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(54) Electrical switch

(57) An electrical switch (12) includes a pair of stamped switch contacts (20) opposed to each other at a gap (22). An insulative substrate (18) supports the contacts and includes a recess (34) below the contacts at said gap. The recess (34) is sufficiently large so that the switch contacts (20) extend into the recess and can flex relative to each other. A conductive actuator (38) is engageable with the switch contacts (20) at the gap (22) to close the switch, with either switch contact being flexible to ensure that the actuator engages both contacts.

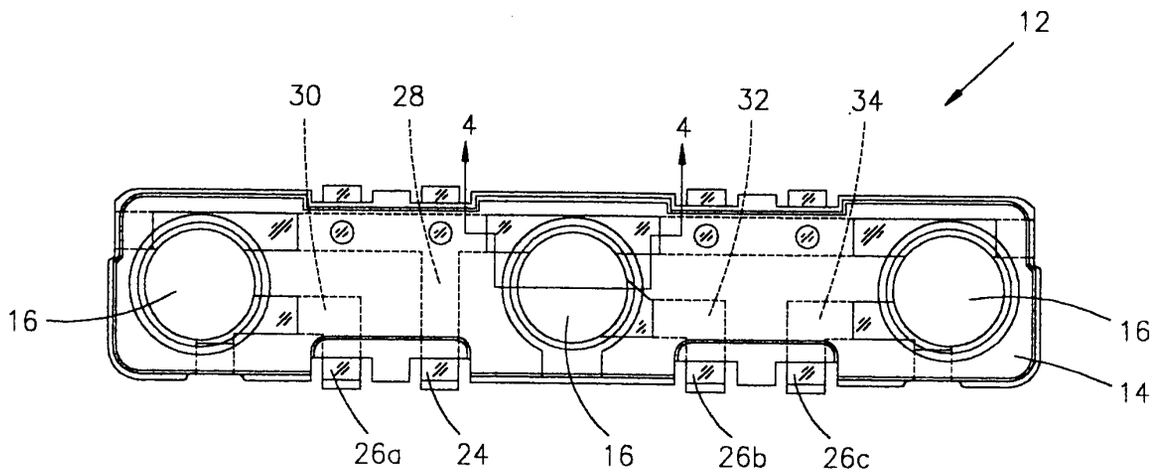

FIG. 1

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Description

Field of the Invention

[0001] This invention generally relates to the art of electrical switches and, particularly, to a laminated or membrane-type electrical switch.

Background of the Invention

[0002] Laminated electrical switches are used in a wide variety of applications and sometimes are called "touch" switches. In particular, such a switch may include an insulative substrate, such as of plastic material, which mounts or supports thin conductive contacts, such as of stamped sheet metal. A flexible membrane is laminated to the substrate. In a normally open membrane switch, a spacer layer often is sandwiched between the membrane and the substrate, with an aperture in the spacer layer aligned with the contacts. When the flexible membrane is depressed in the area of the aperture in the spacer layer, it flexes such that its contact engages the contacts on the substrate to close the switch.

[0003] In some membrane electrical switches of the character described above, there are conductors or leads connected to the switch contacts on the membrane and on the substrate for connecting the contacts to external circuits. In other switches, the membrane may carry only a contact pad, and the substrate supports a pair of switch contacts separated at a gap. The contact pad on the membrane spans the gap and, when the membrane is depressed, the contact pad shorts the pair of contacts on the substrate to close the switch and establish a circuit therethrough.

[0004] In the latter type of membrane switch described immediately above, wherein a contact pad on the membrane shorts a pair of switch contacts on a substrate when the membrane is depressed, reliability problems often are encountered. Specifically, it is necessary for the depression of the membrane to cause a firm connection across the switch. In other words, if the depression causes the contact pad on the membrane to engage only one of the switch contacts, a circuit through the spaced contacts is not established. In the prior art, the spaced switch contacts typically are rigidly supported, and the above unreliable situation may easily occur. The present invention is directed to solving these problems by providing a system wherein the switch contacts are sufficiently flexible to ensure that depression of the membrane causes the contact pad on the membrane to engage both of the switch contacts supported by the substrate.

Summary of the Invention

[0005] An object, therefore, of the invention is to provide a new and improved electrical switch of the character described.

[0006] In the exemplary embodiment of the invention, the electrical switch includes a pair of stamped sheet metal switch contacts opposed to each other at a gap. An insulative substrate supports the contacts and includes a recess below the contacts at the gap. The recess is sufficiently large so that the contacts extend into the recess and can flex relative to each other. A conductive actuator is engageable with the contacts at the gap to close the switch, with either contact being flexible to ensure that the actuator engages both contacts.

