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Weng et al.

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(54) **TOUCH DISPLAY PANEL**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

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G06F 3/044	(2006.01)
G06F 3/041	(2006.01)
G02F 1/1368	(2006.01)
G02F 1/1335	(2006.01)

(52) **U.S. Cl.**

CPC ***G02F 1/133308*** (2013.01); ***G02F 1/1368*** (2013.01); ***G02F 1/13338*** (2013.01); ***G06F 3/044*** (2013.01); ***G06F 3/0412*** (2013.01); *G02F 1/133514* (2013.01); *G02F 2001/13332* (2013.01); *G02F 2001/133314* (2013.01); *G02F 2001/133317* (2013.01); *G02F 2201/46* (2013.01); *G06F 2203/04105* (2013.01); *G06F 2203/04112* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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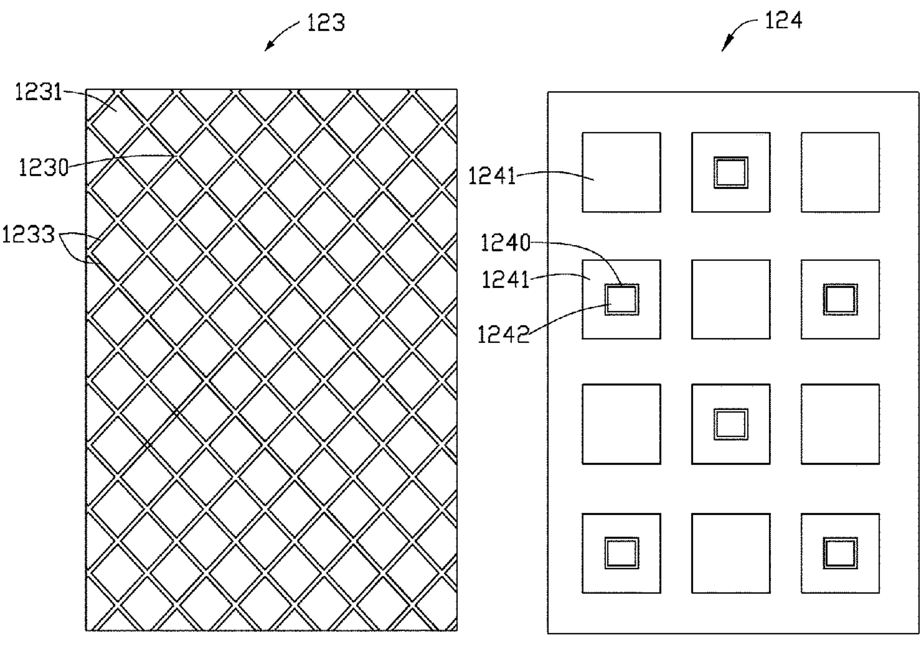
(57) **ABSTRACT**

A touch display device includes a touch display module. The touch display module includes a TFT substrate, a color filtering substrate, and a liquid crystal layer encapsulated between the TFT substrate and the color filtering substrate. A first electrode layer is formed on a surface of the color filtering substrate facing the TFT substrate. A second electrode layer is formed on a surface of the TFT substrate facing the color filtering substrate. The touch display device further includes at least one supporting element on a side of the touch display module. The supporting element is elastic and configured for elastically resisting against the touch display module.

