacer **360b** may be disposed close to the second opposite electrode **370b**. In other words, the height  $5d$  of the second sensing spacer **360b** is larger or the second sensing gap  $g_2$  is smaller. The first sensing spacer **360a** may be disposed away from the first opposite electrode **370a**, i.e. the height  $4d$  of the first sensing spacer **360a** is smaller or the first sensing gap  $g_1$  is larger.

As shown in FIG. 3A, the second sensing spacer **360b** may be formed by the organic conductive layers **260c** having the total height of  $5d$ , and the distance between the second sensing spacer **360b** and the second opposite electrode **370b** is the second sensing gap  $g_2$ . Further, the first sensing spacer **360a** may be formed by the organic conductive layers **260c** having the total height of  $4d$ , and the distance between the first sensing spacer **360a** and the first opposite electrode **370a** is the first sensing gap  $g_1$ .

Because the second opposite electrode **370b** on the peripheral area **314** is closer to the second sensing spacer **360b** and the first opposite electrode **370a** on the central area **312** is away from the first sensing spacer **360a**, the first sensing gap  $g_1$  is larger than the second sensing gap  $g_2$ . On the other hand, there are also other reasons influencing the relationship between the first sensing gap  $g_1$  and the second sensing gap  $g_2$ , the present invention is not limited the reasons. In a preferable embodiment, the range of the first sensing gap  $g_1$  or the second sensing gap  $g_2$  falls between  $0.3\ \mu\text{m}$  and  $0.8\ \mu\text{m}$ . Thereby, the touch panel **300** has favorable touch sensitivity.

According to a preferable embodiment, the first sensing spacer **360a**, the second sensing spacer **360b**, the first opposite electrode **370a**, and the second opposite electrode **370b** are all formed by multiple organic conductive layers **260c**, but the present invention is not limited thereto. That is to say, this embodiment does not require a photomask and photolithography process to form the first sensing spacer **360a**, the second sensing spacer **360b**, the first opposite electrode **370a**, and the second opposite electrode **370b**. Moreover, the use of the ink-jet process helps to vary the heights of the first sensing spacer **360a**, the second sensing spacer **360b**, the first opposite electrode **370a**, and the second opposite electrode **370b**.

The first sensing spacer **360a** and the second sensing spacer **360b** may also be disposed on the first substrate **210**, and the first opposite electrode **370a** and the second opposite electrode **370b** may be disposed on the second substrate **220** to respectively correspond to the first sensing spacer **360a** and the second sensing spacer **360b**, wherein the first sensing

spacer **360a** and the second sensing spacer **360b** are formed by the organic conductive material, as shown in FIG. 3B.

FIG. 3B is a cross-sectional view illustrating a portion of a touch panel in the fourth embodiment of the present invention. It is known from FIG. 3B that the first sensing spacer **360a** and the second sensing spacer **360b** are respectively arranged above the first transparent electrode **390a** and the second transparent electrode **390b** of the protective layer **286**, and contact the first transparent electrode **390a** and the second transparent electrode **390b**.

In other embodiments, one of the first sensing spacer **360a** and the second sensing spacer **360b** may be selected to be formed by the organic conductive layers **260c**, and one of the first opposite electrode **370a** and the second opposite electrode **370b** may be selected to be formed by the organic conductive layers **260c**. In a word, at least one of the first sensing spacer **360a** and the second sensing spacer **360b** is formed by the organic conductive layers **260c**. Similarly, at least one of the first opposite electrode **370a** and the second opposite electrode **370b** is formed by the organic conductive layers **260c**.

In addition, this embodiment may make use of the ink-jet process to dispose the first, the second sensing spacers **360b**, **360b** or the first, the second opposite electrodes **370a**, **370b** on the first substrate **210** or the second substrate **220**. It is certain that other suitable methods may also be adapted to form the first, the second sensing spacers **360a**, **360b** or the first, the second opposite electrodes **370a**, **370b**. The present invention is not intended to limit the forming methods thereof.

