A keyboard includes a resilient foam layer (28) having an array of holes (30) therein with the layer (28) being sandwiched between a flexible sheet having dome-shaped areas (34) aligned with said holes and a dielectric member (38), the flexible sheet and dielectric member having electrodes (36, 40) thereon which are arranged to complete a circuit associated with a hole (30) when the flexible sheet and member are moved toward each other. A snap action of the dome-shaped areas (34) in the switch movement provides for improved tactile response and switch travel and reduced switch actuating force. Additional foam layers enhance the operating characteristics of the embodiments. A method of production of the keyboard entails determining the operating parameters of a desired keyboard and selecting the relative density and thicknesses of various resilient layers and flexible sheets in the keyboard to determine the switch actuating force, the extent of travel of the switch, and the location of the "makepoint" of the switch at a position between the start and end of switch travel.
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KEYBOARD AND METHOD OF PRODUCING A KEYBOARD

Technical Field

This invention relates to a keyboard and method of producing a keyboard.

5 Background Art

As small computer systems decrease in cost, the cost of the associated keyboards becomes a larger percentage of the total manufacturing cost and becomes a prime target for cost reduction. At the same time, keyboards for these small computer systems must meet stringent operator entry performance requirements for alpha-numeric and must also enable the manufacturer thereof to provide many custom design features intended to provide a competitive advantage for the associated keyboards and systems. Consequently, a successful key-switch or keyboard design must simultaneously meet the requirements of low-materials costs, good operator performance, durability, and low manufacturing costs for both standard and custom production runs. A keyswitch that meets these requirements would also be useful in small control panels or individual momentary closure switch modules.

U. S. Patent 4,090,045 discloses a "flexible membrane" keyboard employing a resilient pad having apertures positioned at the key positions of the keyboard accommodating stationary contacts mounted on a base plate. A conductive screen material is mounted over the pad, and protective plastic films overlie the screen material. Depression by an operator's finger of the screen material at a key position above an aperture in the resilient pad causes the screen material to engage a stationary contact to actuate the key position. A disadvantage of this construction is that the switch makepoint during actuation is located at the end of switch travel. The consequent lack of after travel shocks the operator's finger by preventing follow-through.
movements. Other disadvantages are those of difficulty in operation and a limited tactile response to key operation since a high actuation force is required which provides only a limited switch travel.

U. S. Patent 4,068,369 discloses another "flexible membrane" keyboard having a dielectric layer having apertures positioned at the key positions of the keyboard accommodating stationary contacts mounted on a base plate. Further stationary contacts are positioned above the dielectric layer around the peripheries of the apertures. A switch actuating electrically conductive disc is placed over each aperture with its outer margin engaging the associated further contact on top of the dielectric layer. The disc is resiliently deformable with a snap action to engage the contact on the base plate to actuate the key position. Such an arrangement has the advantage of providing a tactile response for the user by the snap action of the disc. However the travel in the snap action of the disc is relatively short and hence the improvement in tactile response is limited. A disadvantage is that with continued use stress cracking of the disc may occur causing unreliable operation.

Disclosure of the Invention

It is an object of the invention to provide a keyboard which is inexpensive and reliable and wherein switch travel and tactile response are improved as compared with the above arrangements.

The present invention provides a keyboard including a first layer of dielectric, resilient material having a plurality of holes arranged in a pattern therein, characterized by a flexible, dielectric sheet having first and second sides and also having a plurality of dome-shaped areas therein with the convex sides of said dome-shaped areas being located on said second side and said dome-shaped areas being aligned with said holes in said layer so that said first side faces said layer; and a dielectric member having first and second sides with
said first side facing said layer; said first sides of said sheet and said member having first and second electrode means arranged, respectively, thereon for completing an electrical connection when a said dome-shaped area is moved into its associated hole to enable said first electrode means to contact said second electrode means.