1 Claim, 9 Drawing Sheets



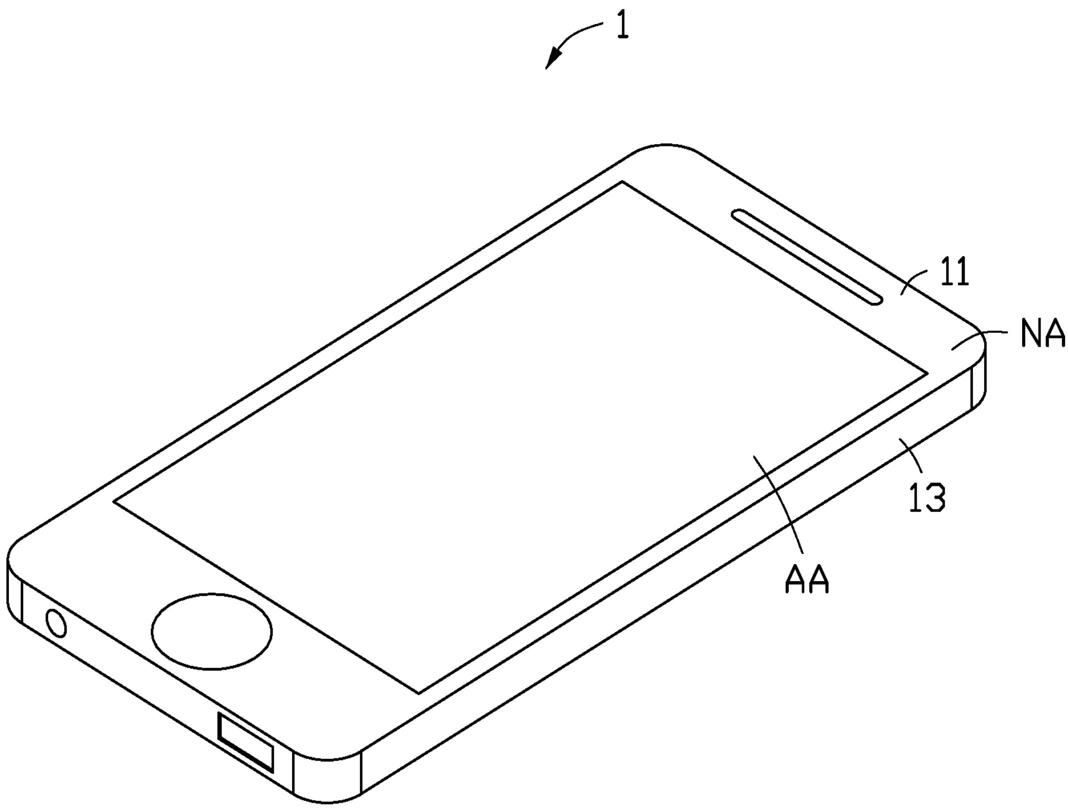


FIG. 1

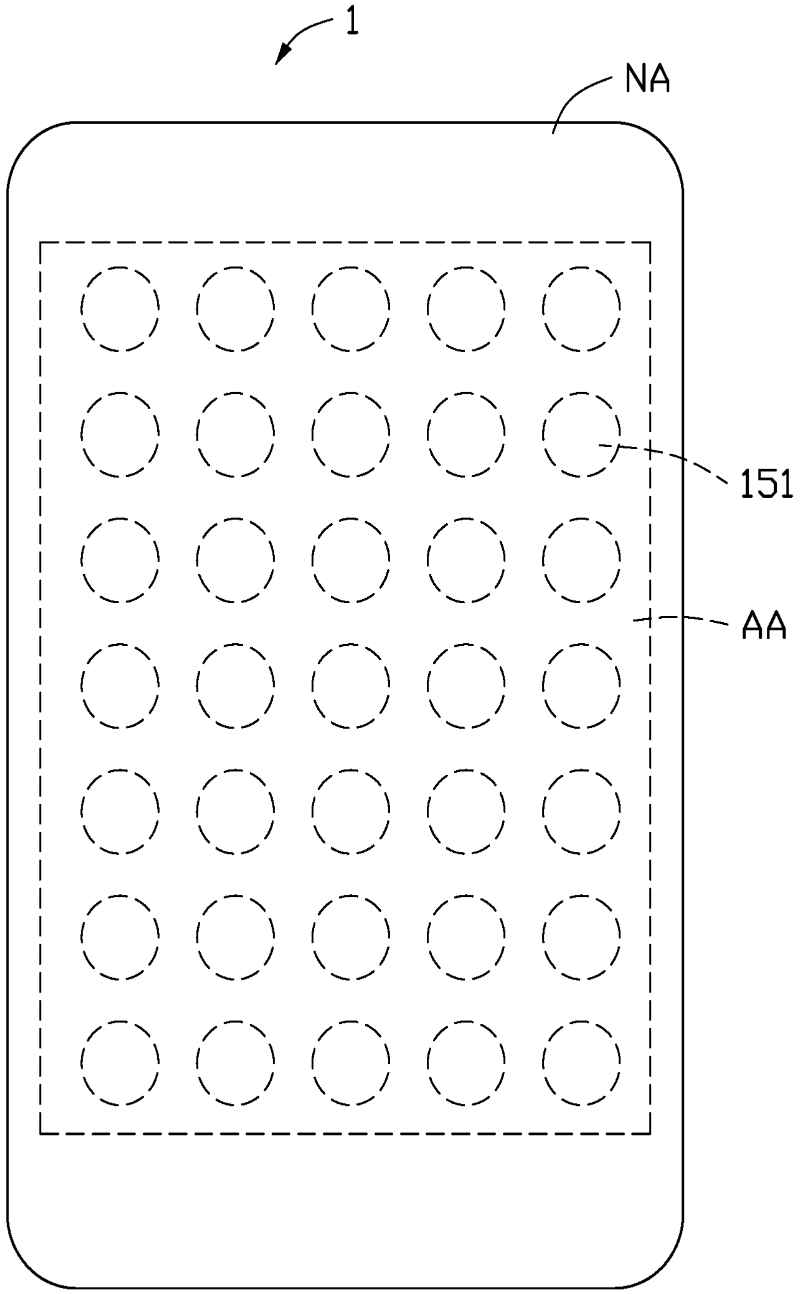


FIG. 2

