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(54) **Illuminated membrane electrical switch**

Elektrischer Schalter mit beleuchteter Membran

Interrupteur électrique à membrane illuminée

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(56) References cited:

<b>EP-A- 0 753 985</b>	<b>EP-A- 0 763 838</b>
<b>EP-A- 0 847 066</b>	<b>US-A- 4 060 703</b>
<b>US-A- 5 680 160</b>	<b>US-A- 5 797 482</b>

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**EP 1 006 543 B1**

## Description

### Field of the Invention

**[0001]** This invention generally relates to the art of electrical switches and, particularly, to an illuminated membrane-type electrical switch such as an electroluminescent switch in a keypad.

### Background of the Invention

**[0002]** Membrane electrical switches are used in a wide variety of applications and often are called "touch" switches. In particular, such a switch includes a pair of non-conductive polymer film substrates or membranes on which thin conductive contacts are printed or otherwise laminated. At least one of the membranes is flexible. In some switches, a single flexible membrane is used in conjunction with a more rigid circuit board. In a normally open membrane switch, a spacer layer is used between the membranes, with an aperture aligned with the contacts. When the flexible membrane(s) is depressed in the area of the aperture in the spacer layer, it flexes such that its contact engages the contact of the other membrane or circuit board to close the switch. Typically, there are conductors or leads connected to the switch contacts for connecting the contacts to external circuits. The conductors or leads often are printed on the flexible substrates or membranes. Such normally open membrane switches are popular as low profile, inexpensive alternatives for more complex mechanical switches.

**[0003]** Some electrical switches are illuminated, such as in electroluminescent lamp panels in keypads for various electronic devices, such as telephones. In general, an electroluminescent switch includes an electroluminescent layer which defines a lamp typically having spaced transparent electrodes sandwiching an electroluminescent layer therebetween. Often a dielectric layer also is sandwiched between the two electrode layers. Conductive leads extend from the electrodes. When an AC voltage is applied across the leads, the current induced between the electrodes causes the electroluminescent layer to emit light, a phenomenon known as electroluminescence. Basically, an electroluminescent lamp essentially is a light emitting capacitor having a dielectric layer between two conductive electrode layers, at least one of which is transparent, and the dielectric layer may be an electroluminescent layer, or there may be a separate dielectric layer.

**[0004]** Such an illuminated switch is disclosed for example in EP 0 763 838 A1. This illuminated switch further comprises a coned disk spring embossed into a dome shaped to obtain a feeling of click.

**[0005]** A similar membrane switch is disclosed in EP 0 847 066 A2. Furthermore, EP 0 847 066 A2 discloses a lighted switch illuminator which comprises an electroluminescent layer directly formed on a film click board.

Upper contacts and lower contacts are formed on the film click board and a printed board, respectively, such that they face each other and form the membrane switch.

**[0006]** US 5,797,482 discloses an electroluminescent key pad which comprises a dielectric layer having a conducting shunt adapted to be moved into contact with the contact on a printed circuit board that underlies the dielectric layer. An electroluminescent layer is disposed directly over the dielectric layer. Both the dielectric layer and electroluminescent layer include a dome portion in registry with an operator rod of a key.

**[0007]** In any event, one of the problems with membrane electrical switches such as illuminated or electroluminescent switches, is that the contact membranes or layers and spacer layers in the laminated switch are so thin that shorting occurs between the switch contacts because of abusive use or simply because of normal wear over time and repetitive usage. Such shorting causes unintentional and, most likely, undesirable closing of the switch. The present invention is directed to solving this problem by intentionally placing a dome in the flexible contact membrane or layer and having that dome project into an aperture in a spacer layer to, thereby, increase the spacing or distance between the normally open contacts of the membrane switch.

**[0008]** Document EP 0 753 985 A2 discloses an electroluminescent lighting element which comprises a base sheet made of insulating transparent film. Furthermore, a switch operating projection is formed on the reversed surface of the lighting element which projects into an aperture of a spacer disposed below the lighting elements. An insulating sheet disposed below the spacer has a dome which also projects into the aperture of the spacer. With this construction a crisp and better click feeling in operation of the switch can be obtained.

