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(54) TOUCH PANEL WITH IMPROVED OPTICAL PERFORMANCE

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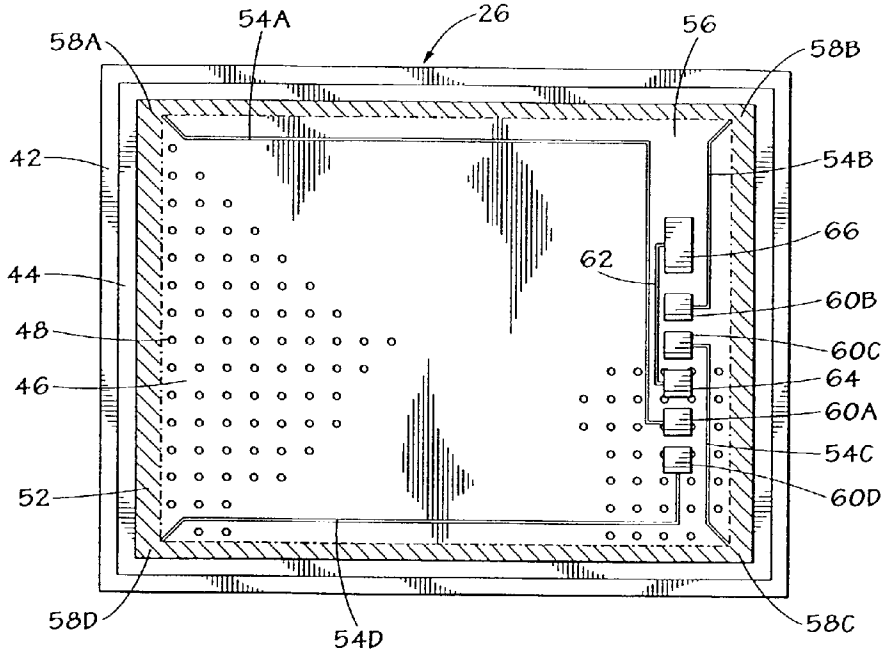
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(57) **ABSTRACT**

Sunlight can damage a conventional touch screen display and cause the display to be quite difficult to read. Furthermore, conventional touch screen displays are easily damaged, and, once damaged, the entire touch screen is replaced. To address these concerns, a touch panel includes anti-reflective coatings on the surfaces of the top plate and the base plate that are open to the air. These coatings substantially reduce reflections and make the touch screen easier to read in direct sunlight. In particular, the anti-reflective coating used on the upper surface of the base plate is dielectric in nature to reduce reflectivity even further. This dielectric coating includes openings to an underlying conductive layer so that an electrical contact is made when a user deflects the top plate into the base plate. Also, the top plate may be detachably coupled to the base plate, advantageously by double stick adhesive tape, so that only the top plate is replaced when damaged. Furthermore, a resistive voltage divider may be fabricated on the base plate. The resistive voltage divider may include a substantially continuous strip of resistive material disposed on the conductive layer of the base plate, and a plurality of conductive traces disposed on the dielectric layer of the base plate and coupled to the resistive material in selected locations.