[0007] As disclosed herein, the insulative substrate is molded of plastic material, and the switch contacts are part of stamped circuitry having portions other than the switch contacts overmolded by the substrate. The conductive actuator comprises a plastic membrane having a depressible tactile dome with a conductive switch pad on the underside thereof engageable with the switch contacts at the gap. Alternatively, the conductive actuator may comprise a tactile metal dome. A spacer layer also may be disposed between the substrate and the conductive actuator, with the spacer layer having an aperture in registry with the recess in the substrate.

[0008] Other features of the invention may include a post molded integrally with the substrate and projecting through an aperture in the membrane. The post is deformed to secure the membrane to the substrate. Alternatively, a metal post may project from the substrate through the membrane and crimped over the membrane to secure the membrane to the substrate.

[0009] 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

[0010] 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 top plan view of an electrical switch assembly embodying the concepts of the invention;
FIGURE 2 is a bottom plan view of the switch assembly;
FIGURE 3 is a top plan view of the assembly, with the actuator layer removed to better illustrate the stamped circuitry overmolded by the substrate;
FIGURE 4 is an enlarged section taken generally along line 4-4 of Figure 1;
FIGURE 5 is a view similar to that of Figure 4, with the switch actuated by a properly aligned push button;

FIGURE 6 is a view similar to that of Figure 5, but with the switch actuated by a misaligned push button;

FIGURE 7 is a fragmented view of one end of the switch assembly, utilizing a separate spacer layer;

FIGURE 8 is a view similar to that of Figure 7, but with the substrate incorporating an integral spacer;

FIGURE 9 is a view similar to that of Figure 1, but showing alternate forms of means for securing the actuator membrane to the substrate;

FIGURES 10A and 10B are sequential views taken generally along line 10-10 of Figure 9, and showing one form of securing post; and

FIGURES 11A and 11B are sequential views taken generally along line 11-11 of Figure 9 and showing a second form of securing post.

Detailed Description of the Preferred Embodiments

[0011] Referring to the drawings in greater detail, and first to Figure 1, the invention is embodied in a laminated or membrane-type electrical switch assembly, generally designated 12. The top of the assembly shown in Figure 1 is substantially covered by an actuator membrane 14, such as of polyester material. The switch assembly has three switches and, correspondingly, actuator membrane 14 has three actuator domes 16.

[0012] Figure 2 is a bottom plan view of switch assembly 12 and shows an elongated insulative substrate 18 which mounts electrical circuitry described hereinafter. The substrate may be fabricated of dielectric material such as plastic. Suffice it to say, the electrical circuitry includes a pair of switch contacts 20 for each of the three switches of the assembly. Each pair of switch contacts 20 are separated at a gap 22. As will be described in greater detail, switch contacts 20 are variously connected to respective ones of a ground contact arm 24 and three signal contact arms 26a, 26b and 26c. Contact arms 24 and 26a-26c are spring arms on the bottom of switch assembly 12 for engaging appropriate contacts on an associated electrical device. For instance, switch assembly 12 may comprise a switch pad in a cellular telephone.

[0013] Figure 3 shows a top plan view of substrate 18 mounting the electrical circuitry of the switch assembly, including switch contacts 20 separated at gaps 22. The circuitry, including switch contacts 20 and contact arms 24 and 26a-26c, is stamped and formed of sheet metal material. As indicated by the dotted lines in Figure 3, portions of the stamped circuitry other than the switch contacts and the contact arms are overmolded by the plastic substrate 18. It also can be seen in Figure 3 that one switch contact 20 in each of the three pairs thereof is connected by overmolded circuitry 28 leading to ground contact arm 24. The other switch contact 20 of the left-hand switch is connected by overmolded circuitry 30 leading to signal contact arm 26a. The other contact switch 20 of the center switch is connected by overmolded circuitry 32 leading to signal contact arm 26b. The other contact switch 20 of the right-hand switch is connected by overmolded circuitry 34 leading to signal contact arm 26c.

[0014] Figure 4 shows an enlarged section through the center switch as viewed in Figure 1. It can be seen that plastic substrate 18 is overmolded around circuitry 28 and 32 leading to switch contacts 20 separated at gap 22. Figure 4 clearly shows that substrate 18 has a recess 34 below switch contacts 20 at gap 22. The recess is sufficiently large so that the contacts extend into the recess and can flex relative to each other in the direction of arrows "A". Actuator membrane 14 is separated from substrate 18 by a spacer layer 36 having an aperture 37. Each actuator dome 16 of actuator membrane 14 carries a contact pad 38 on the underside thereof. Therefore, when dome 16 is depressed in the direction of arrow "B", contact pad 38 engages switch contacts 20 to short the switch contacts and close the switch, thereby establishing a circuit between signal contact arm 26b and ground contact arm 24. Finally, actuator membrane 14 and dome 16 are sufficiently thick to give a tactile indication when the dome is depressed "overcenter" the plane of the membrane to actuate the switch. It is contemplated that the present invention could utilize metal tactile domes instead of the actuator membrane 14 and domes 16.