### Summary of the Invention

**[0009]** An object, therefore, of the invention is to provide a new and improved membrane switch, such as an illuminated switch, which is not prone to shorting during use.

**[0010]** This object is solved by an illuminated switch which comprises a resilient actuation layer having at least a light transmissive portion. A flexible illumination layer is arranged below that actuation layer and having a plane lower surface. The first spacer layer is disposed below that plane lower surface of that illumination layer and includes an aperture in registry with a light transmissive portion of the actuation layer. A contact layer is disposed below the spacer layer and includes a dome portion having a convex side projecting into the aperture in the spacer layer and directly beneath the plane lower surface of the illumination layer. A conductive contact is arranged on a concave side of the dome portion for engaging a conductive switch contact spaced below the conductive contact on the contact layer, when the dome

portion of the contact layer is depressed by the actuation layer through the flexible illumination layer.

**[0011]** In the exemplary embodiment of the invention, the switch includes a resilient actuation layer having at least a light transmissive portion. A flexible illumination layer is disposed below the actuation layer. A spacer layer is disposed below the illumination layer and includes an aperture in registry with the light transmissive portion of the actuation layer. A contact layer is disposed below the spacer layer and includes a dome portion having a convex side projecting into the aperture in the spacer layer, with a conductive contact on the concave side of the dome portion. A circuit sheet is disposed below the contact layer and includes a conductive contact in registry with the contact on the contact layer for engagement therewith when the dome portion of the contact layer is depressed by the actuation layer through the flexible illumination layer.

**[0012]** As disclosed herein, the illumination layer comprises an electroluminescent layer. The dome portion comprises an embossed portion of the contact layer. A second spacer layer is interposed between the contact layer and the circuit sheet, with an aperture in the second spacer layer in registry with the conductive contacts. A third spacer layer is interposed between the actuation layer and the illumination layer, with an aperture in the third spacer layer in registry with the apertures in the first and second spacer layers. The resilient actuation layer may include a dome-shaped tactile actuator portion in registry with the dome portion of the contact layer.

**[0013]** Other objects, features and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawings.

#### Brief Description of the Drawings

**[0014]** The features of this invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with its objects and the advantages thereof, may be best understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements in the figures and in which:

FIGURE 1 is a perspective view of an electrical display device having a keypad incorporating a plurality of illuminated membrane switches according to the invention;

FIGURE 2 is an enlarged fragmented section taken generally along line 2-2 of Figure 1; and

FIGURE 3 is an exploded section including the components of Figure 1.

#### Detailed Description of the Preferred Embodiment

**[0015]** Referring to the drawings in greater detail, and first to Figure 1, the illuminated electrical membrane switch of the invention has a wide variety of applications, and Figure 1 shows an electrical display device, generally designated 10, which is but only one application of the invention. The display device has a display window 12 which will show illuminated data in response to information calculated by pushing one or more of a plurality of depressable switch buttons 14. Each switch button is operatively associated with one of the switches of the invention. One of the switch buttons is removed in Figure 1 to expose a dual-switch arrangement 16. The array of switch buttons and membrane switches form a keypad 18 for display device 10. It must be understood that the illuminated membrane switch of the invention is not limited to the particular device 10 shown in Figure 1.

**[0016]** Referring to Figures 2 and 3, one of the switch buttons 14 of keypad 18 is shown in operative association with an illuminated membrane switch, generally designated 20, according to the invention. The membrane switch includes a resilient actuation layer 22 above a spacer layer 24 which, in turn, is above an illumination layer 26, comprising several layers 42-52 which will be described subsequently. The illumination layer 26, in turn, is above a spacer layer 28 which, in turn, is above a contact membrane or layer 30 which, in turn, is above a spacer layer 32 which, in turn, is above a circuit sheet or board 34. All of layers 22-34 are laminated together by means of films of adhesive 36 applied to both sides of all three spacer layers 24, 28 and 32 so that the illuminated membrane switch 20 is laminated in the condition shown in Figure 2, below switch button 14. The adhesive may be an acrylic adhesive.