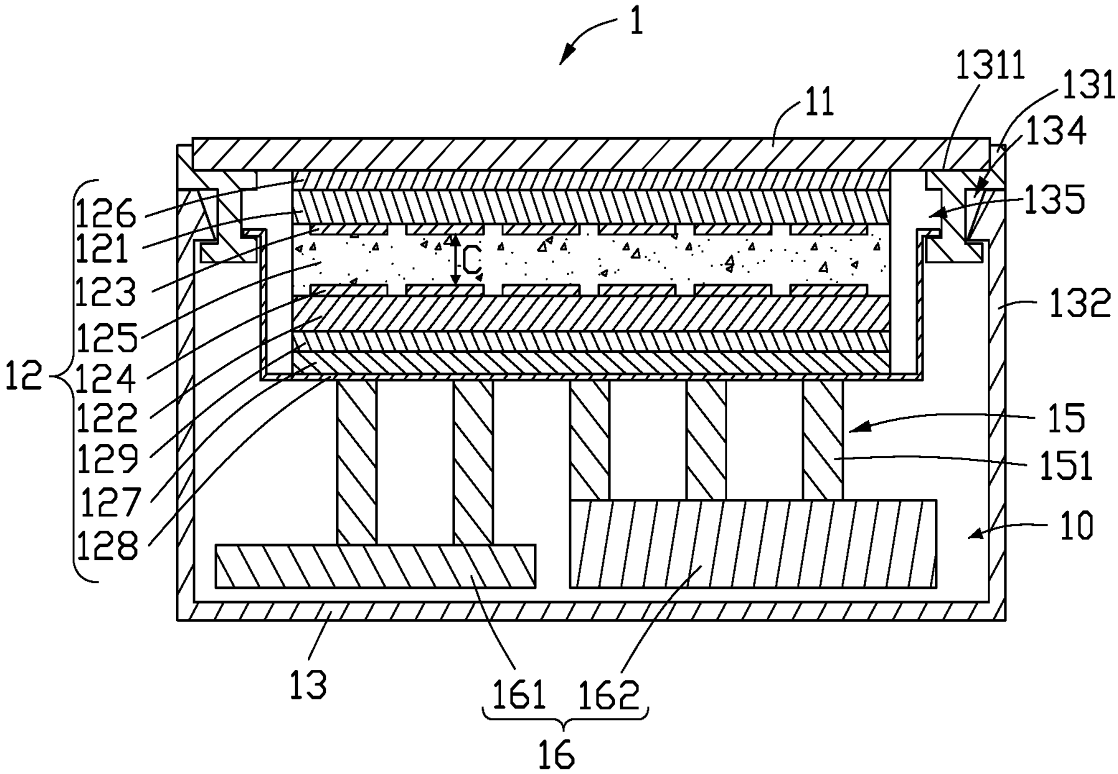

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FIG. 3

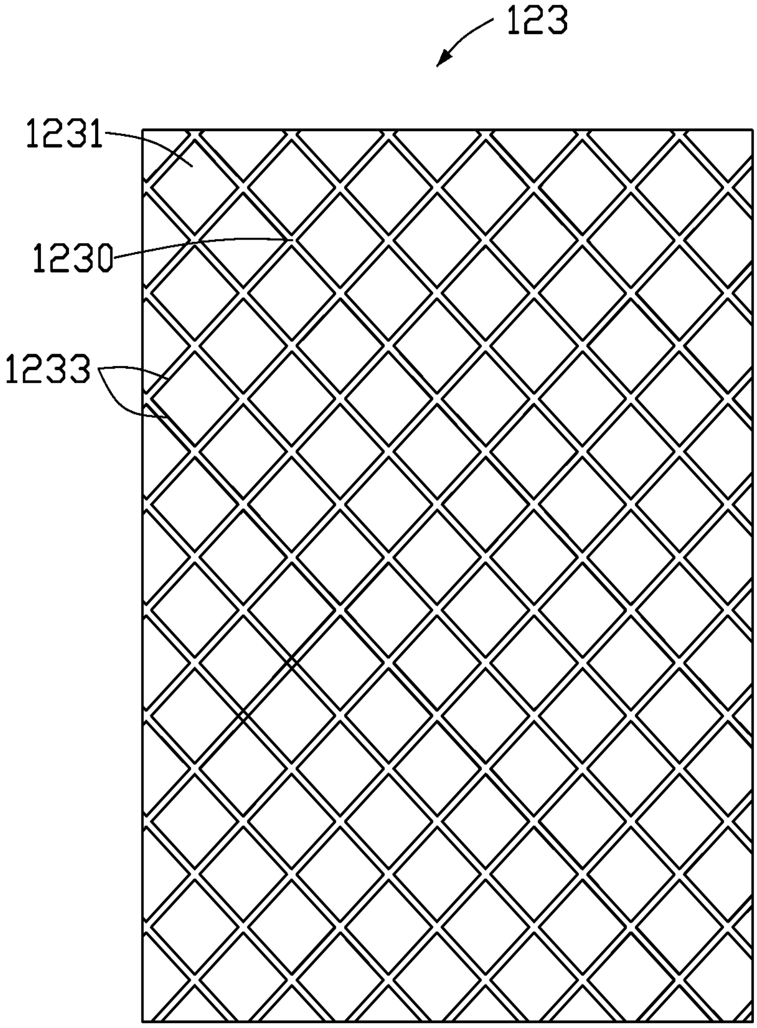

FIG. 4