[0015] Figures 5 and 6 show the advantages of the invention in ensuring a reliable connection between switch contacts 22. Specifically, Figure 5 shows a properly aligned push button 40 engaging dome 16 and depressing contact pad 38 on the underside of the dome into engagement with switch contacts 20 at gap 22.

[0016] However, there may be instances wherein push button 40 is not centrally aligned with the gap 22 and may be cocked to one side or the other, as seen in Figure 6. Nevertheless, since switch contacts 20 extend into recess 34, the stamped contacts can flex as represented by the right-hand contact in Figure 6, to ensure that the push button engages both contacts. If the switch contacts were rigid as in the prior art, the cocked push button would engage and abut against the right-hand contact and never engage the left-hand contact, resulting in an incomplete or insufficient connection.

[0017] Figures 7 and 8 show comparisons between the use of a separate spacer layer 36 as seen in Figure 7 and an integral spacer "buildup" 42 as seen in Figure 8. In other words, Figure 7 substantially corresponds to the depiction described above in relation to Figure 4, with the spacer layer having aperture 37 in registry with switch contacts 20. Alternatively, substrate 18 could be built up or made thicker and provided with an aperture 42 in registry with the switch contacts as seen in Figure 8. In other words, the alternative of Figure 8 would integrate the spacer directly into the overmolded substrate.

[0018] In the embodiment of Figures 1-6, actuator membrane 14 can be secured to substrate 18 by an appropriate adhesive. Alternatively, Figures 9-11B show

mechanical means for securing the membrane to the substrate. More particularly, referring to Figures 10A and 10B in conjunction with Figure 9, a plurality of securing posts 44 are molded integrally with substrate 18 for projection through apertures 46 in actuator membrane 14. After the membrane is positioned on top of the substrate, with the securing posts 44 projecting through apertures 46, the plastic posts can be deformed as at 44a in Figure 10B to secure the membrane to the substrate. Referring to Figures 11A and 11B in conjunction with Figure 9, a plurality of metal securing posts 48 can be overmolded in substrate 18 for projection through slits 50 in actuator membrane 14. After the membrane is positioned on top of the substrate, the metal posts can be crimped as at 48a in Figure 11B to secure the membrane to the substrate. Although both types of mechanical means 44 and 48 are shown utilized in the switch assembly 12 in Figure 9, it is contemplated that only one or the other mechanical means 44 or 48 will be used to secure the actuator membrane 14 to the substrate 18 of a given switch assembly 12.

[0019] 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 electrical switch (12), comprising:

a pair of stamped switch contacts (20) opposed to each other at a gap (22);
an insulative substrate (18) supporting the switch contacts and including a recess (34) below the contacts at said gap (22), the recess being in communication with said gap and being sufficiently large so that the switch contacts extend into the recess and can flex relative to each other; and
a conductive actuator (38) engageable with the switch contacts (20) at said gap (22) to close the switch, with either switch contact being flexible to ensure that the actuator (38) engages both contacts (20).

2. The electrical switch of claim 1 wherein said insulative substrate (18) is molded of plastic material and said switch contacts (20) are part of stamped circuitry having portions (28-34) other than said switch contacts overmolded by the substrate.

3. The electrical switch of claim 1 wherein said conductive actuator comprises a depressible dome (16,38).

4. The electrical switch of claim 1 wherein said conductive actuator comprises a plastic membrane (14) having a conductive switch pad (38) engageable with the switch contacts (20) at said gap (22).

5. The electrical switch of claim 4 wherein said conductive actuator comprises a tactile dome (16).

6. The electrical switch of claim 1 wherein said conductive actuator (38) comprises a tactile metal dome.

7. The electrical switch of claim 1 wherein said conductive actuator comprises a membrane (14), and said substrate (18) includes an integral post (44) projecting through an aperture (46) in the membrane, the post being deformed to secure the membrane to the substrate.

8. The electrical switch of claim 1 wherein said conductive actuator comprises a membrane (14), and including a metal post (48) projecting from the substrate (18) through the membrane and crimped over the membrane to secure the membrane to the substrate.

9. The electrical switch of claim 1, including s spacer layer (36) disposed between the substrate (18) and the conductive actuator (14,38), the spacer layer including an aperture (37) in registry with the recess (34) in the substrate.

10. An electrical switch (12), comprising:

stamped circuitry including a pair of stamped, planar switch contacts (20) opposed to each other at a gap (22);
an insulative substrate (18) of molded plastic material overmolded about portions (28-34) of the stamped circuitry other than said switch contacts (20), the substrate including a recess (34) below the contacts (20) at said gap (22), the recess being sufficiently large so that the contacts extend into the recess and can flex relative to each other; and
a conductive actuator (14,16,38) including a plastic membrane (14) having a conductive switch pad (38) engageable with the switch contacts (20) at said gap (22) to close the switch, with either switch contact being flexible to ensure that the switch pad (38) engages both switch contacts (20).

11. The electrical switch of claim 10 wherein said conductive actuator comprises a depressible dome (16).

12. The electrical switch of claim 11 wherein said con-

ductive actuator comprises a tactile dome (16).