**[0017]** Resilient actuation layer 22 is fabricated of a polymer material, such as a polyester, and includes a raised or embossed tactile dome 22a. The dome is immediately below or in registry with a depending actuating portion 14a of switch button 14. When the switch button is depressed in the direction of arrow "A", actuating portion 14a depresses dome 22a into engagement with illumination layer 26 and closes the switch, as described hereinafter, as dome 22a gives a tactile indication of switch actuation.

**[0018]** Spacer layer 24 is fabricated of polymer material, such as a polyester material, and includes an aperture 24a. The aperture is immediately below or in the registry with tactile dome 22a of resilient actuation layer 22 so that the dome can be depressed through the aperture.

**[0019]** Spacer layer 28 may be fabricated of polymer material, such as a polyester material, and includes an aperture 28a. The aperture is in registry with aperture 24a in spacer layer 24 and tactile dome 22a of actuation layer 22. Preferably, the spacer layer 28 comprises only a layer of adhesive with an aperture 28a punched there-through. The aperture 28a is punched before assembly

when backing paper is adhered to both sides of the adhesive layer.

**[0020]** Contact membrane or layer 30 is fabricated of polymer material, such as a polyester material, and includes a dome portion 30a. A switch contact 38 is printed or otherwise laminated to the underside of dome portion 30a. The dome portion has negligible tactility and is raised or embossed sufficiently to project into aperture 28a of spacer layer 28 as seen clearly in Figure 2. In fact, the dome portion can be raised to an extent that it touches the bottom of illumination layer 26, as shown.

**[0021]** Spacer layer 32 is fabricated of polymer material, such as a polyester material, and includes an aperture 32a. The aperture is in registry with dome portion 32a of contact layer 30 and, particularly, contact 38. Alternatively, the spacer layers 24 and 32 may also be made in the preferred way of making the spacer layer 28.

**[0022]** Circuit sheet or layer 34 is fabricated of polymer material and includes a switch contact 40 on the top side thereof. Contact 40 is in direct registry with switch contact 38 on the bottom of contact layer 30, so that contacts 38 and 40 can engage through aperture 32a in spacer layer 32. As is known in the art, switch contacts 38 and 40 are connected to appropriate conductors or leads printed on or embedded in contact layer 30 and circuit sheet 34, the leads connecting the switch contacts to external circuits. Moreover, contact 40 could be replaced with two contacts (not shown) comprising an open circuit. When contact 38 engages the two contacts on the circuit sheet, contact 38 would close the circuit path between the two contacts.

**[0023]** In operation, when switch button 14 is depressed in the direction of arrow "A", actuator portion 14a of the switch button depresses and deforms tactile dome 22a of resilient actuation layer 22 and drives the dome through aperture 24a in spacer layer 24 and into engagement with illumination layer 26. The illumination layer is sufficiently flexible to drive dome portion 30a of contact layer 30 and switch contact 38 through aperture 32a in spacer layer 32 and into engagement with switch contact 40 of circuit sheet 34 to, thereby, close the illuminated electrical switch.

**[0024]** Switch button 14 and at least tactile dome 22a of resilient actuation layer 22 are made of light transmissive material so that illumination layer 26 can be seen through aperture 24a in spacer layer 24 and through the actuation layer and the switch button. An ink layer 14b may be applied to the button 14 to selectively allow light from the illumination layer 26 to transmit only through selected areas of the top surface of the key. Illumination layer 26 may be an electroluminescent layer or lamp.

**[0025]** More particularly, referring to Figures 2 and 3, illumination layer 26 includes a top transparent or translucent substrate 42 of polymer material, such as a polyester material. A top electrode film or layer 44 is deposited by printing or sputter coating onto the underside of substrate 42. Electrode layer 44 is transparent or

translucent and can comprise such material as indium tin oxide or indium oxide. An illumination or electroluminescent layer 46 is printed onto the backside of top electrode 44. The illumination layer may be a zinc sulfide doped with copper and manganese. A dielectric layer 48 is disposed beneath illumination layer 46. The dielectric layer should be made of a material that has a high dielectric constant to raise the capacitance and has a reflective color to reflect light back toward illumination layer 46. The dielectric layer 48 is preferably made of barium tin oxide. A bottom electrode 50, such as of silver or carbon, is deposited against the bottom of dielectric layer 48, and an insulating layer 52 is printed or laminated over the rear electrode. From the foregoing, it can be seen that illumination layer 46 is sandwiched between a pair of electrodes 44 and 50 to define a light emitting capacitor as is known in the art. Of course, conductive leads (not shown) extend from the electrodes. This illumination layer 26 is sufficiently flexible to be moved into engagement with contact layer 30 to close switch 20.