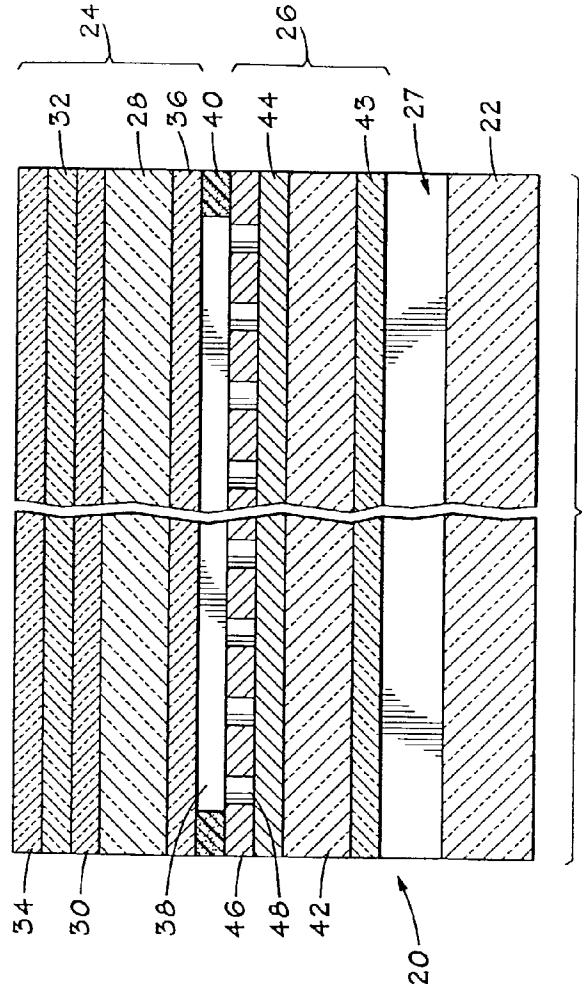

24
26
32
28
36
40
44
43
27
22
34
30
38
46
48
42
20

FIG. 2

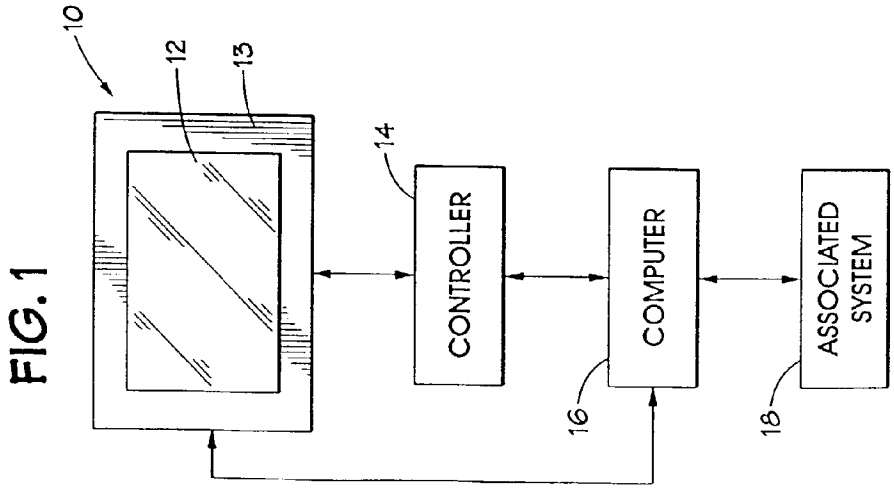

10
12
13
14
CONTROLLER
COMPUTER
ASSOCIATED SYSTEM
16
18

FIG. 1

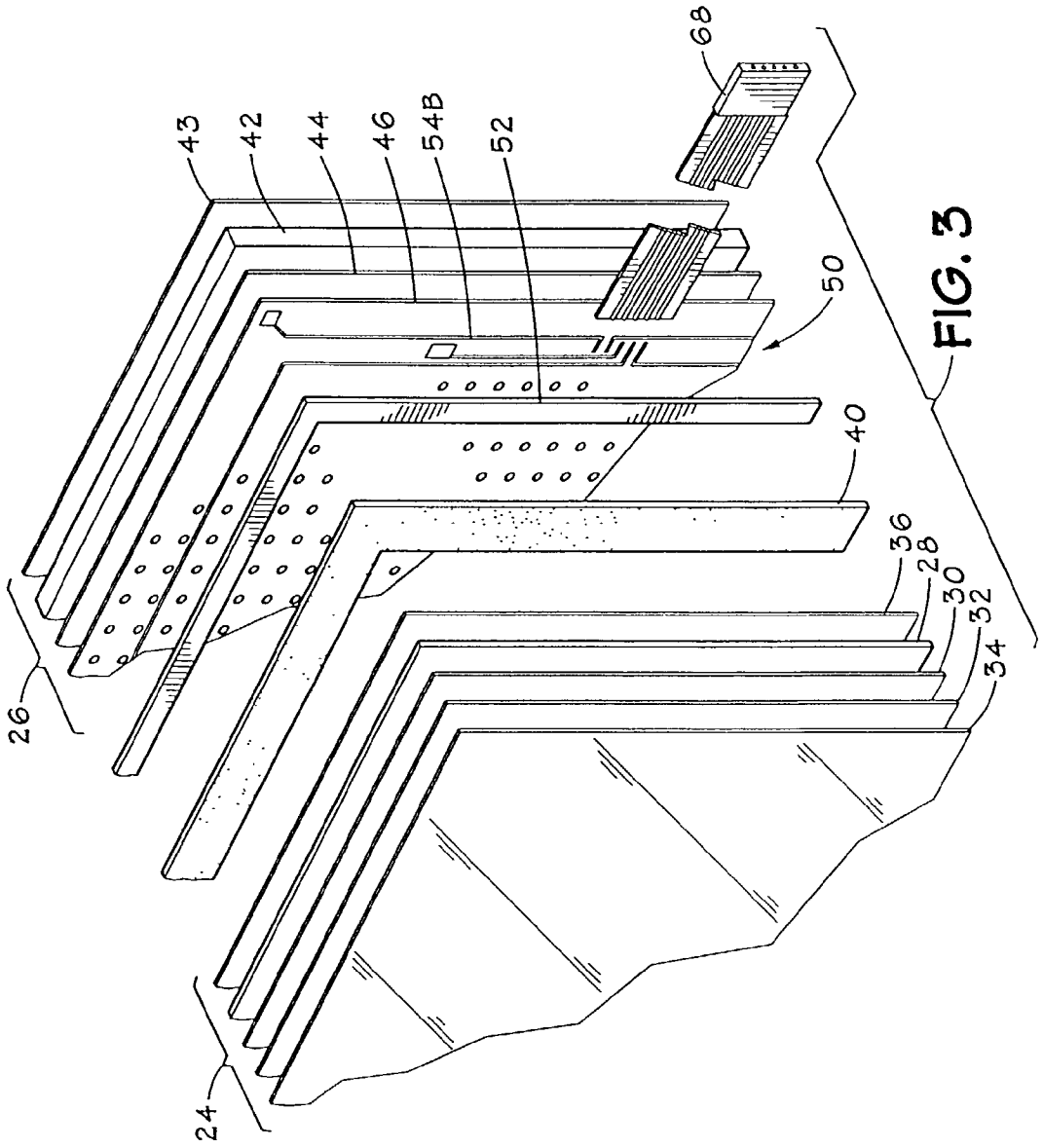


FIG. 3

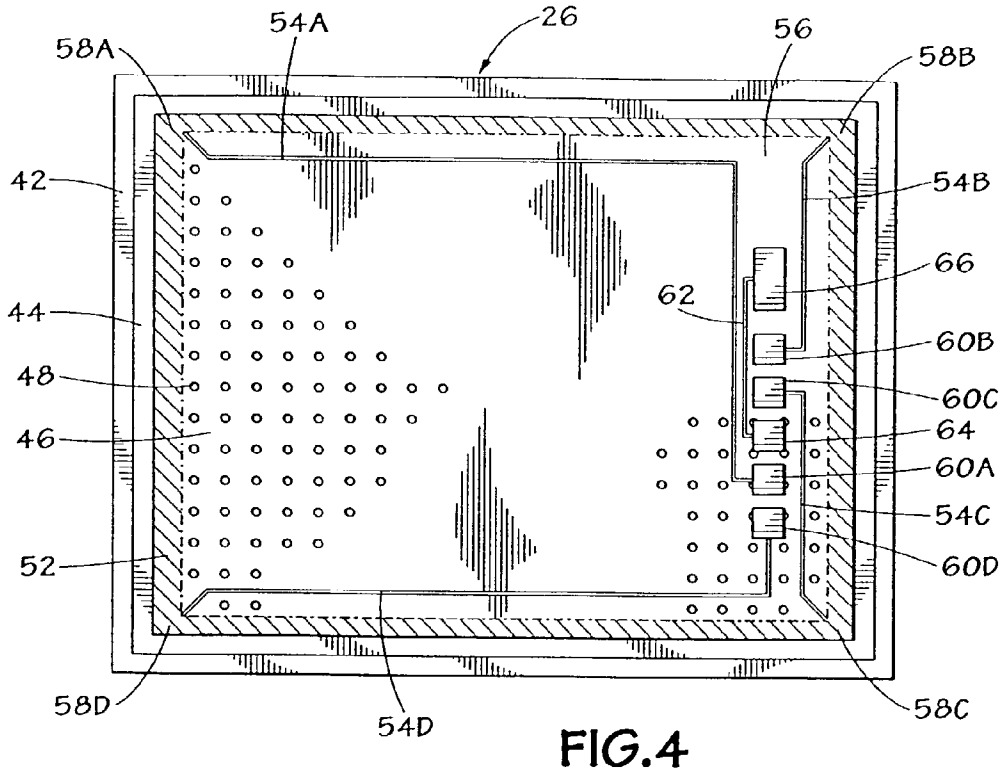

58A
54A
26
56
58B
42
54B
66
62
44
60B
48
60C
46
64
60A
54C
52
60D
58D
54D
58C

FIG.4

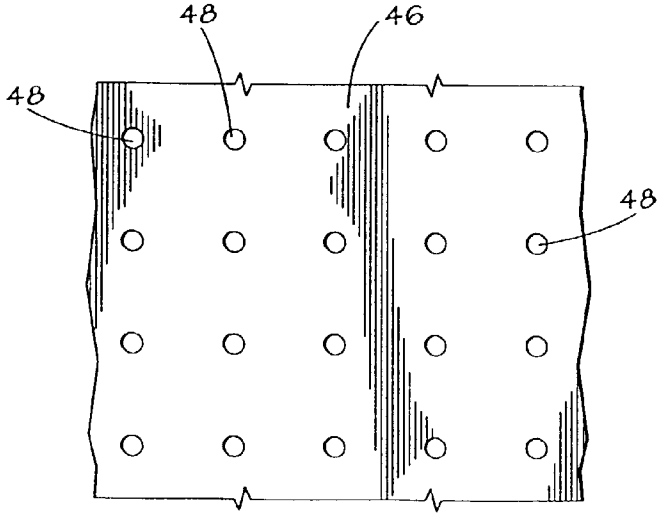

48
46
48
48

FIG.6

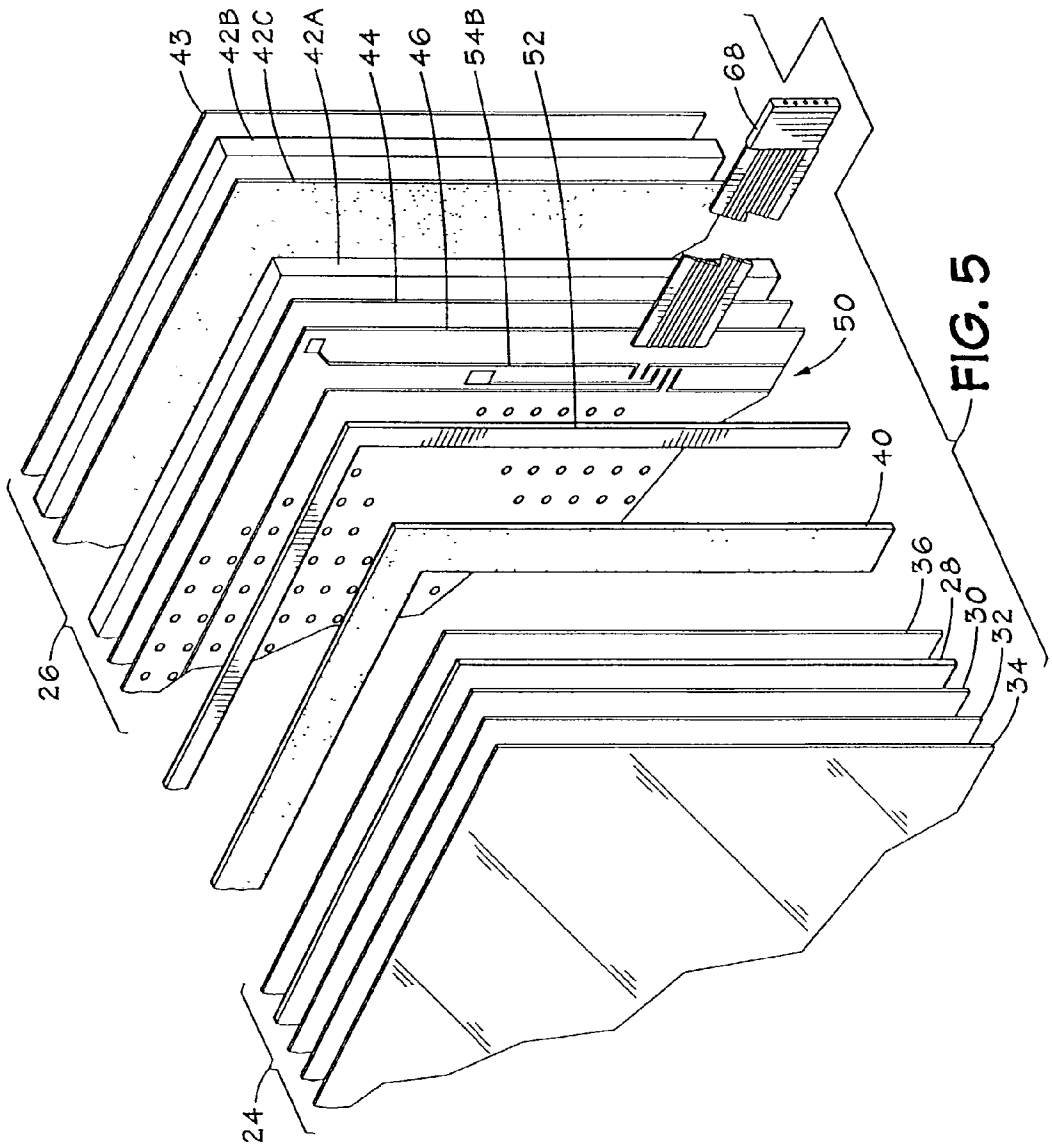


FIG. 5

TOUCH PANEL WITH IMPROVED OPTICAL PERFORMANCE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates generally to input devices and, more particularly, to improvements for touch panel displays.

[0003] 2. Background of the Related Art

[0004] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present invention which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present invention. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

[0005] Input devices perform the function of providing some means for entering commands and data into a computer, data processor, or information system. A variety of input devices are currently available, including keyboards, light pens, data tablets, mice, track balls, joysticks, scanners, voice recognition devices, and touch screens. Each of these input devices exhibits various advantages and disadvantages, and the input device or devices used in any particular application are typically chosen to maximize the efficient input of information into the system.

[0006] This disclosure is primarily directed to the last of the input devices mentioned above, namely touch screens. Unlike the other input devices mentioned above, touch screens not only act as a data input device, they also act as a display unit. Essentially, a touch screen is a display unit with some form of a touch-sensitive surface. Due to this unique characteristic, touch screens are currently utilized in a variety of different applications, such as computer terminals, cash registers, automatic teller machines, and automated gasoline pumps to name just a few.

[0007] Currently, there are at least four different technologies used for touch screens: (1) capacitive, (2) resistive, (3) surface acoustic wave, and (4) light beam interruption. Although each of these different types of touch screens operate in a different manner and exhibit certain advantages and disadvantages, certain similarities exist. For example, regardless of the type of touch screen, the touch screen system typically includes a sensor unit, which senses the location touched on the display, and a controller unit, which interfaces with the sensor unit and communicates the location information to a system computer. Thus, regardless of the technology employed, each type of touch screen performs the same general function.