13. The electrical switch of claim 12 wherein said conductive actuator (14,16) comprises a tactile metal dome.

14. The electrical switch of claim 10 wherein said conductive actuator comprises a membrane (14), and said substrate (18) includes an integral post (44) projecting through an aperture (46) in the membrane, the post being deformed to secure the membrane to the substrate.

15. The electrical switch of claim 10 wherein said conductive actuator comprises a membrane (14), and including a metal post (48) projecting from the substrate (18) through the membrane and crimped over the membrane to secure the membrane to the substrate.

16. The electrical switch of claim 10, including s spacer layer (36) disposed between the substrate (18) and the conductive actuator (14), the spacer layer including an aperture (37) in registry with the recess (34) in the substrate.

17. An electrical switch (12), comprising:

stamped circuitry including a pair of stamped switch contacts (20) opposed to each other at a gap (22);
an insulative substrate (18) of molded plastic material overmolded about portions (28-34) of the stamped circuitry other than said switch contacts (20), the substrate including a recess (34) below the contacts (20) at said gap (22), the recess being in communication with said gap and being sufficiently large so that the contacts extend into the recess and can flex relative to each other; and
a conductive actuator (14,16,38) including a depressible dome (16) engageable with the switch contacts (20) at said gap (22) to close the switch, with either switch contact being flexible to ensure that the actuator engages both contacts.

18. The electrical switch of claim 17 wherein said conductive actuator comprises a plastic membrane (14) having a conductive switch pad (38) engageable with the switch contacts (20) at said gap (22).

19. The electrical switch of claim 18 wherein said conductive actuator comprises a tactile dome (16).

20. The electrical switch of claim 17 wherein said conductive actuator (14,16) comprises a tactile metal dome.

21. The electrical switch of claim 17 wherein said conductive actuator comprises a membrane (14), and said substrate (18) includes an integral post (44) projecting through an aperture (46) in the membrane, the post being deformed to secure the membrane to the substrate.

22. The electrical switch of claim 17 wherein said conductive actuator comprises a membrane (14), and including a metal post (48) projecting from the substrate (18) through the membrane and crimped over the membrane to secure the membrane to the substrate.

23. The electrical switch of claim 17, including s spacer layer (36) disposed between the substrate (18) and the conductive actuator (14), the spacer layer including an aperture (37) in registry with the recess (34) in the substrate.

24. An electrical switch (12), comprising:

stamped circuitry including a pair of stamped, planar switch contacts (20) opposed to each other and defining a gap (22) therebetween;
an insulative substrate (18) of molded plastic material overmolded about portions of the stamped circuitry other than said switch contacts, the substrate including a recess (34) below the gap between the contacts, the recess being in communication with said gap (22) and being sufficiently large so that the contacts (20) can descend into the recess and can flex relative to each other; and
a conductive actuator (14, 16, 38) including a plastic membrane (14) having a conductive switch pad (38) under an embossed dome (16), said switch pad being engageable with the switch contacts (20) at said gap to close the switch, with either switch contact being flexible to ensure that the switch pad (38) engages both switch contacts (20).