**[0026]** It will be understood that the invention may be embodied in other specific forms without departing from the spirit or central characteristics thereof. The present examples and embodiments, therefore, are to be considered in all respects as illustrative and not restrictive, and the invention is not to be limited to the details given herein.

## Claims

### 1. An illuminated switch (20), comprising:

a resilient actuation layer (22) having at least a light transmissive portion;  
a flexible illumination layer (26) below said actuation layer;  
a first spacer layer (28) below said illumination layer and including an aperture (28a) in registry with the light transmissive portion of the actuation layer; and  
a contact layer (30) below said spacer layer (28) and including a dome portion (30a) having a convex side projecting into the aperture (28a) in the spacer layer, with a conductive contact (38) on a concave side of the dome portion (30a) for engaging a conductive switch contact (40) spaced below the conductive contact (38) on the contact layer (30), when the dome portion (30a) of the contact layer (30) is depressed by the actuation layer (22) through the flexible illumination layer (26) **characterized in that** said flexible illumination layer (26) has a plane lower surface and said contact layer (30) projects directly beneath and is in contact with the plane lower surface of the illumination layer (26).

2. The illuminated switch of claim 1 wherein said dome portion (30a) comprises an embossed portion of the contact layer (30).
3. The illuminated switch of claim 1 or 2, including a second spacer layer (32) interposed between the contact layer (30) and the conductive switch contact (40), with an aperture (32a) in the second spacer layer (32) in registry with the conductive contact (38) on the contact layer (30) and said conductive switch contacts (40). 5
4. The illuminated switch of claim 3, including a third spacer layer (24) interposed between the resilient actuation layer (22) and the illumination layer (26), with an aperture (24a) in the third spacer layer (24) in registry with said apertures (28a, 32a) in the first and second spacer layers (28, 32). 10
5. The illuminated switch of claim 1 or 2, including a second spacer layer (24) interposed between the actuation layer (22) and the illumination layer (26), with an aperture (24a) in the second spacer layer (24) in registry with the aperture (28a) in the first spacer layer (28). 15
6. The illuminated switch of any one of the claims 1 to 5 wherein said illumination layer comprises an electroluminescent layer (26). 20
7. The illuminated switch of claim 6 wherein said illumination layer comprises an electroluminescent layer (26) having a light transmissive conductive electrode (44) disposed on a top surface thereof and a second conductive electrode (50) disposed on a bottom surface thereof. 25
8. The illuminated switch of any one of the claims 1 to 7, wherein said resilient actuation layer (22) includes a dome-shaped tactile actuator portion (22a) in registry with the dome portion (30a) of the contact layer (30). 30
9. The illuminated switch of any one of the claims 1 to 8, wherein a circuit sheet (34) is arranged below said contact layer (30) and including said conductive switch contact (40) in registry with the conductive contact (38) on the contact layer (30) for engagement therewith when the dome portion (30a) of the contact layer (30) is depressed by the resilient actuation layer (22), through the flexible illumination layer (26). 35