[0008] However, it is the differences in the way that the various types of touch screens operate that causes a designer to use one type of touch screen over another for a particular application. Resistive touch screens, for example, advantageously exhibit low cost, high touch point density, and can be operated with a gloved hand. Disadvantageously, however, resistive touch screens can be easily damaged and exhibit poor display characteristics (particularly in sunlight). Capacitive touch screens also provide high touch point density and low cost, but capacitive touch screens can be easily damaged, must be calibrated due to large temperature changes, and cannot be operated with a gloved hand.

[0009] In contrast, surface acoustic wave touch screens have no overlay to be damaged or to reduce the visual quality of the display. However, surface acoustic wave touch screens typically exhibit the highest cost and can be falsely triggered by noise, wind, transmission signals, and insects. Touch screens that use light beam interruption, typically called infrared touch screens, are relatively expensive. Advantageously however, they have no touch sensitive overlay to be damaged, exhibit high touch point density, can be operated with heavy gloves, exhibit good immunity to most false trigger sources, and are extremely rugged and weather sealable. Although these advantages typically make infrared touch screens the most suitable type of touch screen to use in outdoor applications, high ambient light conditions, such as direct sunlight, can cause an infrared touch screen to malfunction.

[0010] It can be seen that each type of touch screen exhibits some disadvantage which makes it not well suited for outdoor use, particularly in high ambient light conditions. Of the different types of touch screens mentioned above, resistive touch screens typically offer the lowest cost along with very good operational performance. In a resistive touch screen, a display, such as a liquid crystal display, resides beneath a multi-layered screen overlay. The top layer touched by a user is a plastic layer with a transparent metallic film on its underside. This top layer is separated by insulating spacers from a bottom layer that has a metallic film on its upper side. These metallic films face one another so that the films make contact when a user presses the top layer into contact with the bottom layer. A conductive path is formed at the point of contact. Thus, the films act as a voltage divider, and the voltage at the point of contact may be measured in the X and Y directions by applying the voltage in one direction and then the other direction. The measured voltages may then be sent to a controller where they are converted into coordinates on the screen and sent to a computer.

[0011] This overlay screen suffers in outdoor applications, and particularly in sunlight, for various reasons. First, the typical reflectance of such overlay screens is about 25%, making the underlying display difficult to read. Second, such overlay screens allow most of the infrared radiation from sunlight to be absorbed by the underlying liquid crystal display, and this radiation can cause solar thermal loading of the display which lead to display malfunction. Third, the materials used for such overlay screens tend to deteriorate rapidly from exposure to the ultraviolet rays of the sun. Fourth, the top layer touched by users is easily scratched or damaged, thus requiring the whole touch panel to be replaced.

[0012] The present invention may address one or more of the problems set forth above.

SUMMARY OF THE INVENTION

[0013] Certain aspects commensurate in scope with the originally claimed invention are set forth below. It should be understood that these aspects are presented merely to provide the reader with a brief summary of certain forms the invention might take and that these aspects are not intended

to limit the scope of the invention. Indeed, the invention may encompass a variety of aspects that may not be set forth below.

[0014] In accordance with one aspect of the present invention, there is provided a touch panel display system that includes a computer, a controller coupled to the computer, and a display screen coupled to the computer. A touch panel is coupled to the controller and disposed over the display screen. The touch panel includes a base plate being disposed adjacent the display screen. The base plate has a rigid substrate having an upper surface and a lower surface. A first conductive layer is disposed over the upper surface of the rigid substrate. An anti-reflective dielectric layer is disposed over the first conductive layer, and the anti-reflective dielectric layer has openings through to the first conductive layer. A first anti-reflective layer is disposed on the lower surface of the rigid substrate. A top plate is disposed in spaced apart relation over the base plate. The top plate has a flexible substrate having an upper surface and a lower surface. A hard coating layer and a second anti-reflective layer are disposed over the upper surface of the flexible substrate, and an anti-reflective conductive layer is disposed on the lower surface of the flexible substrate.

[0015] In accordance with another aspect of the present invention, there is provided a touch screen overlay that includes a flexible substrate having an upper surface and a lower surface. Double stick adhesive tape is coupled to the lower surface of the flexible substrate.

[0016] In accordance with still another aspect of the present invention, there is provided a touch screen that includes a top plate having an upper surface and a lower surface and a base plate having an upper surface and a lower surface. A member detachably couples the lower surface of the top plate to the upper surface of the base plate.

[0017] In accordance with yet another aspect of the present invention, there is provided a method of repairing a damaged touch screen having a flexible top plate disposed in spaced apart relation over a relatively rigid base plate. The method includes the acts of: (a) removing the top plate from the base plate; and (b) disposing a replacement top plate on the base plate.

[0018] In accordance with a further aspect of the present invention, there is provided a method of manufacturing a touch panel. The method includes the acts of: (a) providing a base plate; (b) providing a top plate; and (c) detachably disposing the top plate over the base plate in spaced apart relation.

[0019] In accordance with a still further aspect of the present invention, there is provided a method of manufacturing a touch panel. The method includes the acts of: (a) disposing a layer of conductive material over an upper surface of a relatively rigid substrate of a base plate; (b) disposing a patterned layer of anti-reflective dielectric material over the layer of conductive material, the patterned layer of anti-reflective dielectric material having openings through to the layer of conductive material; (c) disposing a first layer of anti-reflective material over a lower surface of the relatively rigid substrate of the base plate; (d) disposing a second layer of anti-reflective material over an upper surface of a relatively flexible substrate of a top plate; (e) disposing a layer of anti-reflective conductive material over a lower surface of the relatively flexible substrate of the top plate; and (f) arranging the top plate over the base plate such that the anti-reflective conductive material disposed over the lower surface of the top plate is in spaced apart relation to the patterned anti-reflective dielectric layer disposed over the upper surface of the base plate.

[0020] In accordance with a yet further aspect of the present invention, there is provided a sensing unit for a touch panel. A first plate of the touch panel has a first layer of conductive material disposed on its surface. A second plate of the touch panel has a second layer of conductive material disposed on its surface and has a layer of dielectric material disposed over the second layer of conductive material such that a peripheral portion of the second layer of conductive material remains exposed. The layer of dielectric material has openings through to the second layer of conductive material. -A substantially continuous resistive member is disposed over the exposed peripheral portion of the second layer of conductive material adjacent a periphery of the layer of dielectric material. A plurality of conductive traces is disposed on the layer of dielectric material, where each of the plurality of conductive traces has a first end coupled to a respective selected location of the resistive member.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The foregoing and other advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings in which:

[0022] **FIG. 1** illustrates a simplified schematic diagram of a display system;

[0023] **FIG. 2** illustrates a cross-sectional view of a touch screen display in accordance with the present invention;

[0024] **FIG. 3** illustrates a partial exploded view of the touch screen display illustrated in **FIG. 2**;

[0025] **FIG. 4** illustrates a base plate having a resistive voltage divider circuit in accordance with the present invention;

[0026] **FIG. 5** illustrates a partial exploded view of the touch screen display illustrated in **FIG. 2** showing a detailed view of the substrate of the base plate; and

[0027] **FIG. 6** illustrates a portion of the anti-reflective dielectric layer of the base plate illustrated in **FIG. 4**.