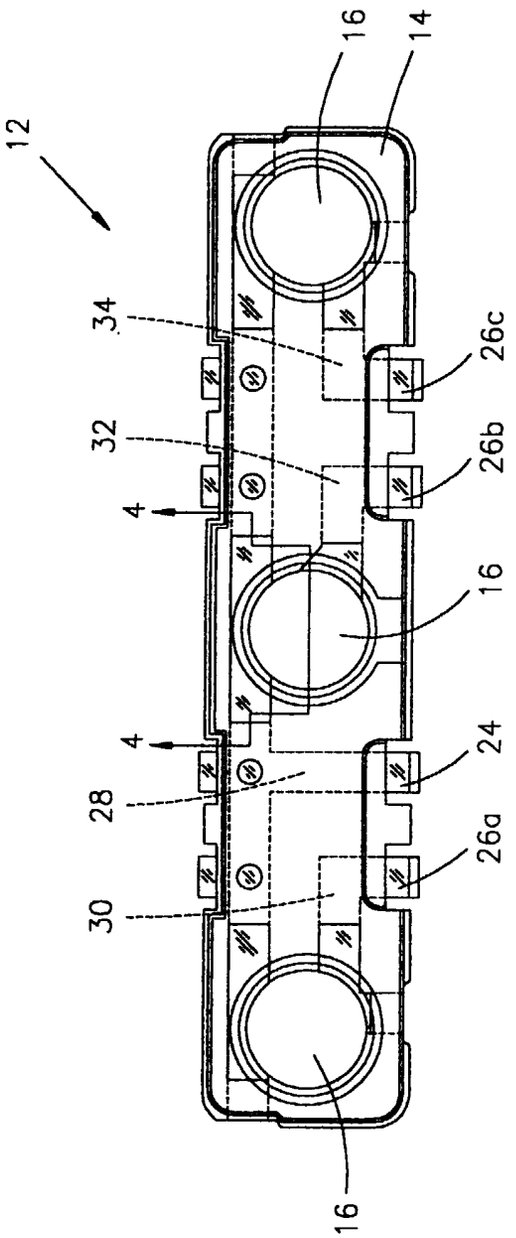

12
16
14
34
26c
32
26b
4
16
4
24
28
26a
30
16

FIG. 1

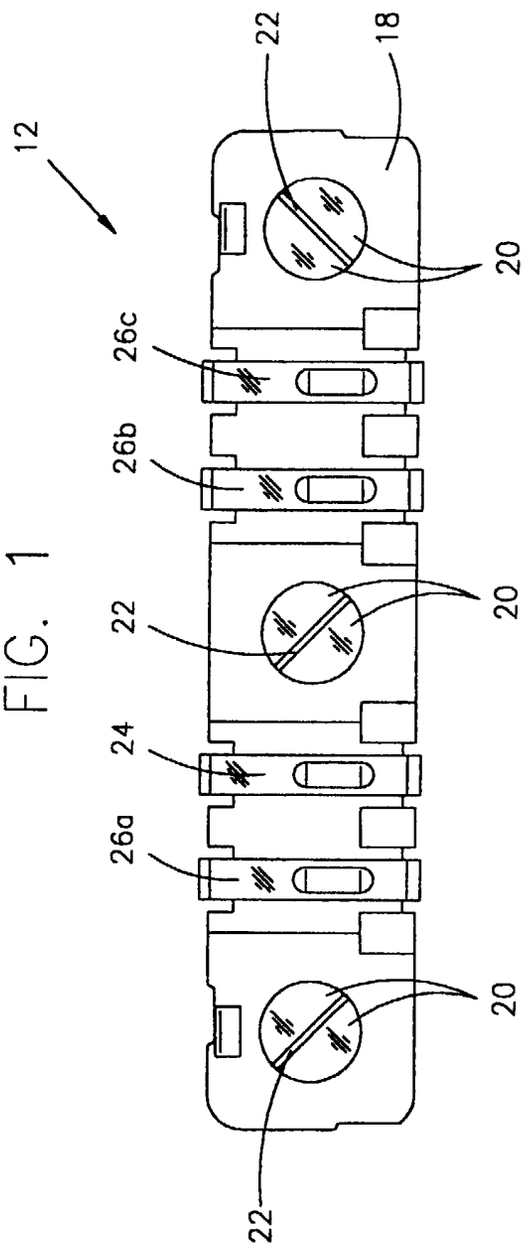
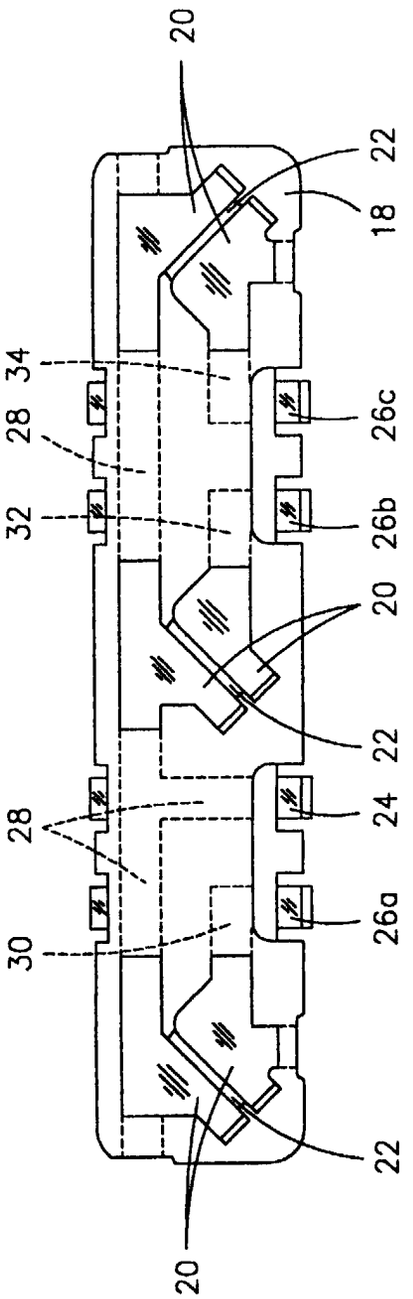

12
22
18
20
26c
26b
22
20
24
26a
20
22

FIG. 2


20
22
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34
28
26c
32
26b
20
22
28
24
26a
30
22
20