#### Patentansprüche

1. Beleuchteter Schalter (20), umfassend:

eine nachgiebige Betätigungsschicht (22) mit mindestens einem lichtdurchlässigen Abschnitt;  
 eine flexible Beleuchtungsschicht (26) unter der Betätigungsschicht;  
 eine erste Abstandhalteschicht (28) unter der Beleuchtungsschicht, die eine Öffnung (28a) in Ausrichtung zu dem lichtdurchlässigen Abschnitt der Betätigungsschicht aufweist; und  
 eine Kontaktschicht (30) unter der Abstandhalteschicht (28), wobei die Kontaktschicht einen gewölbten Abschnitt (30a), der eine konvexe Seite aufweist, welche in die Öffnung (28a) in der Abstandhalteschicht hineinragt aufweist, mit einem leitfähigen Kontakt (38) auf einer konkaven Seite des gewölbten Abschnitts (30a), und zwar zur Anlage an einen leitfähigen Schalterkontakt (40), der im Abstand unterhalb des auf der Kontaktschicht (30) vorgesehenen leitfähigen Kontakts (38) angeordnet ist, wenn der gewölbte Abschnitt (30a) der Kontaktschicht (30) mit Hilfe der Betätigungsschicht (22) durch die flexible Beleuchtungsschicht (26) heruntergedrückt wird;

#### **dadurch gekennzeichnet, dass**

die flexible Beleuchtungsschicht (26) eine ebene Unterseite aufweist und dass die Kontaktschicht (30) direkt unterhalb der ebenen Unterseite der Beleuchtungsschicht (26) vorragt und sich in Kontakt mit dieser befindet.

2. Beleuchteter Schalter nach Anspruch 1, bei welchem der gewölbte Abschnitt (30a) einen ausgebauchten Abschnitt der Kontaktschicht (30) umfasst.
3. Beleuchteter Schalter nach Anspruch 1 oder 2, welcher eine zweite Abstandhalteschicht (32) aufweist, die zwischen der Kontaktschicht (30) und dem leitfähigen Schalterkontakt (40) angeordnet ist, mit einer Öffnung (32a) in der zweiten Abstandhalteschicht (32) in Ausrichtung zu dem leitfähigen Kontakt (38) auf der Kontaktschicht (30) und dem leitfähigen Schalterkontakt (40).
4. Beleuchteter Schalter nach Anspruch 3, der eine dritte Abstandhalteschicht (24) aufweist, die zwischen der nachgiebigen Betätigungsschicht (22) und der Beleuchtungsschicht (26) angeordnet ist, mit einer Öffnung (24a) in der dritten Abstandhalteschicht (24) in Ausrichtung zu den Öffnungen (28a, 32a) in der ersten und der zweiten Abstandhalteschicht (28, 32).
5. Beleuchteter Schalter nach Anspruch 1 oder 2, der eine zweite Abstandhalteschicht (24) aufweist, die zwischen der Betätigungsschicht (22) und der

Beleuchtungsschicht (26) angeordnet ist, mit einer Öffnung (24a) in der zweiten Abstandhalteschicht (24) in Ausrichtung zu der Öffnung (28a) in der ersten Abstandhalteschicht (28).

6. Beleuchteter Schalter nach einem der Ansprüche 1 bis 5, bei welchem die Beleuchtungsschicht eine Elektrolumineszenzschicht (26) umfasst.
7. Beleuchteter Schalter nach Anspruch 6, bei welchem die Beleuchtungsschicht eine Elektrolumineszenzschicht (26) umfasst, auf deren Oberseite eine lichtdurchlässige, leitfähige Elektrode (44) angeordnet ist und auf deren Unterseite eine zweite leitfähige Elektrode (50) angeordnet ist.
8. Beleuchteter Schalter nach einem der Ansprüche 1 bis 7, bei welchem die nachgiebige Betätigungsschicht (22) einen domförmigen taktilen Betätigungsabschnitt (22a) in Ausrichtung zu dem gewölbten Abschnitt (30a) der Kontaktschicht (30) umfasst.
9. Beleuchteter Schalter nach einem der Ansprüche 1 bis 8, bei welchem eine Schaltungsplatte (34) unter der Kontaktschicht (30) angeordnet ist und den leitfähigen Schalterkontakt (40) in Ausrichtung zu dem leitfähigen Kontakt (38) auf der Kontaktschicht (30) aufweist, und zwar zur Anlage an diesen, wenn der gewölbte Abschnitt (30a) der Kontaktschicht (30) mit Hilfe der nachgiebigen Betätigungsschicht (22) von der flexiblen Beleuchtungsschicht (26) heruntergedrückt wird.