In order to actuate the keyboard, a dome-shaped area is moved into its associated hole to complete an electrical connection. The combination of movement of the dome-shaped area and the compression of the resilient material surrounding the associated hole provide an improved switch travel and increases the tactile response as compared with the prior art. A snap-action movement of the dome-shaped area reduces the force required for switch actuation.

In a further aspect the invention provides a method of producing a keyboard comprising a first layer of dielectric resilient material having a plurality of holes arranged in a pattern therein, first and second flexible sheets, with said first sheet having designated areas covering associated said holes and with said first and second sheets having first and second electrode means thereon for completing an electrical connection when a said designated area is moved into its associated hole to enable said first electrode means to contact said second electrode means; a second layer of dielectric resilient material positioned adjacent to said first sheet and a third layer of dielectric resilient material positioned adjacent to said second sheet; said method characterized by the steps of: (a) determining the force desired to actuate said switch, the extent of travel of said switch, and the location of a makepoint (m) between the start and end of said travel whereby said electrical connection is made at said makepoint; (b) selecting the density of said first, second and third layers and said first and second sheets in accordance with said force desired to actuate said switch; and (c) selecting the thicknesses of
said first, second and third layers in accordance with the determination as to the location of said makepoint within said travel of said switch.

By providing said first, second and third layers of resilient material and selecting their thickness and density, it is possible to produce a keyboard with a selected switch travel and selected tactile response, improved as compared with the prior art, and a switch actuation force decreased as compared with the prior art.

**Brief Description of the Drawings**

Embodiments of the invention will now be described with reference to the accompanying drawings wherein:

Fig. 1 is a general, perspective view of a utilization device such as a computer system (only a portion of which is shown) in which a keyboard, shown only generally, but made according to this invention, may be used;

Fig. 2 is an expanded or exploded view, in perspective, of one embodiment of the keyboard shown only generally in Fig. 1;

Fig. 3 is a cross-sectional view of one embodiment of the keyboard shown in Figs. 1 and 2 and is taken along the line 3-3 of Fig. 1; and

Fig. 4 is a view similar to Fig. 3 showing a key which has been depressed beyond the makepoint and is in the aftertravel area; and

Fig. 5 is a cross-sectional view similar to Fig. 3 of a second embodiment of this invention;

Figs. 6, 7, 8 and 9 are views of additional embodiments of the invention;

Figs. 6A, 7A, 8A and 9A show various "Force vs. Switch Travel" graphs for the embodiments shown in Figs. 6, 7, 8, and 9 respectively.
Best Mode for Carrying Out the Invention

Fig. 1 shows a typical utilization device such as a portion of a computer system 10 in which a keyboard, designated generally as 12 and made according to this invention, may be used.

The keyboard 12 (Fig. 1), which represents a first embodiment of this invention, is shown in more detail in Figs. 2 and 3. The keyboard 12 includes a plurality of keys 14 (only a few are shown) which are arranged in a predetermined pattern or array and are slidably mounted in a guide plate 16. The plate 16 has a plurality of square, flanged openings 18 therein to slidably receive the square key stems 20. Each key stem 20 has an enlarged actuation area 22 on one end thereof which is positioned on one side of plate 16 and also has a ribbed area 24 located on the other end thereof. The ribbed area 24 is used to detachably secure an associated key cap 26 to the key stem 20 to provide a two-piece, key construction which facilitates the assembling of the keyboard 12.

The keyboard 12 is comprised of a plurality of elements as shown in Figs. 2 and 3. The keyboard 12 includes a first layer 28 of dielectric, resilient material such as flexible foam which has a plurality of holes 30 therein which are arranged in the same pattern or array as are the keys 14, with one such hole 30 being located in alignment with an associated key 14.