FIG. 3

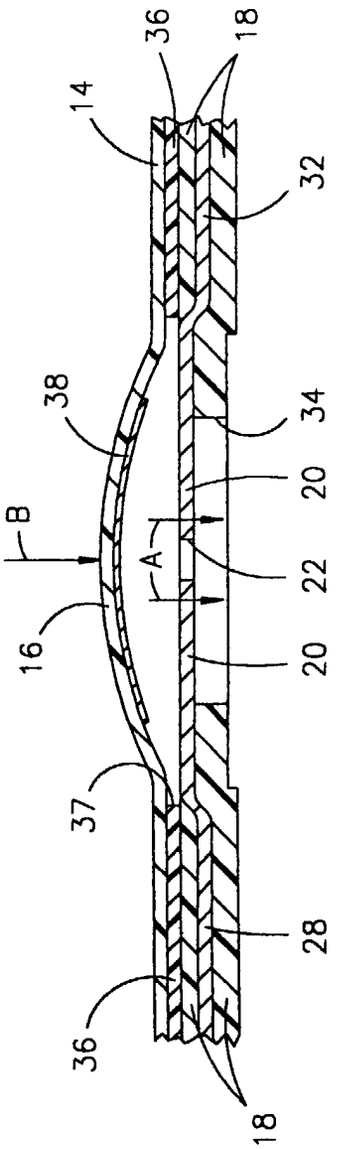
36
18
14
32
38
34
B
20
A
22
16
20
37
28
36
18