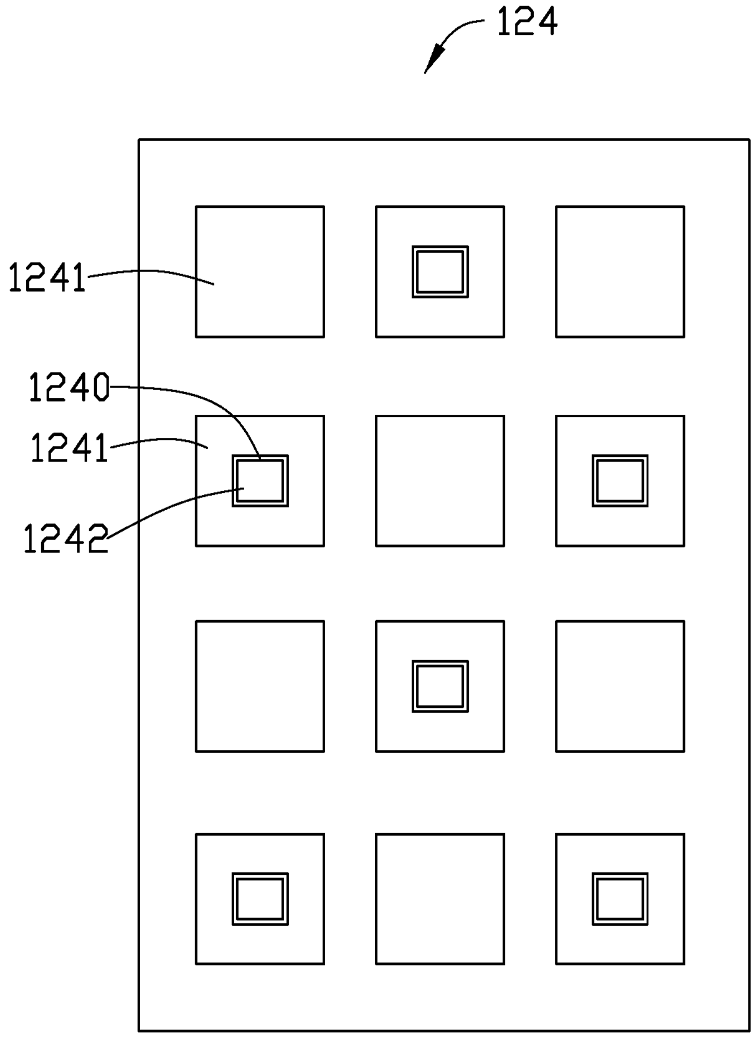

FIG. 5

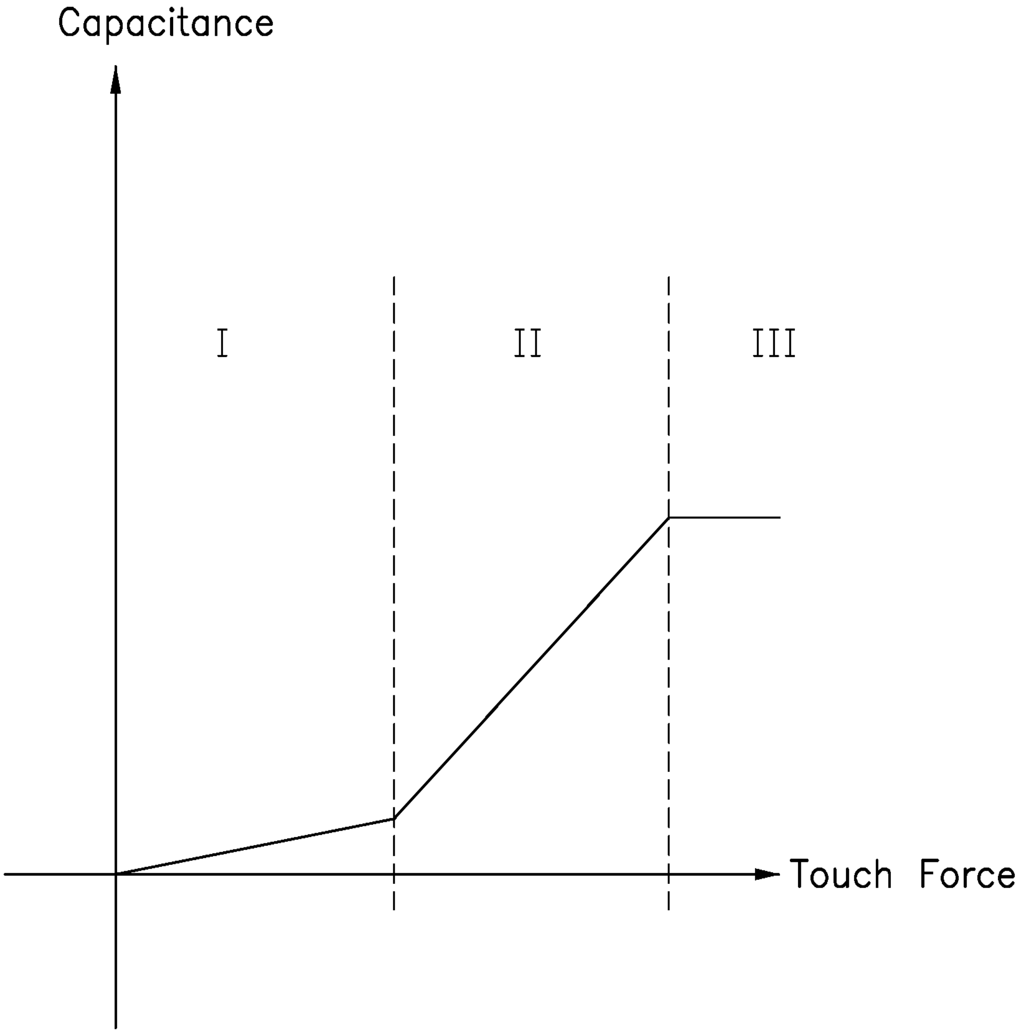

FIG. 6

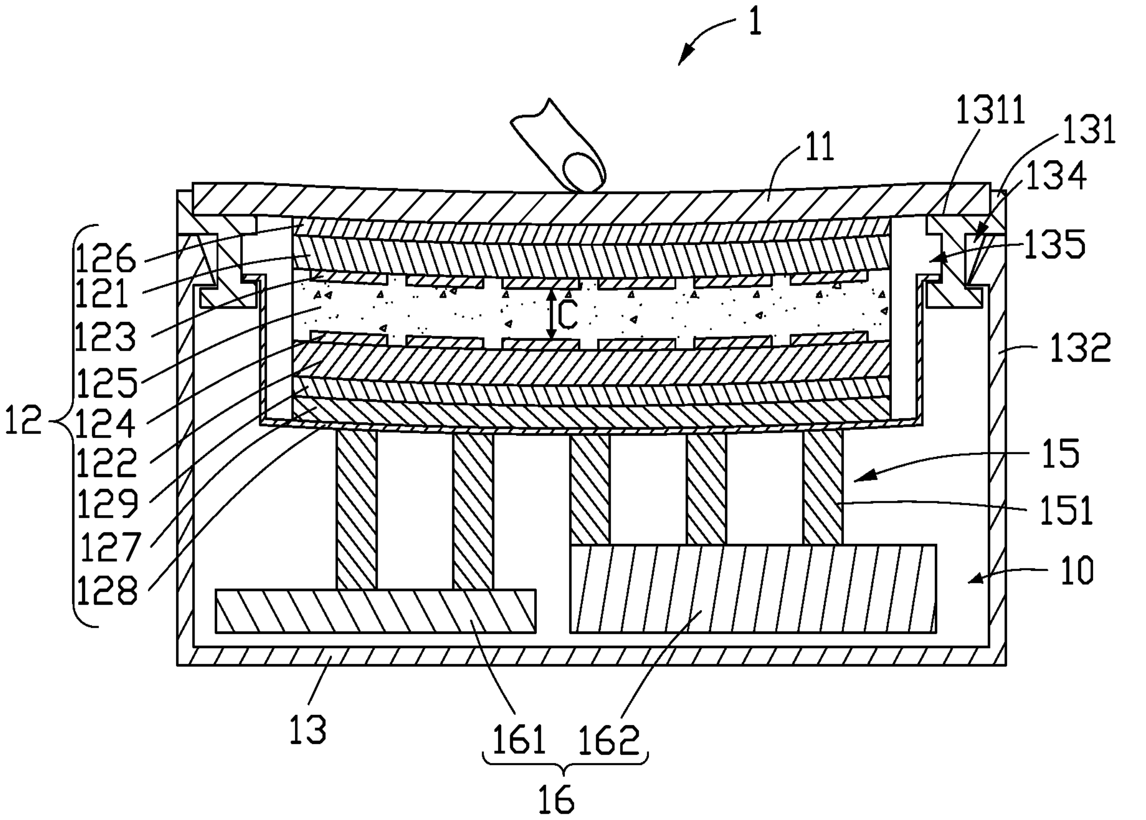