DESCRIPTION OF SPECIFIC EMBODIMENTS

[0028] One or more specific embodiments of the present invention will be described below. In an effort to provide a concise description of these embodiments, not all features of an actual implementation are described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0029] Turning now to the drawings, and referring initially to **FIG. 1, a** touch screen display system is illustrated and generally designated by a reference numeral **10**. The touch screen display system **10** includes a touch screen and display assembly **12**. The touch screen is mounted in front of the display, such as a liquid crystal display or a cathode ray tube, so that information on the display may be read through the touch screen. Advantageously, a face plate **13** is coupled to the assembly **12** in a manner which seals and protects the assembly **12** from damage, such as damage caused by impacts or weather. It should also be noted that the face plate **13** defines the periphery of an opening in which the assembly **12** resides that allows a user to contact the touch panel overlying the display.

[0030] A controller **14** is electrically coupled to the touch screen of the assembly **12**. The controller **14** may be mounted on the assembly **12**, or it may be mounted in a separate location. When a user inputs data into the system **10** by touching a portion of the touch screen overlying selected indicia on the display, the controller **14** receives information from the touch screen related to the user inputs and converts this information to coordinate data. The coordinate data is delivered to a computer **16** that is electrically coupled to the controller **14**. The computer **16** is also electrically coupled to the display of the assembly **12** and, typically, to an associated system **18** that the system **10** controls. The computer **16** determines which displayed indicia corresponds to the coordinate data, and it controls the display and the associated system **18** accordingly.

[0031] As discussed previously, resistive touch panels have been historically disadvantaged because they can be easily damaged and because they exhibit poor display characteristics, particularly in high ambient light conditions. Also, once a typical touch panel is damaged, the entire touch panel usually must be replaced. These problems and others are addressed by the touch panel and display assembly illustrated in **FIGS. 2 and 3**, which includes a touch panel **20** and a display screen **22**.

[0032] The touch panel **20** includes a top plate **24** and a base plate **26**. As illustrated in **FIG. 2**, the touch panel **20** may be situated relative to the display screen **22** such that an air gap **27** exists between the base plate **26** and the display screen **22**. This arrangement facilitates the cooling of the display screen **22** as air may circulate about it.

[0033] The primary structural component of the top plate **24** is a substrate **28**. The substrate **28** is advantageously selected to be a durable, flexible, and transparent material, since it is intended for use as a deflecting element which moves into contact with the base plate **26** when pushed by a user. Suitable materials may include Mylar, Lexan, and CR-39, for example. The thickness of the substrate **28** should advantageously allow deflection into the base plate **26** with light finger pressure, while not becoming wavy at high temperature. Advantageously, it should also be stiff enough so as not to make contact with the base plate **26** unless pressed. The thickness of the substrate **28** may be in the range from about 5 to about 20 mils, for example.

[0034] To enhance the damage resistance of the top plate **24**, the substrate **28** is coated with a hard transparent coating **30**. Although the individual needs of particular applications may be taken into account when selecting the material for the hard coating **30**, the material should advantageously be one that will wear well when subjected to the abuse of the general public. Such abuse may not only include general wear and tear from normal operation of the touch panel **20**, but may also include vandalistic abuse such as being struck with rocks, poked with sticks, cut by knives, or burned by lighters. While it is unlikely that any material would adequately protect the top plate **24** from all such abuses, it is generally advisable that the hard coating **30** be selected from the most durable material that falls within the technical and financial constraints of a particular application. Suitable materials may include, for instance, silicon dioxide.

[0035] The optical qualities of the top plate **24** are enhanced by the use of one or more anti-reflective coatings **32** which may be placed over and/or under the hard coating **30**. An anti-reflective coating is advantageously index matched to the substrate **28** to provide low levels of reflectivity, advantageously in the range of 0.25 to 1.00%. In addition to enhancing the reflection properties of the top plate **24**, the coatings **32** also advantageously include a "hot mirror" capability to reflect solar energy outside the visible spectrum, i.e., infrared and ultraviolet light, to protect the underlying elements of the touch screen **20** and the display **22** from damage. Suitable anti-reflective materials may include silicon dioxide or magnesium fluoride.

[0036] To improve the optical characteristics of the top plate **24** further, an anti-fingerprint coating **34** may be applied as the outer surface of the top plate **24**. The anti-fingerprint coating **34** may be a commercially available coating that is resistant to dirt and oils, i.e., hydrophobic, so that fingers and dirty gloves will not smudge the top plate **24**.

[0037] The underside of the substrate **28** is spaced from the upper surface of the base plate **26** by an air gap **38**. This surface of the substrate **28** is coated with an anti-reflective conductive material **36**. As described below in greater detail, it is the conductive material **36** which makes contact with a conductive layer on the base plate **26** when a user presses the top plate **24** and deflects it across the air gap **38**. The anti-reflective nature of the conductive material **36** further improves the optical qualities of the top plate **24**, and the conductive layer **36** is advantageously indexed matched to the substrate **28** to reduce reflection. The conductive layer **36** may be made of titanium or indium tin oxide (ITO), for example.

[0038] The top plate **24** may be fixed to the base plate **26** in a spaced apart relationship in a conventional manner. However, in this embodiment, the top plate **24** is advantageously spaced from the base plate **26** in a manner than allows the top plate **24** to be removed from the base plate **26** so that the top plate **24** may be separately replaced if damaged.

[0039] One particularly cost effective arrangement is the use of a strip of double stick adhesive tape **40** that is applied about a peripheral portion of the touch panel between the top plate **24** and the base plate **26**, as best illustrated in **FIG. 3**. An advantageous type of double stick adhesive tape **40** is a high tack/low tack Scotch brand adhesive tape available from 3M. This tape features a carrier having a strong adhesive on one side and a repositionable adhesive on the other side. Because the adhesive properties of such tape may degrade with repeated use, it may be desirable to place the high tack side of the adhesive tape **40** on the top plate **24**. In this situation, the tape **40** is retained on the top plate **24** when

a damaged top plate is removed, and a new piece of tape will be affixed to the replacement top plate. However, as described below, a resistive voltage divider circuit may be fabricated on a peripheral portion of the base plate **26**. Thus, it may be desirable to provide additional protection for this circuit by placing the high tack side of the adhesive tape **40** on the base plate **26** to cover this circuit so that the tape **40** remains on the base plate **26** when a damaged top plate **24** is removed and replaced.