## Revendications

1. Interrupteur éclairé (20), comportant:

une couche élastique (22) d'actionnement ayant au moins une partie transmettant la lumière;  
 une couche flexible (26) d'éclairage en dessous de ladite couche d'actionnement;  
 une première couche (28) d'écartement en dessous de ladite couche d'éclairage et présentant une ouverture (28a) en alignement avec la partie transmettant la lumière de la couche d'actionnement; et  
 une couche de contact (30) en dessous de ladite couche d'écartement (28) et comprenant une partie en dôme (30a) ayant un côté convexe faisant saillie dans l'ouverture (28a) dans la couche d'écartement, avec un contact conducteur (38) sur un côté concave de la partie en dôme (30a) destiné à engager un contact conducteur (40) de l'interrupteur espacé en dessous du contact conducteur (38) sur la couche

de contact (30), lorsque la partie en dôme (30a) de la couche de contact (30) est enfoncée par la couche d'actionnement (22) à travers la couche flexible (26) d'éclairage, **caractérisé en ce que** ladite couche flexible (26) d'éclairage présente une surface inférieure plane et ladite couche de contact (30) fait saillie directement en dessous de, et est en contact avec, la surface inférieure plane de la couche (26) d'éclairage.

2. Interrupteur éclairé selon la revendication 1, dans lequel ladite partie en dôme (30a) comprend une partie bosselée de la couche de contact (30).
3. Interrupteur éclairé selon la revendication 1 ou 2, comprenant une seconde couche d'écartement (32) interposée entre la couche de contact (30) et le contact conducteur (40) de l'interrupteur, avec une ouverture (32a) dans la seconde couche d'écartement (32) en alignement avec le contact conducteur (38) sur la couche de contact (30) et lesdits contacts conducteurs (40) de l'interrupteur.
4. Interrupteur éclairé selon la revendication 3, comprenant une troisième couche d'écartement (24) interposée entre la couche élastique d'actionnement (22) et la couche d'éclairage (26), avec une ouverture (24a) dans la troisième couche d'écartement (24) en alignement avec lesdites ouvertures (28a, 32a) dans les première et deuxième couches d'écartement (28, 32).
5. Interrupteur éclairé selon la revendication 1 ou 2, comprenant une deuxième couche d'écartement (24) interposée entre la couche d'actionnement (22) et la couche d'éclairage (26), avec une ouverture (24a) dans la deuxième couche d'écartement (24) en alignement avec l'ouverture (28a) dans la première couche d'écartement (28).
6. Interrupteur éclairé selon l'une quelconque des revendications 1 à 5, dans lequel ladite couche d'éclairage comprend une couche électroluminescente (26).
7. Interrupteur éclairé selon la revendication 6, dans lequel ladite couche d'éclairage comprend une couche électroluminescente (26) ayant une électrode conductrice (34) transmettant la lumière, disposée sur une surface supérieure de cette couche, et une seconde électrode conductrice (50) disposée sur une surface inférieure de cette couche.
8. Interrupteur éclairé selon l'une quelconque des revendications 1 à 7, dans lequel ladite couche élastique (22) d'actionnement comprend une partie d'actionneur tactile (22a) en forme de dôme en alignement avec la partie en dôme (30a) de la couche

de contact (30).

9. Interrupteur éclairé selon l'une quelconque des revendications 1 à 8, dans lequel une feuille (34) à circuit est agencée en dessous de ladite couche de contact (30) et comprenant ledit contact conducteur (40) de l'interrupteur en alignement avec le contact conducteur (38) sur la couche de contact (30) pour réaliser un engagement avec lui lorsque la partie en dôme (30a) de la couche de contact (30) est enfoncée par la couche élastique (22) d'actionnement, à travers la couche flexible (26) d'éclairage.