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FIG. 7

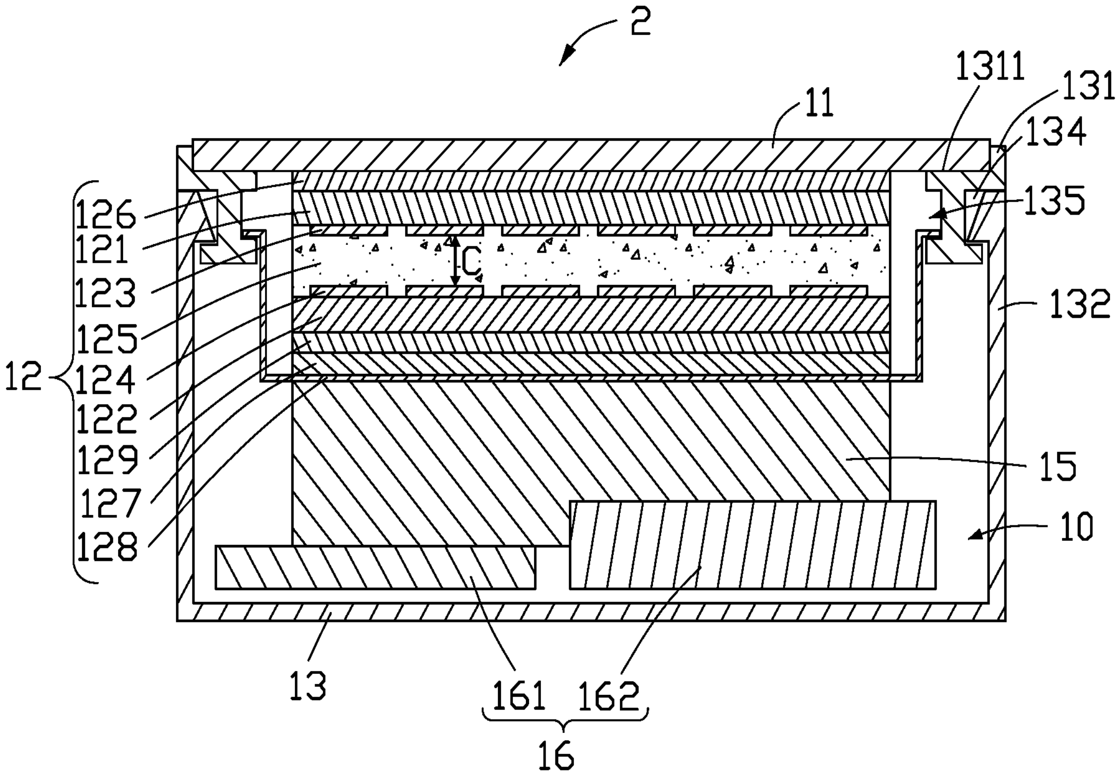
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FIG. 8