FIG. 4

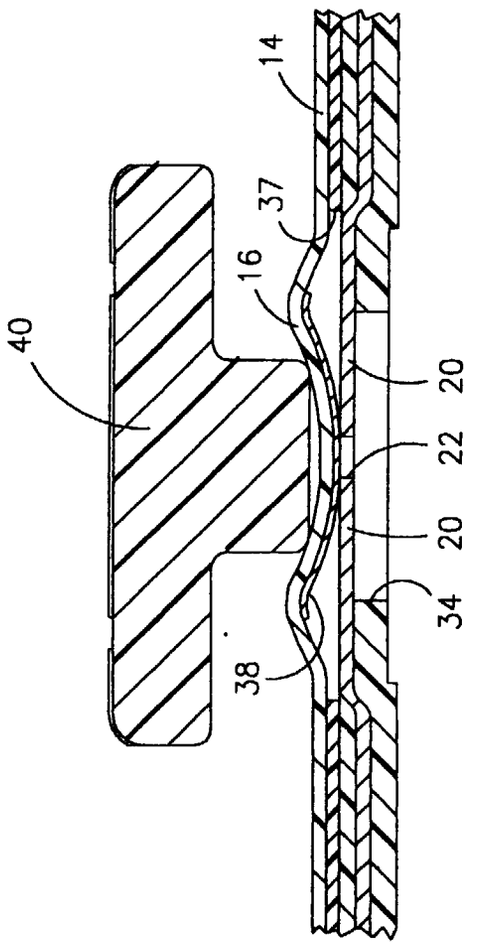

FIG. 5

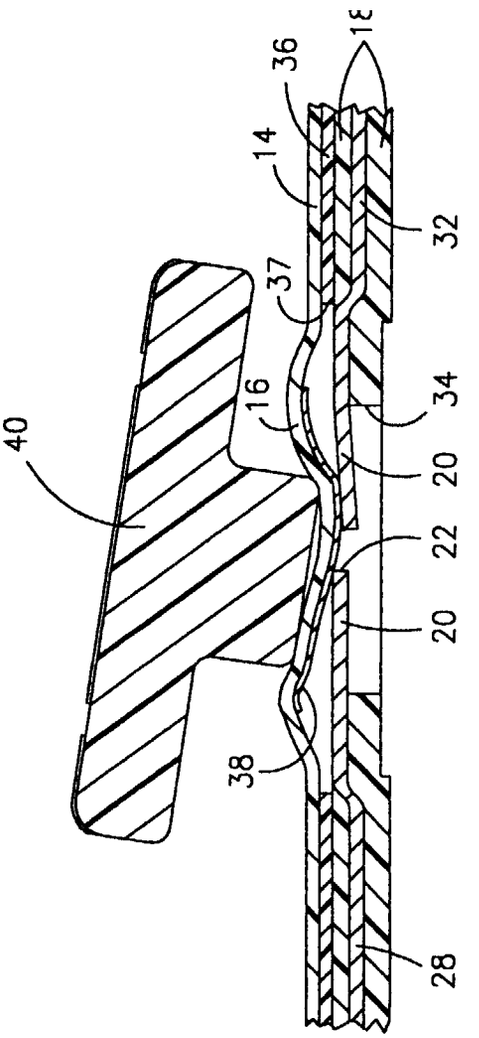

FIG. 6

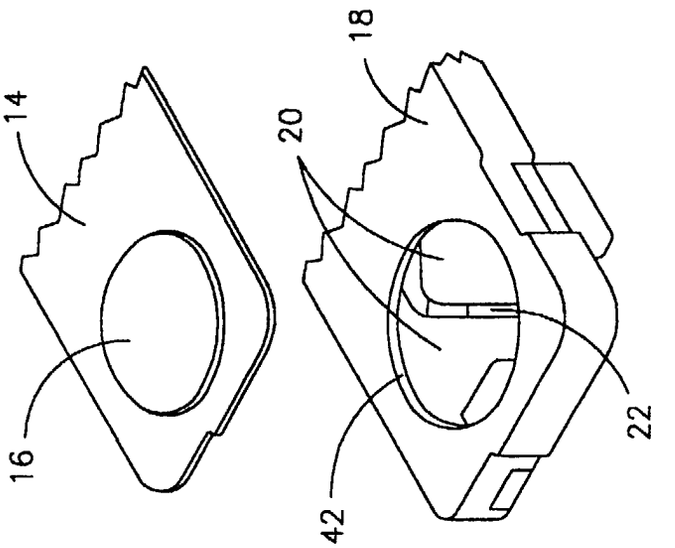

FIG. 8

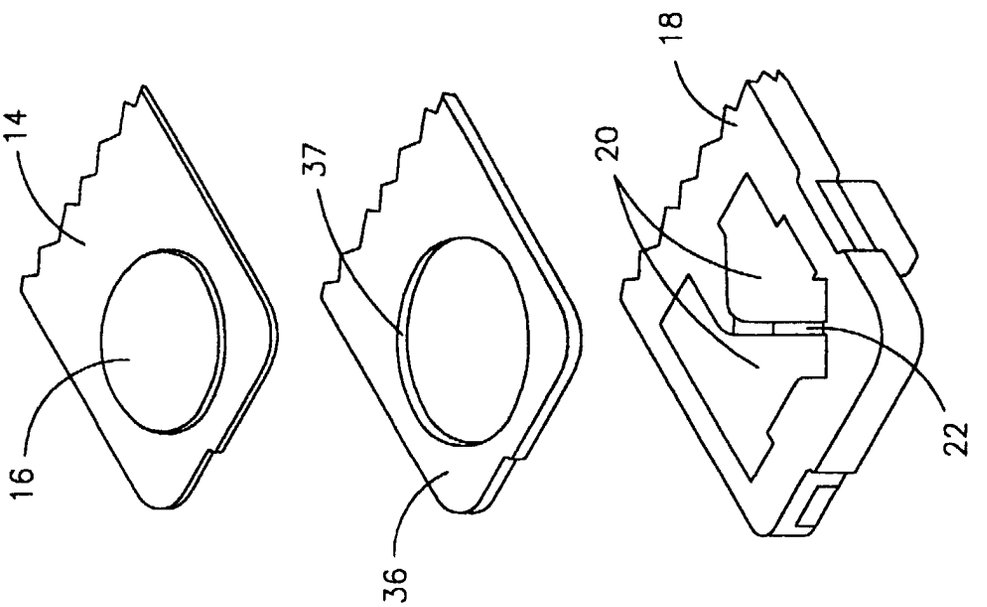

FIG. 7

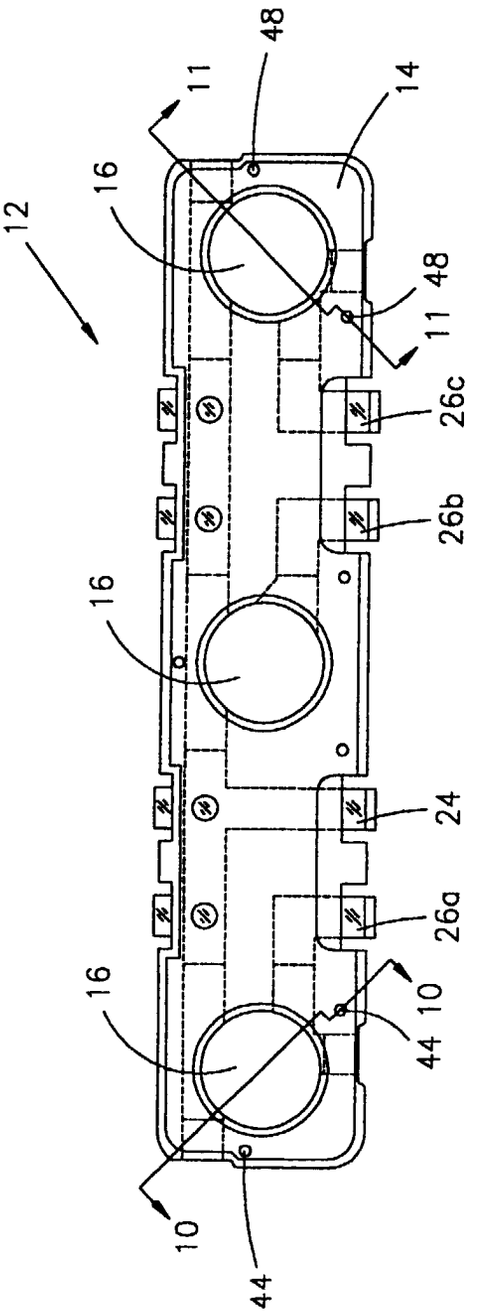