A first sheet 32 of flexible, dielectric material having first and second sides is then positioned above the first layer 28 as shown in Figs. 2 and 3. The sheet 32 has a plurality of dome-shaped areas 34 which are arranged in a predetermined pattern so as to be positioned over an associated hole 30 when the keyboard 12 is in the assembled relationship shown. The areas 34 are located on the second side of sheet 32 and conventional electrode means such as spaced, parallel conductors 36 (Fig. 2) are located on the first side of sheet
32 which faces the first layer 28. Each conductor 36 extends over a column of keys 14, as best seen in Fig. 2. The conductors 36 are flexible and are aligned with an associated column of dome-shaped areas 34.

The keyboard 12 also includes a second sheet 38 of flexible, dielectric material which is positioned below the first layer 28 as shown in Figs. 2 and 3. The sheet 38 has first and second sides with the first side facing the layer 28 and also having electrode means thereon such as the spaced, parallel conductors 40 which are located on the first side thereof. The conductors 40 are flexible and are aligned with an associated row of dome-shaped areas 34. The electrical conductors 36 and 40 are connected to conventional keying circuitry 42 whose output is connected to a utilization device such as the computer system 10 shown in Fig. 1.

The keyboard 12 also includes a second layer 46 of resilient, dielectric material such as flexible foam which is positioned between the second sheet 38 and a back plate 48. The back plate 48 is made of a rigid material which extends over the entire keyboard 12. Also, the keyboard 12 includes a third layer 50 of resilient, dielectric material which may be a flat layer or one which has a plurality of concave areas or recesses 52 therein. When the keyboard 12 is in the assembled relationship shown in Fig. 3, for example, the recesses 52 (when present) are aligned with and are complementary to the dome-shaped areas 34 in the first sheet 32.

The operation of the keyboard 12 (Figs. 2 and 3) is as follows. When a key 14 is depressed by a user's finger, the actuation area 22 of the associated key 14 pushes against the third layer 50 which holds the key 14 in the "up" position shown in Fig. 3 and also provides some of the pre-travel of the key 14 prior to an electrical connection being made. As the key 14 is depressed further towards the back plate 48, the associated dome-shaped area 34 "snaps" to the position shown
in dashed outline 34-1. The dome-shaped areas 34 provide the tactile feel or "snap action" just before the makepoint of the particular key 14 when the associated conductor 36 on the first sheet 32 contacts the associated conductor 40 on the second sheet 38. As the key 14 is depressed further towards the back plate 48, the perimeter of the associated dome-shaped area 34 is supported by the portion 54 (Fig. 3) of the first layer 28 which surrounds the associated hole 30. The portion 54 supports the perimeter of the associated dome-shaped area 34 and lessens the radius of curvature thereof because the layer 28 deforms as the key 14 is depressed further towards the back plate 48; this prolongs the life of the dome-shaped areas 34 and sheet 32. Fig. 4 shows a key 14 which has been depressed beyond the makepoint (where an electrical connection is made) and is shown in the aftertravel area.

The layer 28 (Figs. 2 and 3) performs two other functions in addition to the function of increasing the life of first sheet 32 as discussed in the previous paragraph. The layer 28 increases the overall "travel" of the associated key 14 and the travel that occurs as the dome-shaped area 34 "snaps down" which is important in making the tactile feedback more noticeable to the operator.

The second sheet 38 (Fig 2) has the conductors 40 thereon and provides the other electrical contacts (in conjunction with conductors 36) to complete an electrical circuit under a depressed key 14. Because the second sheet 38 is flexible, it permits switch aftertravel following an electrical circuit being completed. The second layer 46 limits the maximum force which can be applied to the flexible sheets 32 and 38 and thereby reduces wear in the keyboard 12.

As previously stated, this invention enables the construction of membrane-key switches or keyboards which permit easy modification of the force, distance,
and tactile properties thereof. For example, "step
changes" in force may be obtained by changing the foam
densities of all the first, second and third layers 28,
46 and 50, respectively, or less than all of them.