[**0040**] Although not specifically illustrated, other techniques may also be used to mount the top plate **24** in a removable fashion over the base plate **26**. For instance, spacers may be provided between the top plate **24** and the base plate **26**, and the top plate **24** may be bolted to the base plate **26**. As another alternative, spacers and/or spacer dots may be provided between the top plate **24** and the base plate **26**, and a removable bezel arrangement, or the like, may be used to clamp or similarly hold the top plate **24** to the base plate **26**.

[**0041**] Referring to **FIGS. 3 and 4**, the primary structural component of the base plate **26** is a transparent substrate **42**. The substrate **42** is advantageously selected to be relatively rigid compared to the relatively flexible substrate **28** of the top plate **24**, since it is intended to limit deflection of the top plate **24** in order to provide an accurate indication of the location on the screen selected by the user. Suitable materials may include glass or acrylic, for example. To enhance the optical properties of the substrate **42**, an anti-reflective coating **43**, such as a multilayer coating, is disposed on the lower surface of the substrate **42**. A broadband visible anti-reflective coating is typically advantageous.

[**0042**] As illustrated in **FIG. 5**, the substrate **42** may be fabricated from multiple layers. In this illustration, the substrate **42** includes a first glass portion **42**A and a second glass portion **42**B coupled together by a sheet adhesive **42**C. The second glass portion **42**B provides extra support for the touch panel **20** and essentially functions as a "vandal" glass to reduce the likelihood that severe impacts will break the touch panel **20**.

[**0043**] A layer of conductive material **44** is disposed on the upper surface of the substrate **42**. When a user presses the top plate **24**, the conductive material **36** on the underside of the top plate **24** should contact the conductive material **44** on the upper side of the base plate **26**. As discussed more fully below, it is the contact between these two layers of conductive material **36** and **44** that completes the resistive voltage divider circuit used to determine the position on the touch screen **20** pressed by the user. However, it is also desirable to reduce the reflection of the base plate **26** as much as possible. While an anti-reflective conductive material, such as the anti-reflective conductive material **36**, would improve the optical qualities of the base plate **26**, reflection would still be about 8%. Other anti-reflective coatings, such as silicon dioxide or magnesium fluoride, can reduce reflection to about 0.6%, but these coatings are dielectric in nature. As such, the use of these coatings over the layer of conductive material **44** would normally prevent electrical contact between the top plate **24** and the base plate **26**.

[**0044**] To address this concern, a patterned anti-reflective dielectric layer **46** is disposed over the conductive material **44**. As best illustrated by the enlarged view of the patterned anti-reflective dielectric layer **46** depicted in **FIG. 6, a** plurality of small circular holes **48** is formed in a regular pattern in the layer **46**, although other types of holes and patterns may also be suitable. These holes **48** extend through the dielectric layer **46** to expose the underlying conductive layer **44**. Thus, when the top plate **24** is pressed by a user, the conductive layer **36** moves into contact with the conductive layer **44** through at least one of the plurality of holes **48** to complete the electrical circuit.

[**0045**] The holes **48** advantageously are between about 2.5 mil and about 10.0 mil in diameter, and have an average spacing between about 10.0 mil and about 50.0 mil. Values may be selected so that between about 1.0% and about 5.0% of the surface of the underlying conductive layer **44** is exposed. In one particularly advantageous embodiment, the holes **48** have a diameter of about 3.0 mils and an average spacing of about 20.0 mils, so that about 1.75% of the underlying conductive layer **44** is exposed as very small dots. In this embodiment, the dot array combined with the low reflectivity properties of the dielectric material used in the layer **46** yields an average reflectivity of about 1%.

[**0046**] The patterned anti-reflective dielectric layer **46** may be formed in any suitable manner. For example, a dielectric material, such as silicon dioxide, may be deposited in a layer over the conductive layer **44**. Then, using photoresist patterning and etching techniques, the holes **48** may be patterned and etched. Alternatively, a photoresist process may be used to deposit a dielectric material, such as magnesium fluoride, onto the conductive layer **44** in its patterned form.

[**0047**] It should be understood that spacer dots (not shown), which are small insulative protrustions often used to separate opposing conductive surfaces between a top plate and base plate of a touch screen, may be used in the touch screen **20**. However, as an additional advantage, the use of a mostly insulated upper surface of the base plate **26** may reduce or eliminate the usage of spacer dots. The reduction or elimination of spacer dots serves two useful ends. First, the cost should be reduced since the spacer dots are not manufactured. Second, spacer dots tend to reflect light passing through a touch screen, so the reduction or elimination of the spacer dots correspondingly reduces or eliminates this reflected light which adversely affects the optical qualities of a touch screen.

[**0048**] The use of the dielectric layer **46** may also facilitate the incorporation of other improvements into the touch screen **20**. For example, as illustrated in **FIGS. 3 and 4**, a resistive voltage divider circuit **50** may be fabricated about a peripheral portion of the base plate **26**. Conventionally, a discrete voltage divider is implemented about the edges of the upper conductive layer of the base plate using a small segment of the sheet resistance of the conductive surface. Disadvantageously, however, such a construction provides a number of fixed voltages, so linearity is adversely affected. To address this concern, the resistive voltage divider circuit **50** includes a thick film resistive trace **52**. The trace **52** is disposed on the conductive layer **44** and extends substantially continuously about the outer periphery of the dielectric layer **46**. Also, to improve linearity further, the trace **52** may be tapered toward the corners to increase resistance gradually along each of the sides of the trace **52**. It should be noted that the layer **46** and the trace **52** are illustrated with diagonal

lines for contrast only—no crosshatching or diagonal lines are actually present on these elements.

[0049] Four conductive traces **54**A, **54**B, **54**C, and **54**D are disposed along a peripheral portion **56** of the dielectric layer **46**. Advantageously, this peripheral portion **56** of the dielectric layer **46** contains no holes **48** and, thus, insulates the conductive traces **54**A-**54**D from the conductive layer **44**. One end of each of the conductive traces **54**A, **54**B, **54**C, and **54**D is coupled to a respective corner **58**A, **58**B, **58**C, and **58**D of the resistive trace **52**. The other end of each of the conductive traces **54**A, **54**B, **54**C, and **54**D is coupled to a respective conductive termination pad **60**A, **60**B, **60**C, and **60**D located on one side of the peripheral portion **56** of the dielectric layer **46**.

[0050] A conductive voltage divider trace **62** is also located on this side of the peripheral portion **56** of the dielectric layer **46**. One end of the voltage divider trace **62** is coupled to a small conductive termination pad **64** disposed amongst the termination pads **60**A, **60**B, **60**C, and **60**D, and the other end of the voltage divider trace **62** is coupled to a larger conductive termination pad **66**. As best illustrated in **FIG. 3**, the conductors of an interface cable **68** may be coupled to the pads **60**A, **60**B, **60**C, **60**D, **64**, and **66** to provide appropriate electrical signals to the controller **14**.