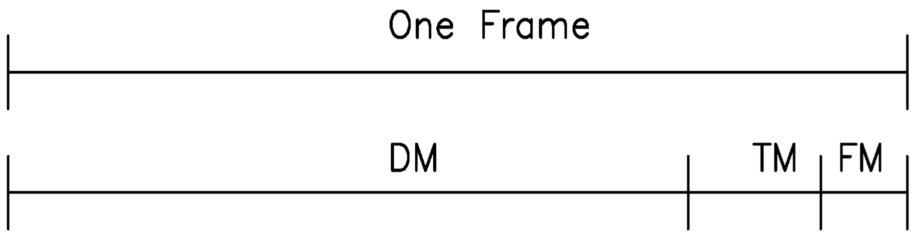

FIG. 9

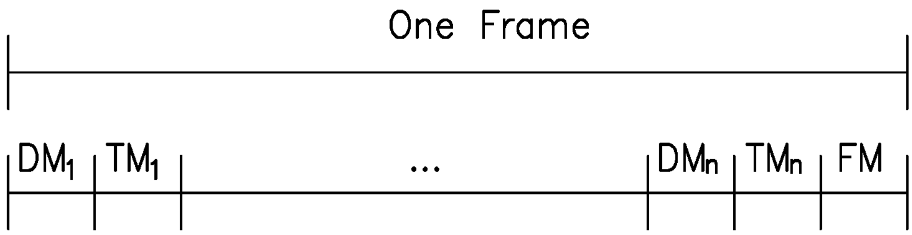

FIG. 10

TOUCH DISPLAY PANEL

FIELD

The subject matter herein generally relates to touch display panels.

BACKGROUND

On-cell or in-cell type touch screen devices can be manufactured by installing a touch device in a display device. Such a touch screen device can be used as an output device for displaying images and an input device for receiving a user's touch commands. However, the touch screen device does not always accurately sense the amount of touch force/pressure applied to the touch screen.

Therefore, there is room for improvement within the art.

BRIEF DESCRIPTION OF THE DRAWINGS

Implementations of the present technology will now be described, by way of example only, with reference to the attached figures.

FIG. **1** is an isometric view of an embodiment of a touch display device.

FIG. **2** is a planar view of the touch display device of FIG. **1**.

FIG. **3** is a cross-sectional view of the touch display device of FIG. **1**.

FIG. **4** is a planar view of a first electrode layer of the touch display device of FIG. **1**.

FIG. **5** is a planar view of a second electrode layer of the touch display device of FIG. **1**.

FIG. **6** is a graph showing a relationship between a touch force and a capacitance of a mutual capacitor C structure in the device of FIG. **1**.

FIG. **7** is a cross-sectional view of the touch display device of FIG. **1** when being touched.

FIG. **8** is a cross-sectional view of the touch display device of a second embodiment.

FIG. **9** is a first diagrammatic view of driving time sequence of the touch display device of FIG. **1**.

FIG. **10** is a second diagrammatic view of driving time sequence of the touch display device of FIG. **1**.

DETAILED DESCRIPTION

It will be appreciated that for simplicity and clarity of illustration, where appropriate, reference numerals have been repeated among the different figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the exemplary embodiments described herein. However, it will be understood by those of ordinary skill in the art that the exemplary embodiments described herein may be practiced without these specific details. In other instances, methods, procedures, and components have not been described in detail so as not to obscure the related relevant feature being described. Also, the description is not to be considered as limiting the scope of the exemplary embodiments described herein. The drawings are not necessarily to scale and the proportions of certain parts may be exaggerated to better illustrate details and features of the present disclosure.

The term "coupled" is defined as connected, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The connection can be such that the objects are permanently connected or releasably connected. The term "comprising" when utilized, means "including, but not necessarily limited to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series, and the like.

FIG. **1** through FIG. **3** show a touch display panel **1** according to a first embodiment. In FIG. **1**, the touch display panel **1** is used with a mobile phone. However, the touch panel can be used with devices other than mobile phones, such as tablets. The touch display panel **1** includes a front cover **11**, a back cover **13**, and a touch display module **12** (see FIG. **3**). The back cover **13** defines a receiving cavity **10**, and the front cover **11** covers the receiving cavity **10**. The touch display module **12** is positioned in the receiving cavity **10**. As shown in FIG. **1** and FIG. **2**, the touch display panel **1** defines a display area AA and a border area NA surrounding the display area AA.

In FIG. **3**, the touch display module **12** is located immediately below the front cover **11** and includes an upper substrate **121**, a lower substrate **122** opposite to the upper substrate **121**, and a liquid crystal layer **125** between the upper substrate **121** and the lower substrate **122**. A first electrode layer **123** having a mesh pattern is formed on a surface of the upper substrate **121** adjacent to the lower substrate **122**. A second electrode layer **124** having a pattern is formed on a surface of the lower substrate **122** adjacent to the upper substrate **121**. In one embodiment, the upper substrate **121** is a color filtering substrate including color filtering elements (not shown) and the lower substrate **122** is a TFT substrate including a thin film transistor array (not shown). The touch display module **12** further includes an upper polarizer **126** between the front cover **11** and the upper substrate **121**. The touch display module **12** further includes a lower polarizer **129** and a backlight module **127** located at a side of the lower substrate **122** away from the upper substrate **121**. The lower polarizer **129** is between the lower substrate **122** and the backlight module **127**.

In FIG. **4**, the first electrode layer **123** includes a plurality of conducting lines **1233** intersecting with each other to form a mesh. A plurality of through holes **1231** is defined in the first electrode layer **123**. The through holes **1231** may be rhombic-shaped or diamond-shaped, as shown, or have a different shape. The first electrode layer **123** includes a plurality of nodes **1230**. Each node **1230** is formed where two conducting lines **1233** intersect with each other. In this embodiment, each opening **1231** is rhombic shape, and there is a node **1230** at each corner of each rhombic-shaped opening **1231**. The through holes **1231** allow light from the backlight module **127** to pass through the first electrode layer **123**, and electrical fields from the second electrode layer **124** to pass through the first electrode layer **123**. The first electrode layer **123** is made of a conductive material, such as Indium tin oxide (ITO).