Adjustable pretravel and aftertravel may be effected by
changing the thicknesses of the third layer 50 and the
second layer 46, respectively or by removing them. An
adjustable makepoint of the keyboard 12 (or travel of a
key 14 before electrical contact is made) can be effected
by changing the relative thicknesses of the layers 28,
46, and 50.

In a preferred embodiment of the keyboard 12,
the first, second and third layers 28, 46, and 50 are
made of a flexible, low-density, foam such as silicone
or urethane, for example. The first and second sheets
32 and 38 are made of Mylar \textsuperscript{R}, polycarbonate, or conduc-
tive silicone rubber, for example. Naturally, the
thicknesses and densities of the various layers and
sheets mentioned in this paragraph are dependent upon
the particular force, distance and tactile properties
desired in a particular keyboard; however, the following
thicknesses of the various sheets and layers are repre-
sentative:

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<th>ITEM</th>
<th>Range</th>
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<tr>
<td>First layer 28 -</td>
<td>0.254 - 1.27 cm thick</td>
</tr>
<tr>
<td>Second layer 46 -</td>
<td>0.254 - 1.27 cm thick</td>
</tr>
<tr>
<td>Third layer 50 -</td>
<td>0.254 - 1.27 cm thick</td>
</tr>
<tr>
<td>First sheet 32 -</td>
<td>0.010 - 0.127 cm thick (Mylar)</td>
</tr>
<tr>
<td></td>
<td>0.127 - 0.51 cm thick (Silicone Rubber)</td>
</tr>
<tr>
<td>Second sheet 38 -</td>
<td>0.010 - 0.127 cm thick (Mylar)</td>
</tr>
<tr>
<td></td>
<td>0.127 - 0.51 cm thick (Silicone Rubber)</td>
</tr>
<tr>
<td>Movement of travel of key 14</td>
<td>0.127-1.27 cm.</td>
</tr>
</tbody>
</table>
Fig. 5 shows a second embodiment of this invention which is designated generally as keyboard 56, with the same reference numerals in Fig. 5 being used for identical parts or elements in Figs. 1-3. The first sheet 32 (Fig. 5) is identical to sheet 32 shown in Fig. 2 and it has the electrodes 36 thereon. Similarly, the second sheet 38 (Fig. 5) is identical to sheet 38 shown in Fig. 3 and it has the electrodes 40 thereon.

The operation of the keyboard 56 (Fig. 5) is generally the same as keyboard 12 already described in Figs. 1-3, except that the first and second layers 46 and 50 shown in Figs. 2 and 3 have been eliminated. When the key 14 is depressed, the associated dome-shaped area 34 is depressed and "snaps" to the position shown by dashed outline 34-1, and thereafter, continued depression of the key 14 towards the back plate 48 will effect the electrical connection between the associated electrode 36 on the first sheet 32 and the associated electrode 40 on the second sheet 38.

Figs. 6A, 7A, 8A, and 9A show various "Force vs. Switch Travel" graphs for the switch embodiments shown in Figs. 6, 7, 8, and 9, respectively. These figures are useful in explaining the method of producing electrical switch arrays according to this invention.

In order to facilitate an explanation of Figs. 6-9, identical elements are given the same numbers. Fig. 6 is substantially identical to the embodiment shown in Fig. 3; consequently, the layers 28, 50, and 46 shown in Fig. 3, correspond to the layers 28-1, 50-1, and 46-1 shown in Fig. 6. With regard to Figs. 7-9, whenever the thicknesses of a layer changes, it is given a new dash number; for example the thickness of layer 50-1 in Fig. 6 is increased in Fig. 7, and it is therefore assigned the number 50-2. Layer 50-2 is the same as layer 50-1 except that layer 50-2 is thicker than layer 50-1.