[0051] The traces and termination pads mentioned above may be fabricated in any suitable manner. For example, these traces and pads may be fabricated from films deposited by a silk screening technique or the like. Alternatively, photoresist patterning and etching techniques may by used to form these traces and pads.

[0052] In view of the specific embodiments disclosed and discussed above, it should be appreciated that the touch panel **20** incorporates several advantageous features that may be useful individually or in combination. As to one advantage, the touch panel **20** exhibits excellent optical properties due to the arrangement of anti-reflective layers on the four surfaces of the touch panel **20** that are adjacent the air. As to another advantage, the top plate **24** of the touch panel **20** may be removed when damaged and replaced without replacing any of the other elements of the system **10**. Yet another advantage stems from the use of the patterned anti-reflective dielectric layer **46** on the base plate **26** to improve optical properties while still facilitating electrical contact between the top plate **24** and the base plate **26**. The use of this layer **46** may further improve the optical properties of the touch panel **20** due to the reduction or elimination of spacer dots. Of course, the touch panel **20** also includes the resistive voltage divider circuit **50** which improves the linearity of the voltage sensing function of the touch panel **20** and, thus, improves the touch point density and accuracy.

[0053] While the invention may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims.

What is claimed is:

1. A touch panel display system comprising:

a computer;

a controller coupled to the computer;

a display screen coupled to the computer;

a touch panel coupled to the controller and being disposed over the display screen, the touch panel comprising:

a base plate being disposed adjacent the display screen, the base plate having a rigid substrate having an upper surface and a lower surface, a first conductive layer disposed over the upper surface of the rigid substrate, an anti-reflective dielectric layer disposed over the first conductive layer, the anti-reflective dielectric layer having openings through to the first conductive layer, and a first anti-reflective layer disposed on the lower surface of the rigid substrate; and

a top plate being disposed in spaced apart relation over the base plate, the top plate having a flexible substrate having an upper surface and a lower surface, a hard coating layer and a second anti-reflective layer disposed over the upper surface of the flexible substrate, and an anti-reflective conductive layer disposed on the lower surface of the flexible substrate.

2. The system, as set forth in claim 1, wherein the display screen comprises a liquid crystal display.

3. The system, as set forth in claim 1, wherein the top plate is removably mounted in spaced apart relation over the base plate.

4. The system, as set forth in claim 3, comprising double stick adhesive tape coupling the top plate to the base plate.

5. The system, as set forth in claim 4, wherein the double stick adhesive tape comprises a relatively high tack adhesive side and a relatively low tack adhesive side.

6. The system, as set forth in claim 5, wherein the relatively high tack adhesive side is coupled to the top plate and the relatively low tack adhesive side is coupled to the base plate.

7. The system, as set forth in claim 5, wherein the relatively high tack adhesive side is coupled to the base plate and the relatively low tack adhesive side is coupled to the top plate.

8. The system, as set forth in claim 1, wherein the second anti-reflective layer is disposed over the hard coating layer.

9. The system, as set forth in claim 1, wherein the top plate comprises an anti-fingerprint layer disposed over the second anti-reflective layer and the hard coating layer.

10. The system, as set forth in claim 1, wherein the anti-fingerprint layer comprises a hydrophobic material.

11. The system, as set forth in claim 1, wherein the rigid substrate comprises glass.

12. The system, as set forth in claim 1, wherein the rigid substrate comprises a first substrate portion bonded to a second substrate portion.

13. The system, as set fort in claim 12, wherein the first substrate portion and the second substrate portion comprise glass.

14. The system, as set forth in claim 1, comprising a coating which reflects solar energy outside the visible spectrum disposed on at least one of the top plate and the base plate.

15. The system, as set forth in claim 14, wherein the coating which reflects solar energy comprises a hot mirror capability.

16. The system, as set forth in claim 1, wherein the first conductive layer comprises at least one of titanium and indium tin oxide.

17. The system, as set forth in claim 1, wherein the anti-reflective dielectric layer comprises at least one of silicon dioxide and magnesium fluoride.

18. The system, as set forth in claim 1, wherein each opening has an area in a range from about 2.5 mils to about 10.0 mils, and wherein the openings have an average spacing in a range from about 10.0 mils to about 50.0 mils.

19. The system, as set forth in claim 1, wherein the first anti-reflective layer comprises multiple layers.

20. The system, as set forth in claim 1, wherein the flexible substrate comprises one of Mylar, Lexan, and CR-39.

21. The system, as set forth in claim 1, wherein the hard coating layer comprises silicon dioxide.

22. The system, as set forth in claim 1, wherein the second anti-reflective layer comprises at least one of silicon dioxide and magnesium fluoride.

23. The system, as set forth in claim 1, wherein the anti-reflective conductive layer comprises at least one of titanium and indium tin oxide.

24. The system, as set forth in claim 1, wherein the touch panel comprises a sensing circuit coupled to the first conductive layer and to the anti-reflective conductive layer, the sensing circuit delivering a signal correlative to a position where the first conductive layer contacts the anti-reflective conductive layer.

25. The system, as set forth in claim 24, wherein the sensing circuit comprises:

a substantially continuous resistive member disposed on the first conductive layer adjacent a peripheral portion of the anti-reflective dielectric layer; and

a plurality of conductive traces disposed on the anti-reflective dielectric layer, each of the plurality of conductive traces having a first end coupled to a respective selected location of the resistive member and having a second end coupled to the controller.

26. A touch screen overlay comprising:

a flexible substrate having an upper surface and a lower surface; and

double stick adhesive tape coupled to the lower surface of the flexible substrate.

27. The overlay, as set forth in claim 20, comprising a hard coating layer disposed over the upper surface of the flexible substrate.

28. The overlay, as set forth in claim 27, wherein the hard coating layer comprises silicon dioxide.

29. The overlay, as set forth in claim 26, wherein the flexible substrate comprises one of Mylar, Lexan, and CR-39.

30. The overlay, as set forth in claim 26, comprising an anti-reflective layer disposed over the upper surface of the flexible substrate.

31. The overlay, as set forth in claim 30, wherein the anti-reflective layer comprises at least one of silicon dioxide and magnesium fluoride.

32. The overlay, as set forth in claim 26, comprising an anti-reflective conductive layer disposed on the lower surface of the flexible substrate.

33. The overlay, as set forth in claim 32, wherein the anti-reflective conductive layer comprises at least one of titanium and indium tin oxide.