FIG. 9

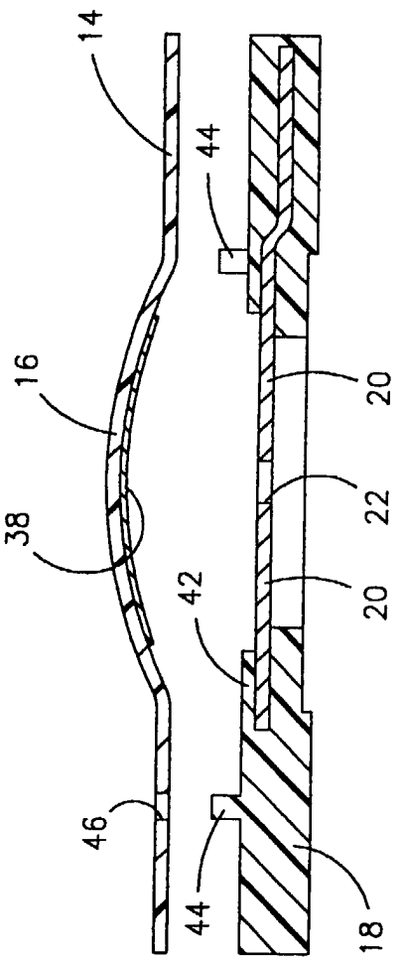

FIG. 10A

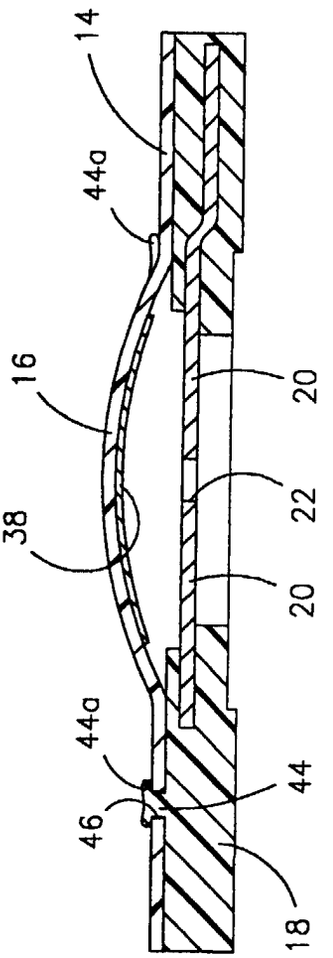

FIG. 10B

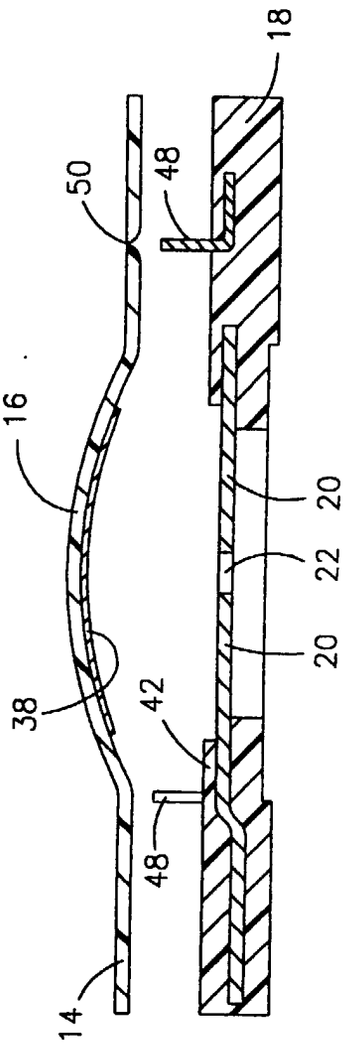

FIG. 11A

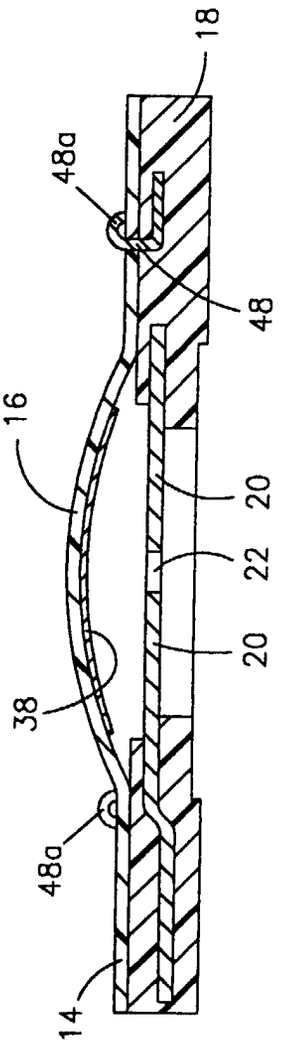

FIG. 11B