The "Force vs Switch Travel" graph shown in Fig. 6A depicts the characteristics of the switch 12-1.
shown in Fig. 6. The method of producing the switch arrays according to specific design parameters can best be understood by changing the dimensions, for example, of certain elements of the switches 12-1, 12-2, 12-3 and 12-4 and looking at the associated graphs in Figs. 6A, 7A, 8A and 9A, respectively. Actually, the method of producing switches according to this invention is basically to determine the force, makepoint, and switch travel characteristics desired, and to select the densities and thicknesses of the layers like 28-1 and the sheets like 32-1 used therein. This is a feature of this invention in that the operating characteristics thereof can be changed without tooling changes by the manufacturer.

With regard to the graphs shown in Figs. 6A–9A, the term "FORCE" as shown in Fig. 6A, for example, refers to the force applied to the key 14 by a finger as shown in Fig. 6, for example. The term "SWITCH TRAVEL" refers to the total extent to which an associated key 14 travels when being depressed or actuated from the position shown in Fig. 6 to the position shown in Fig. 4. Finally, the term "MAKE" refers to the point in the switch travel at which an electrical connection is made by the electrical conductors 36 (Fig. 3) contacting the associated electrical conductors 40 for the associated key 14 as previously explained.

As previously stated, the keyboard 12-1 in Fig. 6 is substantially the same as keyboard 12. Each of the layers 28-1, 46-1 and 50-1 is made of equal thickness and of the same density according to the parameters given earlier herein.

The characteristics of the keyboard 12-1 (Fig. 6) are shown in the graph in Fig. 6A. Notice that when the layers 28-1, 46-1 and 50-1 of keyboard 12-1 are of the same thickness, the MAKE point of the keyboard 12-1 will occur about midway in the SWITCH TRAVEL.
The keyboard 12-2 shown in Fig. 7 is identical to the keyboard 12-1 shown in Fig. 6 except for the fact that the thickness of layer 50-2 in keyboard 12-2 is changed to twice the thickness of layer 50-1 in keyboard 12-1. This change moves the MAKE point of switch 12-2 further along in the SWITCH TRAVEL as seen in Fig. 7A when compared to Fig. 6A. Also, the FORCE required to actuate a key 14 of keyboard 12-2 is greater than that associated with keyboard 12-1.

The keyboard 12-3 shown in Fig. 8 is identical to the keyboard 12-1 shown in Fig. 6 except for the fact that the thickness of layer 46-2 in keyboard 12-3 is changed to twice the thickness of layer 46-1 in keyboard 12-1. This change moves the MAKE point of switch 12-3 relatively earlier in the total SWITCH TRAVEL as seen in Fig. 8A when compared to Fig. 6A.

The keyboard 12-4 shown in Fig. 9 is identical to keyboard 12-1 shown in Fig. 6 except for the fact that the thickness of layer 28-2 in keyboard 12-4 is changed to twice the thickness of layer 28-1 in keyboard 12-1. This change widens the "hump" between points "a" and "c" in Fig. 9A (as shown by bracket 58) compared to the distance between points "a" and "c" in Fig. 6A. Also, the FORCE required to actuate a key 14 of the keyboard 12-4 is greater than that associated with keyboard 12-1.

The portion of the graph between points "b" and "c" in Fig. 6A represents a dynamic situation in which an operator has depressed a key 14 with sufficient force or momentum so that as far as actuation of the associated switch (represented by a key 14) is concerned, there is nothing that the operator can do to stop it and the SWITCH TRAVEL represented by the depression of a key 14 proceeds from point C to the MAKE point in Fig. 6A.

The points a, b, and c shown in Fig. 6A are not shown in Figs. 7A and 8A; however, they are similarly located in Figs. 7A and 8A. This discussion with regard to points
a, b, and c of Figs. 6A and 9A, for example, relates to keyboards having dome-shaped areas 34 therein.