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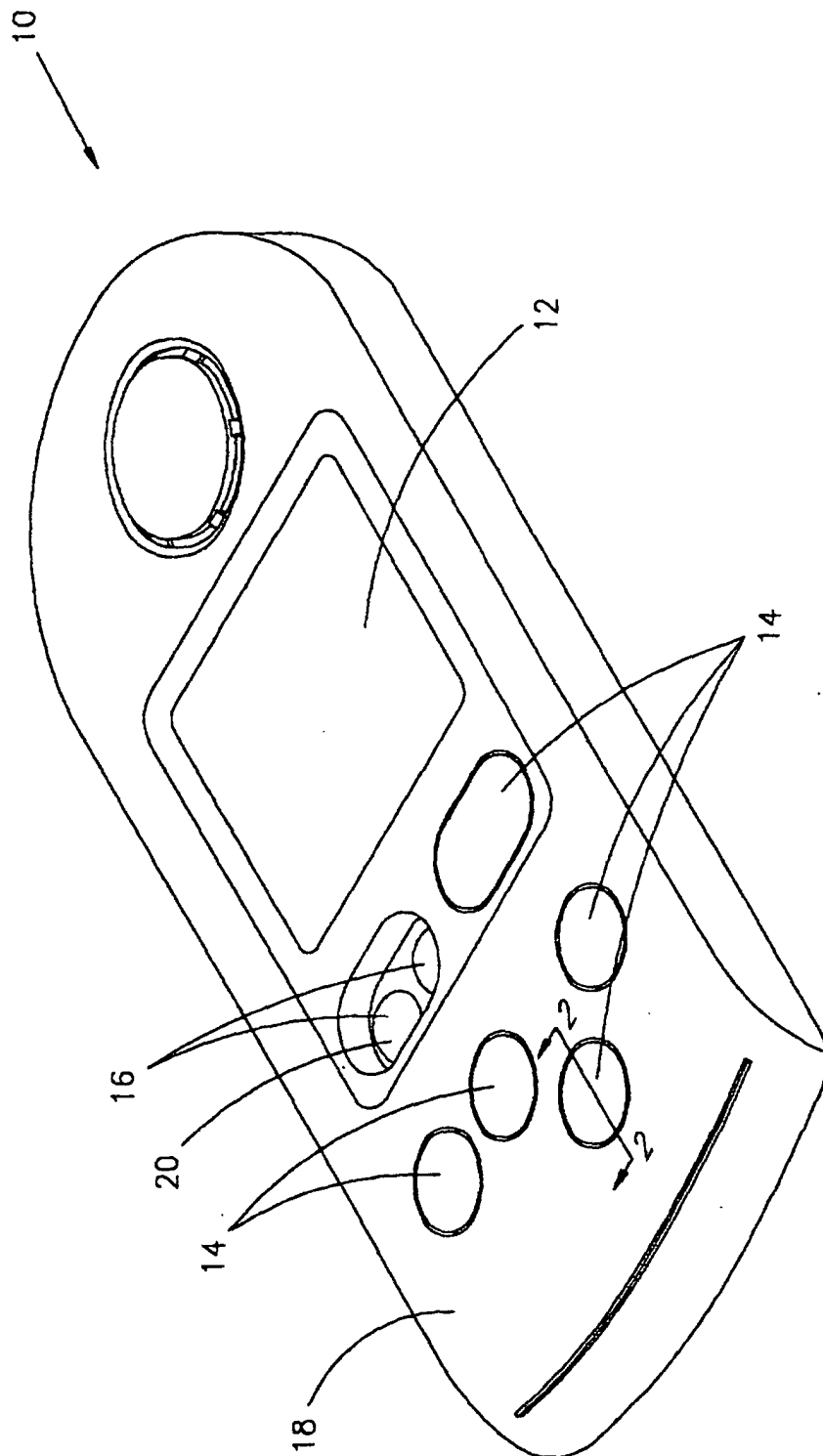