It is known from the above that the touch sensitivity of the peripheral area **314** may be enhanced by making the first sensing gap  $g_1$  larger than the second sensing gap  $g_2$ . In other embodiment, any persons having ordinary skill in the art may dispose the first sensing spacer **360a** on the first substrate **210** (disposing the first opposite electrode **370a** on the second substrate **220**) and dispose the second sensing spacer **360b** on the second substrate **220** (disposing the second opposite electrode **370b** on the first substrate **210**), so as to make the first sensing gap  $g_1$  larger than the second sensing gap  $g_2$ . Alternatively, the first sensing spacer **360a** may be disposed on the second substrate **220** (disposing the first opposite electrode **370a** on the first substrate **210**) and the second sensing spacer **360b** may be disposed on the first substrate **210** (disposing the second opposite electrode **370b** on the second substrate **220**) to achieve the same effect.

To solve the problem that the peripheral area **314** has low touch sensitivity, this embodiment makes the first sensing gap  $g_1$  in the touch panel **300** larger than the second sensing gap  $g_2$ , and thereby improves the touch sensitivity of the peripheral area **314**. In addition, the first sensing spacer **360a** or the second sensing spacer **360b** has the spherical top or blunt top which serves as a buffer between the first sensing spacer **360a** or the second sensing spacer **360b** and the first opposite electrode **370a** or the second opposite electrode **370b** for preventing the breaking or damage to the transparent conductive layer **382** or other structures caused by excessive stress.

In conclusion, the embodiments mentioned above of the present invention make use of the organic conductive material to form the sensing spacers, which is adapted for adjusting the sensing spacers. As a consequence, the touch sensitivity of certain areas having worse sensitivity in the touch panel is enhanced, and the touch panel can have uniform touch sensitivity. Different products may include sensing spacers of different heights, but the present invention is not required to change photomask for different products during the production. Moreover, using the organic conductive material to form

the opposite electrodes facilitates the adjustment of the sensing gaps. Therefore, the sizes of the sensing gaps may be varied more flexibly. Because the organic conductive material has softer texture in some embodiments, the possibility of damaging the touch panel is also greatly reduced.

Although the present invention has been disclosed by the above embodiments, they are not intended to limit the present invention. Anybody with ordinary knowledge in the art may make some modifications and alterations without departing from the spirit and scope of the present invention. Therefore, the protection range of the present invention falls in the appended claims.

What is claimed is:

1. A touch panel, comprising:

a first substrate, having a central area and a peripheral area;  
 a second substrate, disposed opposite to the first substrate;  
 a sealant, disposed on the peripheral area for bonding the first and the second substrates;  
 a liquid crystal layer, disposed between the first substrate and the second substrate;  
 a main spacer, disposed between the first substrate and the second substrate;  
 a first sensing spacer, disposed on the central area and between the first substrate and the second substrate;  
 a second sensing spacer, disposed on the peripheral area and between the first substrate and the second substrate;  
 a first opposite electrode, disposed corresponding to the first sensing spacer, and a first sensing gap being arranged between the first sensing spacer and the first opposite electrode; and  
 a second opposite electrode, disposed corresponding to the second sensing spacer, a second sensing gap being arranged between the second sensing spacer and the second opposite electrode, and the first sensing gap being larger than the second sensing gap.

2. The touch panel as claimed in claim 1, wherein at least one of the first sensing spacer and the second sensing spacer comprises multiple organic conductive layers.

3. The touch panel as claimed in claim 2, wherein a material of the organic conductive layers may be selected from a group of poly(3,4-ethylene dioxythiophene)/poly(styrene sulfonate) (PEDOT/PSS), polyaniline, polypyrrole, polythiophene, polyacetylene, polyphenyl, polyfuran, polysele-nophene, isothianaphthene, polyphenylsulfide, polystyrene, polythienylstyrene, polynaphthalene, polyanthracene, polypyrrene, polyazulene, phthalocyanine, pentacene, hemicyanine dye, and 3,4-polyethylene dioxythio phene (PEDT).