34. The overlay, as set forth in claim 26, wherein the double stick adhesive tape comprises a relatively high tack adhesive side and a relatively low tack adhesive side.

35. The overlay, as set forth in claim 34, wherein the relatively high tack adhesive side is coupled to the flexible substrate.

36. The overlay, as set forth in claim 34, wherein the relatively low tack adhesive side is coupled to the flexible substrate.

37. The overlay, as set forth in claim 26, comprising an anti-fingerprint layer disposed over the flexible substrate.

38. The overlay, as set forth in claim 37, wherein the anti-fingerprint layer comprises a hydrophobic material.

39. The overlay, as set forth in claim 26, comprising a coating which reflects solar energy outside the visible spectrum disposed over the flexible substrate.

40. The overlay, as set forth in claim 39, wherein the coating which reflects solar energy outside the visible spectrum comprises a hot mirror capability.

41. A touch screen comprising:

a top plate having an upper surface and a lower surface;

a base plate having an upper surface and a lower surface; and

a member detachably coupling the lower surface of the top plate to the upper surface of the base plate.

42. The touch screen, as set forth in claim 41, wherein the top plate comprises a flexible substrate having an upper surface and a lower surface.

43. The touch screen, as set forth in claim 42, wherein the flexible substrate comprises one of Mylar, Lexan, and CR-39.

44. The touch screen, as set forth in claim 42, comprising a hard coating layer disposed over the upper surface of the flexible substrate.

45. The touch screen, as set forth in claim 44, wherein the hard coating layer comprises silicon dioxide.

46. The touch screen, as set forth in claim 42, comprising an anti-reflective layer disposed over the upper surface of the flexible substrate.

47. The touch screen, as set forth in claim 46, wherein the anti-reflective layer comprises at least one of silicon dioxide and magnesium fluoride.

48. The touch screen, as set forth in claim 42, comprising an anti-reflective conductive layer disposed on the lower surface of the flexible substrate.

49. The touch screen, as set forth in claim 48, wherein the anti-reflective conductive layer comprises at least one of titanium and indium tin oxide.

50. The touch screen, as set forth in claim 41, wherein the member comprises double stick adhesive tape.

51. The touch screen, as set forth in claim 50, wherein the double stick adhesive tape comprises a relatively high tack adhesive side and a relatively low tack adhesive side.

52. The touch screen, as set forth in claim 51, wherein the relatively high tack adhesive side is coupled to the lower surface of the top plate and the relatively low tack adhesive side is coupled to the upper surface of the base plate.

53. The touch screen, as set forth in claim 51, wherein the relatively low tack adhesive side is coupled to the lower surface of the top plate and the relatively high tack adhesive side is coupled to the upper surface of the base plate.

54. The touch screen, as set forth in claim 42, comprising an anti-fingerprint layer disposed over the flexible substrate.

55. The touch screen, as set forth in claim 54, wherein the anti-fingerprint layer comprises a hydrophobic material.

56. The touch screen, as set forth in claim 42, comprising a coating which reflects solar energy outside the visible spectrum disposed over the flexible substrate.

57. The touch screen, as set forth in claim 56, wherein the coating which reflects solar energy outside the visible spectrum comprises a hot mirror capability.

58. The touch screen, as set forth in claim 41, wherein the base plate comprises a rigid substrate having an upper surface and a lower surface.

59. The touch screen, as set forth in claim 58, comprising a conductive layer disposed over the upper surface of the rigid substrate.

60. The touch screen, as set forth in claim 59, wherein the conductive layer comprises at least one of titanium and indium tin oxide.

61. The touch screen, as set forth in claim 59, comprising an anti-reflective dielectric layer disposed over the conductive layer, the anti-reflective dielectric layer having openings through to the conductive layer.

62. The touch screen, as set forth in claim 61, wherein the anti-reflective dielectric layer comprises one of silicon dioxide and magnesium fluoride.

63. The touch screen, as set forth in claim 58, comprising an anti-reflective layer disposed on the lower surface of the rigid substrate.

64. The touch screen, as set forth in claim 63, wherein the anti-reflective layer comprises multiple layers of anti-reflective material.

65. The touch screen, as set forth in claim 41, comprising a sensing circuit coupled to the top plate and to the base plate, the sensing circuit delivering a signal correlative to a position where the top plate contacts the base plate.

66. The touch screen, as set forth in claim 65, wherein the sensing circuit comprises:

a substantially continuous resistive member disposed on a conductive layer on the base plate adjacent a peripheral portion of a patterned anti-reflective dielectric layer disposed over the conductive layer on the base plate; and

a plurality of conductive traces disposed on the anti-reflective dielectric layer, each of the plurality of conductive traces having a first end coupled to a respective selected location of the resistive member.

67. A method of repairing a damaged touch screen having a flexible top plate disposed in spaced apart relation over a relatively rigid base plate, the method comprising the acts of:

(a) removing the top plate from the base plate; and

(b) disposing a replacement top plate on the base plate.

68. The method, as set forth in claim 67, wherein act (a) comprises the act of breaking an adhesive seal of adhesive tape holding the top plate to the base plate.

69. A method of manufacturing a touch panel, the method comprising the acts of:

(a) providing a base plate;

(b) providing a top plate; and

(c) detachably disposing the top plate over the base plate in spaced apart relation.

70. A method of manufacturing a touch panel, the method comprising the acts of:

(a) disposing a layer of conductive material over an upper surface of a relatively rigid substrate of a base plate;

(b) disposing a patterned layer of anti-reflective dielectric material over the layer of conductive material, the patterned layer of anti-reflective dielectric material having openings through to the layer of conductive material;

(c) disposing a first layer of anti-reflective material over a lower surface of the relatively rigid substrate of the base plate;

(d) disposing a second layer of anti-reflective material over an upper surface of a relatively flexible substrate of a top plate;

(e) disposing a layer of anti-reflective conductive material over a lower surface of the relatively flexible substrate of the top plate; and

(f) arranging the top plate over the base plate such that the anti-reflective conductive material disposed over the lower surface of the top plate is in spaced apart relation to the patterned anti-reflective dielectric layer disposed over the upper surface of the base plate.

71. A sensing unit for a touch panel comprising:

a first plate having a first layer of conductive material disposed on its surface;

a second plate having a second layer of conductive material disposed on its surface and having a layer of dielectric material disposed over the second layer of conductive material such that a peripheral portion of the second layer of conductive material remains exposed, the layer of dielectric material having openings through to the second layer of conductive material;

a substantially continuous resistive member disposed over the exposed peripheral portion of the second layer of conductive material adjacent a periphery of the layer of dielectric material; and

a plurality of conductive traces disposed on the layer of dielectric material, each of the plurality of conductive traces having a first end coupled to a respective selected location of the resistive member.

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