FIG. 1



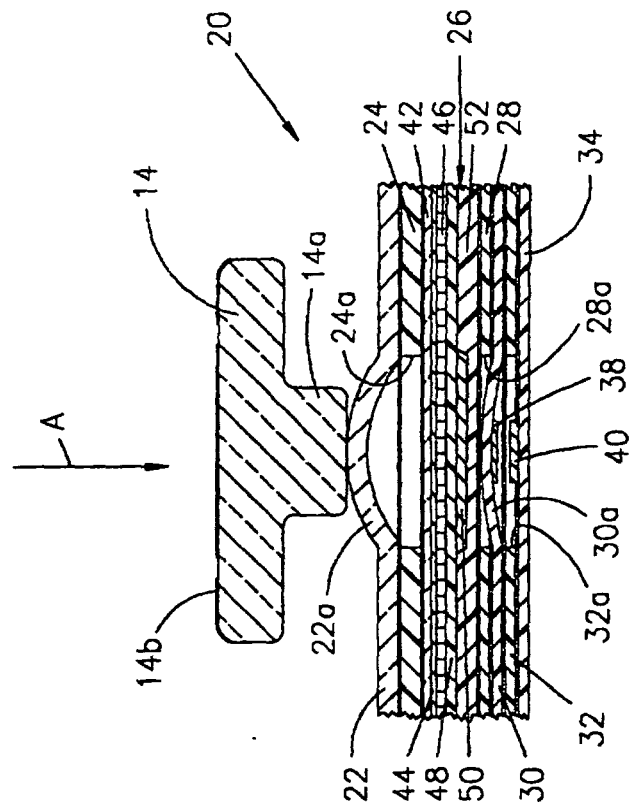


FIG. 2

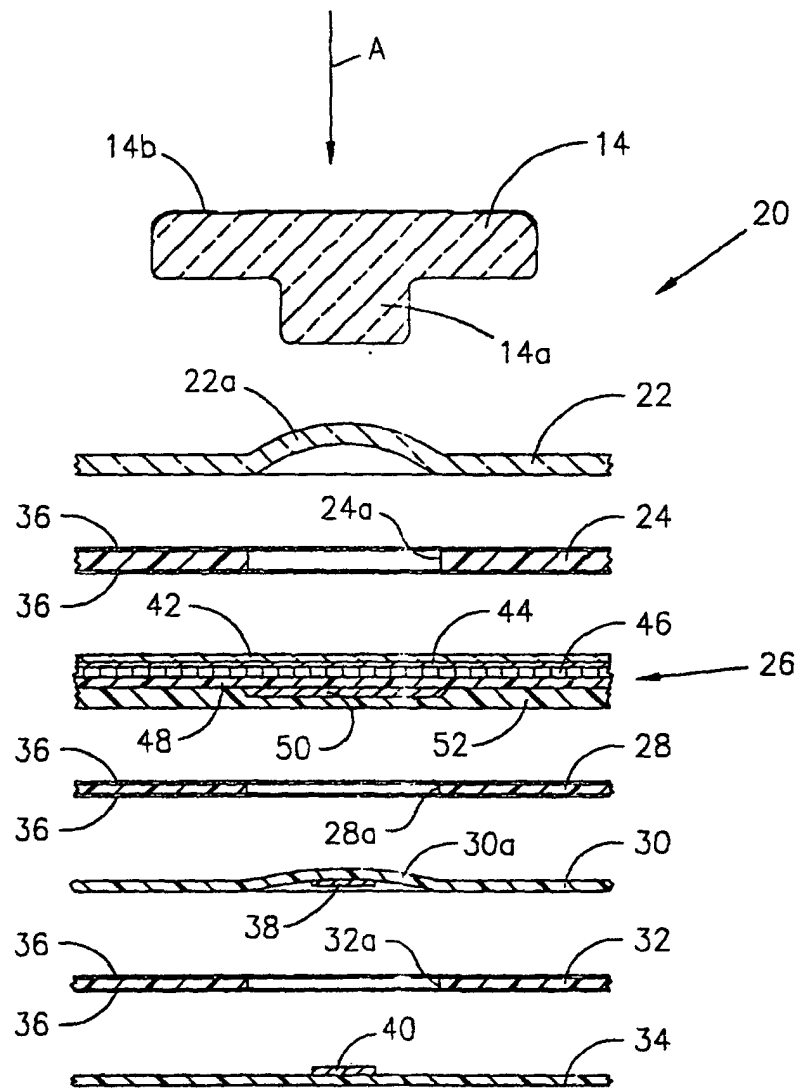


FIG. 3