In FIG. **5**, the second electrode layer **124** includes a plurality of touch sensing electrodes **1241** and a plurality of force sensing electrodes **1242**. The touch sensing electrodes **1241** are spaced apart from each other. In this embodiment, the touch sensing electrodes **1241** are arranged in a matrix. Also in this embodiment, the touch sensing electrodes **1241** can have one of two shapes, some touch sensing electrodes **1241** are a solid rectangular plate, and other touch sensing electrodes **1241** may have an overall rectangular shape with a rectangular opening **1240**. Each force sensing electrode **1242** is located in one opening **1240**, spaced apart from, and surrounded by, a touch sensing electrode **1241**. The touch sensing electrode **1241** forms a self-capacitive structure configured for sensing a touch position.

Returning to FIG. **3**, the first electrode layer **123** and the second electrode layer **124** both extend towards the liquid crystal layer **125** and face each other. Each force sensing electrode **1242** corresponds to and overlaps with the location of one node **1230** of the first electrode layer **123**. The force sensing electrode **1242** and the first electrode layer **123** form a mutual capacitor C structure configured for detecting the touch force applied on the touch display device **1**. When a touch force is applied on the front cover **11** of the touch display device **1**, the front cover **11** and the touch display module **12** deform. The deformation causes a distance between the force sensing electrode **1242** and the first electrode layer **123** to changes. As the distance between the force sensing electrode **1242** and the first electrode layer **123** changes, a capacitance of the mutual capacitor C changes, and the touch force can be calculated according to the variation of the capacitance of the mutual capacitor C.

As shown in FIG. **3**, the touch display panel **1** further includes a plurality of supporting elements **151** located at a side of the touch display module **12** opposite the front cover **11**, particularly between the touch display module **12** and the back cover **13**. The supporting elements **151** are spaced apart from each other. Each supporting element **151** is elastic. The supporting elements are configured for elastically resisting against the touch display module **12**. FIG. **2** shows, each supporting element **151** is a columnar structure, for example, cylindrical. FIG. **2** also shows that the supporting elements **151** are in the display area AA. The supporting elements **151** may be made of an organic substance, such as polycarbonate (PC), polyimide (PI), polyethylene naphthalate (PEN), and polyethylene glycol terephthalate (PET).

FIG. **7** shows that when a touch force is applied on the outside of the front cover **11** of the touch display device **1**, the supporting elements **151** elastically deform and exert a force on the lower substrate **122**. Thus, a greater touch force (that an inadvertent touch) is needed to make the touch display module **12** deform. The supporting elements **151** cause a greater touch force to need to be applied to the cover **11** to make the distance between the force sensing electrode **1242** and the first electrode layer **123** to reach a minimum value. With the mutual capacitor C structure, the supporting elements **151** can increase a range of the touch forces applied on the touch display device **1** that can be detected.

FIG. **6** shows a relationship between the touch force applied on the touch display device **1** and a capacitance of the mutual capacitor C structure. The abscissa X indicates the touch force, and the ordinate Y indicates the capacitance of the mutual capacitor C structure.

There are three capacitance stages shown in FIG. **6**, which are an I-capacitance stage, a II-capacitance stage, and a III-capacitance stage. In the I-capacitance stage, the capacitance of the mutual capacitor C structure increases as the touch force applied on the touch display device **1** increases. During the I-capacitance stage, both the supporting element **151** and the touch display module **12** deform. During the II-capacitance stage, the supporting element **151** deforms its maximum amount and the capacitance of the mutual capacitor C structure more steeply increases as the touch force applied on the touch display device **1** increases. A ratio of the capacitance of the mutual capacitor C structure to the touch force in the capacitance stage-II is greater than a ratio of the capacitance of the mutual capacitor C structure to the touch force in the capacitance stage-I. During the III-capacitance stage, the touch display module **12** is already deformed its maximum amount and the distance between the force sensing electrode **1242** and the first electrode layer **123** reaches a minimum value, thus the capacitance of the mutual capacitor C structure cannot change despite the continued application of a touch force on the touch display device **1**.

In FIG. **3** and FIG. **7**, the touch display device **1** further includes a fixing frame **128** on a side of the backlight module **127** opposite from the lower polarizer **129**. The fixing frame **128** is located between the backlight module **127** and the supporting elements **151**. The fixing frame **128** is configured for supporting the touch display module **12**. In this embodiment, the fixing frame **128** is made of a rigid material, such as a metal or an alloy; but that does not permanently deform when a force is applied to it by a user of the touch display device. The material used for the fixing frame **128** should have a fast rebounding speed. Therefore, when the touch force is removed, the fixing frame **128** will rebound and the touch display module **12** will quickly revert to an original state.

In FIG. **3** and FIG. **7**, the front cover **11** and the back cover **13** are fixed together. The back cover **13** includes a receiving portion **131** and a main portion **132** engaged with the receiving portion **131**. The receiving portion **131** surrounds a peripheral portion of the front cover **11**. The main portion **132** forms the receiving cavity **10**. The receiving portion **131** defines a first receiving groove **134** and a second receiving groove **135**. The first groove **134** is defined on a surface of the receiving portion **131** adjacent to the touch display module **12**. The second receiving groove **135** is defined on a surface of the receiving portion **131** opposite from the touch display module **12**. One end of the main portion **132** is engaged in the first groove **134** of the receiving portion **131**. The fixing frame **128** extends so that one end is engaged in the second receiving groove **135**.

In FIG. **3** and FIG. **7**, the touch display device **1** further includes other internal components **16**. In this embodiment, the other internal components **16** may include a circuit board **161** and a battery **162** as shown in FIG. **3** and FIG. **7**. Other internal components **16** may include a fingerprint recognition module or a camera module.