When no dome-shaped areas 34 exist in the first sheet 32-1 shown in Figs. 6-9, (i.e., with the sheet 32-1 being flat) the associated FORCE vs. SWITCH TRAVEL graphs or curves for the embodiments 12-1 through 12-4 appear in dashed outline as shown in the associated Figs. 6A-9A, respectively. Notice that without the dome-shaped areas 34, the MAKE points for these embodiments (as shown by the letters "m") appear slightly later in the SWITCH TRAVEL than the embodiments having the dome-shaped areas 34 therein. An important difference here is that with the dome-shaped areas 34 included in the embodiments shown in Figs. 6-9, an important tactile feel is relayed to the operator to indicate that data has been inputted into the associated keyboards 12-1 through 12-4.

It should also be noted, however, that the use of resilient material in layer 28-1 (Fig. 6, for example) also prolongs the life of the first sheet 32-1 when this first sheet is made flat, without the dome-shaped areas 34 therein. This prolonged life of sheet 32-1 is due to the fact that distortion of the sheet 32-1 is lessened at the perimeter of hole 30 (as at point 54) and the distortion is spread over a broader area of the first sheet 32-1.

In order to achieve very low actuation forces, the sheets 32-1 should be made of silicone rubber.

A typical range of urethane material for use in the layers 28, 46, and 50, for example, as shown in Fig. 3, would be a range of 0.69 to 5.5 kN/m² which results from a testing procedure standardized by the American Society for Testing Materials (ASTM-D1564 Method B). In general, the testing procedure entails taking a 2.54 cms thick layer of the foam material, compressing an area of 322 square cms of the material by 25% (so that the thickness of the layer is reduced to 1.9 cm) and measuring the force necessary to compress
the layer. Materials which show a force of 0.69 to 5.5 kN/m² in such a testing procedure may be used as a starting point for the types of switch embodiments shown herein; however, it is understood that the principles of this invention may be extended to more exotic switch applications.
CLAIMS:

1. A keyboard including a first layer (28) of dielectric, resilient material having a plurality of holes (30) arranged in a pattern therein, characterized by a flexible, dielectric sheet (32) having first and second sides and also having a plurality of dome-shaped areas (34) therein with the convex sides of said dome-shaped areas being located on said second side and said dome-shaped areas being aligned with said holes in said layer so that said first side faces said layer; and a dielectric member (38) having first and second sides with said first side facing said layer (28); said first sides of said sheet (32) and said member (38) having first (36) and second (40) electrode means arranged, respectively, thereon for completing an electrical connection when a said dome-shaped area (34) is moved into its associated hole (30) to enable said first electrode means (36) to contact said second electrode means (40).

2. A keyboard according to claim 1, characterized in that each dome-shaped area (34) is designed for snap action and also has a perimeter, with each said dome-shaped area having its perimeter aligned with respect to an associated hole (30) in said layer (28) so as to be resiliently supported by a portion of said layer surrounding said hole.

3. A keyboard according to claim 1, characterized in that said layer (28) is made of flexible foam, and said sheet (32) is made of plastic material, and each said dome-shaped area (34) having a size to enable it to be depressed by a user's finger.

4. A keyboard according to claim 3, characterized in that said layer (28) is made of urethane or silicone rubber, and said sheet (32) is made of Mylar or silicone rubber.
5. A keyboard according to claim 1, characterized by a first supporting means (48) and a second layer (46) of resilient material positioned between said second face of said member and said supporting means.

6. A keyboard according to claim 5, characterized by a second supporting means (16) having support holes (18) therein which are aligned with said holes (30) in said first layer (28), a third layer (50) of resilient material positioned between said second supporting means (16) and said second side of said sheet (32); and actuable keys (14) slidably mounted in said support holes (18) for moving the dome-shaped areas (34) into their associated holes in said first layer.

7. A keyboard according to claim 6, characterized in that each of said actuable keys (14) has a length of travel beginning with a start point and ending with an end point, with a makepoint (m) occurring therebetween; said first layer (28), said second layer (46), and said third layer (50) having thicknesses which are selected to locate said makepoint (m) at a specific position between said start and end points.