4. The touch panel as claimed in claim 1, wherein at least one of the first opposite electrode and the second opposite electrode comprises multiple organic conductive layers.

5. The touch panel as claimed in claim 4, wherein the material of the organic conductive layers may be selected from a group of poly(3,4-ethylene dioxythiophene)/poly(styrene sulfonate) (PEDOT/PSS), polyaniline, polypyrrole, polythiophene, polyacetylene, polyphenyl, polyfuran, poly-

selenophene, isothianaphthene, polyphenylsulfide, polystyrene, polythienylstyrene, polynaphthalene, polyanthracene, polypyrrene, polyazulene, phthalocyanine, pentacene, hemicyanine dye, and 3,4-polyethylene dioxythio phene (PEDT).

6. The touch panel as claimed in claim 1, wherein the first sensing gap or the second sensing gap ranges from 0.3  $\mu\text{m}$  to 0.8  $\mu\text{m}$ .

7. The touch panel as claimed in claim 1, wherein at least one of the first sensing spacer and the second sensing spacer has a spherical top or a blunt top.

8. The touch panel as claimed in claim 1, further comprising a transparent conductive layer, the first sensing spacer and the second sensing spacer disposed on the transparent conductive layer, and the first sensing spacer and the second sensing spacer contacting the transparent conductive layer.

9. The touch panel as claimed in claim 1, further comprising a first shielding layer, a second shielding layer, and a third shielding layer disposed on the second substrate.

10. The touch panel as claimed in claim 9, wherein the first shielding layer, the second shielding layer, and the third shielding layer are arranged corresponding to the first sensing spacer, the second sensing spacer, and the main spacer respectively.

11. The touch panel as claimed in claim 1, further comprising a protective layer disposed on the first substrate and a plurality of transparent electrodes disposed on the protective layer, and the transparent electrodes being arranged corresponding to the first sensing spacer and the second sensing spacer.

12. The touch panel as claimed in claim 11, wherein the first opposite electrode and the second opposite electrode are separately disposed on the transparent electrodes.

13. A touch panel, comprising:

a first substrate, having a central area and a peripheral area;  
 a second substrate, disposed opposite to the first substrate;  
 a sealant, disposed on the peripheral area for bonding the first and the second substrates;  
 a liquid crystal layer, disposed between the first substrate and the second substrate;  
 a main spacer, disposed between the first substrate and the second substrate;  
 a first sensing spacer, disposed on the central area and between the first substrate and the second substrate; and  
 a second sensing spacer, disposed on the peripheral area and between the first substrate and the second substrate, and the second sensing spacer being higher than the first sensing spacer.

14. The touch panel as claimed in claim 13, further comprising a first opposite electrode disposed corresponding to the first sensing spacer and a second opposite electrode disposed corresponding to the second sensing spacer.

15. The touch panel as claimed in claim 13, wherein at least one of the first sensing spacer and the second sensing spacer comprises multiple organic conductive layers.

\* \* \* \* \*

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摘要(译)

提供一种触控面板，包括第一基板，第二基板，密封剂，液晶层，主间隔物，第一感测间隔物，第二感测间隔物，第一对向电极和第二对向电极。第一基板具有中心区域和外围区域。第二基板与第一基板相对设置。第一传感间隔物设置在中心区域上以及第一和第二基板之间。第二传感间隔物设置在外围区域上以及第一和第二基板之间。在第一感测间隔物和对应于第一感测间隔物设置的第一相对电极之间存在第一感测间隙。在第二感测间隔物和第二相对电极之间存在第二感测间隙，第二感测间隔物对应于第二感测间隔物设置。第一感测间隙大于第二感测间隙。