FIG. **8** shows a touch display panel **2** according to another embodiment. The touch display panel **2** is substantially the same as the touch display panel **1**, except that the touch display panel **2** includes only one supporting element **15** to support the touch display panel **12**. The touch display panel **1** includes, as an example, the plurality of spaced-apart individual cylindrical supporting elements **151** that support the touch display panel **12**. The supporting element **15** of FIG. **8** has a cross-sectional area that is greater than a total cross-sectional area of all the supporting elements **151**.

FIG. **9** and FIG. **10** show two different driving time sequences of the touch display device **1**. The touch sensing electrodes **1241** also function as common electrodes for image display. The touch display device **1** is driven by a time division driving method.

As shown in FIG. **9**, one frame time, or a single frame, is divided into a display period (DM), a touch sensing period (TM), and a touch force sensing period (FM). The driving circuit of the touch display device alternately drives the touch display device to display during the DM, to detect touch position during the TM, and to detect touch force during the FM in one frame time.

As shown in FIG. **10**, one frame time, or a single frame, is divided into a plurality of display sub-periods (DM_1 through DM_n), a plurality of touch sensing sub-periods (TM_1 through TM_n), and a plurality of touch force sensing sub-periods (FM_1 through FM_n). The display sub-periods (DM_1 through DM_n), the touch sensing sub-periods (TM_1

through TM_n), and the touch force sensing sub-periods (FM_1 through FM_n) alternate. The driving circuit of the touch display device repeatedly cycles the touch display device through the DM, TM, and FM periods, to display during each display sub-period, to detect touch position during each touch sensing sub-period, and to detect touch force during each touch force sensing sub-period in one frame time.

During the display period or the display sub-period, the first electrode layer **123** may be floating or may be supplied with a common voltage. Each touch sensing electrode **1241** and each force sensing electrode **1242** may be supplied with common voltages, the fixing frame **128** may be electrically grounded.

During the touch sensing period or the touch sensing sub-period, the first electrode layer **123** may be floating or applied with a common voltage; each touch sensing electrodes **1241** may be applied with a signal plus voltage; each force sensing electrode **1242** may be applied with common voltages; and the fixing frame **128** is electrically grounded.

During the touch force sensing period or the touch force sensing sub-period, the first electrode layer **123** may be floating or applied with a signal plus voltage; each touch sensing electrodes **1241** may be electrically grounded or applied with a common voltage; each force sensing electrode **1242** may be applied with a signal plus voltage; and the fixing frame **128** is electrically grounded.

It is to be understood, even though information and advantages of the present exemplary embodiments have been set forth in the foregoing description, together with details of the structures and functions of the present exemplary embodiments, the disclosure is illustrative only. Changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the present exemplary embodiments to the full extent indicated by the plain meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A touch display device comprising:

a touch display module comprising:

a TFT substrate;

a color filtering substrate; and

a liquid crystal layer between the TFT substrate and the color filtering substrate;

wherein a first electrode layer is formed on a surface of the color filtering substrate facing the TFT substrate; a second electrode layer is formed on a surface of the TFT substrate facing the color filtering substrate;

wherein the touch display device further comprises at least one supporting element elastically resisting against the touch display module from a side of the TFT substrate opposite to the color filtering substrate; the at least one supporting element is elastic;

wherein:

the first electrode layer comprises a plurality of conducting lines intersecting with each other to form a mesh;

a plurality of through holes is defined in the first electrode layer;

the first electrode layer comprises a plurality of nodes; and

each of the plurality of nodes is formed where two conducting lines intersect with each other;

wherein the second electrode layer comprises a plurality of touch sensing electrodes spaced apart from each other; the plurality of touch sensing electrodes forms a self capacitor structure configured for sensing touch position;

wherein the second electrode layer further comprises a plurality of force sensing electrodes; some of the plurality of touch sensing electrodes each defines an opening; each of the plurality of force sensing electrodes is located in one opening, spaced apart from and surrounded by one of the plurality of touch sensing electrodes;

wherein each of the plurality of force sensing electrodes overlaps with one of the plurality of nodes; the plurality of force sensing electrodes and the first electrode layer form a mutual capacitor structure configured for detecting a touch force applied on the touch display device.

* * * * *

专利名称(译)	触控显示面板
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公开(公告)日	2020-06-23
申请号	US16/112617
申请日	2018-08-24
[标]申请(专利权)人(译)	鸿海精密工业股份有限公司
申请(专利权)人(译)	鸿海精密工业股份有限公司.
当前申请(专利权)人(译)	鸿海精密工业股份有限公司.
[标]发明人	WENG YU FU LIN CHIEN WEN LIU CHIA LIN CHENG TZU YU
发明人	WENG, YU-FU LIN, CHIEN-WEN LIU, CHIA-LIN CHENG, TZU-YU
IPC分类号	G02F1/1333 G02F1/1368 G06F3/041 G06F3/044 G02F1/1335
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优先权	201810637769.2 2018-06-20 CN
其他公开文献	US20190391440A1
外部链接	Espacenet

摘要(译)

触摸显示设备包括触摸显示模块。 触摸显示模块包括：TFT基板，滤色基板以及封装在TFT基板和滤色基板之间的液晶层。 在滤色基板的面对TFT基板的表面上形成第一电极层。 在TFT基板的面对滤色基板的表面上形成第二电极层。 触控显示装置在触控显示模块的一侧还包括至少一个支撑元件。 支撑元件是弹性的，并且被配置为弹性地抵抗触摸显示模块。