8. A keyboard according to claim 7, characterized in that said first layer (28-1), said second layer (46-1) and said third layer (50-1) are substantially equal in thickness.

9. A keyboard according to claim 7, characterized in that said first layer (28), said second layer (46), and said third layer (50) each have a thickness which ranges from 0.25 - 1.27 cm, and said sheet and said member each have a thickness of 0.010 - 0.127 cm when said sheet and said member are made of a plastic and said sheet and said member each have a thickness 0.127 - 0.51 cm when said sheet and said member are made of silicone rubber.
10. A keyboard according to claim 6, characterized in that said third layer (50-1) has a plurality of concave areas (52) therein arranged in said pattern so that a said concave area (52) contacts an associated dome-shaped area (34) in said sheet (32).

11. A method of producing a keyboard comprising a first layer (28) of dielectric resilient material having a plurality of holes (30) arranged in a pattern therein, first (32) and second (38) flexible sheets, with said first sheet (32) having designated areas (34) covering associated said holes (30) and with said first and second sheets having first (36) and second (40) electrode means thereon for completing an electrical connection when a said designated area (34) is moved into its associated hole to enable said first electrode means to contact second electrode means; a second layer (50) of dielectric resilient material positioned adjacent to said first sheet and a third layer (46) of dielectric resilient material positioned adjacent to said second sheet; said method characterized by the steps of: (a) determining the force desired to actuate said switch, the extent of travel of said switch, and the location of a makepoint (m) between the start and end of said travel whereby said electrical connection is made at said makepoint; (b) selecting the density of said first (28), second (50) and third (46) layers and said first (32) and second (38) sheets in accordance with said force desired to actuate said switch; and (c) selecting the thicknesses of said first (28), second (50), and third (46) layers in accordance with the determination as to the location of said makepoint within said travel of said switch.

12. A method according to claim 11, characterized in that said step (c) is effected by making said first (28), second (50) and third (46) layers
12. (concluded)
(Fig. 6) of equal thickness when said makepoint is to occur approximately half-way between the start and end of said travel.

13. A method according to claim 11, characterized in that said step (c) is effected by making said first (28-1) and third (46-1) layers of equal thickness and said second layer (50-2) twice the thickness of each of said first and third layers when said makepoint is to occur substantially closer to the end of said travel than to the start thereof.

14. A method according to claim 11, characterized in that said step (c) is effected by making said first (28-1) and second (50-1) layers of equal thickness and said third layer (46-2) twice the thickness of each of said first and second layers when said makepoint (m) is to occur substantially closer to the start of said travel than to the end thereof.

15. A method according to claim 11, characterized in that said method includes the step of forming dome-shaped areas (34) in said designated areas of said first sheet (32) with the convex sides of said dome shaped areas facing said second layer (50).
INTERNATIONAL SEARCH REPORT

International Application No PCT/US 81/01214

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) *

According to International Patent Classification (IPC) or to both National Classification and IPC ³

H01H 13/70

II. FIELDS SEARCHED

Minimum Documentation Searched *

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III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴

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<td>US,A, 3,860,771, Published 14 January 1975, Lynn et al</td>
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<td>US,A, 3,723,673, Published 27 March 1973, Clary et al</td>
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<td>X</td>
<td>US,A, 3,308,253, Published 7 March 1967, Krakinowski</td>
<td>6-9, 10-15</td>
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* Special categories of cited documents: ¹⁵

“A” document defining the general state of the art

“E” earlier document but published on or after the international filing date

“L” document cited for special reason other than those referred to in the other categories

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but on or after the priority date claimed

“T” later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

“X” document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search ² | Date of Mailing of this International Search Report ³
4 November 1981                                              19 November 1981

International Searching Authority ¹                          Signature of Authorized Officer ¹⁰

TSA/115                                                    James R. Scott