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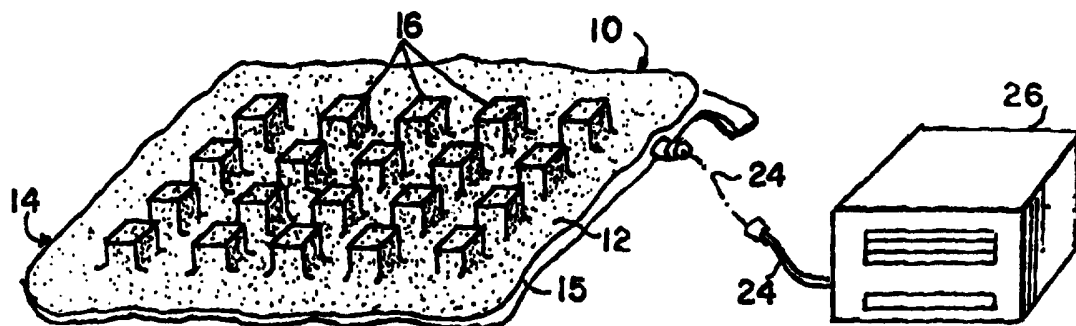
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**(54) Title:** INFLATABLE KEYBOARD



**(57) Abstract**

A flexible, pressurizable signal processing device such as a keyboard device (10) is made of resilient layers (12, 14) of plastic material having a common periphery (15), with molded keys (16) which are deformable when pressed so as to send a signal via a conduit (24) to an electrical device (26). The keys are arranged with a flexible electrical circuit (22) thereattached and with interconnected inflation channels (13) therebetween, such that when a key is depressed an associated conductive trace (20) establishes a proper complete circuit.

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## INFLATABLE KEYBOARD

### Background of the Invention

#### (1) Field of the Invention

This invention relates to the field of signal generating keyboards for computers, calculators, telephones, and electronic devices and even toys, where data entry is necessary.

#### (2) Prior Art

Miniaturization of electronic devices such as calculators, computers, telephones, amusement devices and like electronic equipment has advanced rapidly over the past few years. Data entry devices have become miniaturized as well. The term "chicklet keys" has been used to identify very small tabs utilized on some small devices for data entry into that device. While these keypads are somewhat flexible, the problem with that type of terminal is that the operator has a difficult time in hitting the proper key to efficiently do the job. The data entry operator's hands/fingers are relatively large, and these keys lack the full stroke, size and tactile contact feedback of full sized keyboards that are preferred. Current laptop and palmtop devices suffer from the problem of short stroke and compacted, dense key layouts.

It is thus an object of the present invention to provide a data entry panel which will accommodate the needs of the electronic device, will accommodate the physical reality of the data entry

operator, and permit the data entry equipment to be functionally full sized and functionally similar feel to conventional keyboards familiar to most keyboard operators, yet be miniaturizable to accommodate the need for reduced components.

It is a further object of the present invention to provide a data entry which will provide the operator with a proper tactile response to pressure on the appropriate keys on that data entry panel and thus provide the same benefits preferred in "hard" keyboards.

It is yet a further object of the present invention to provide a relatively thin, low mass, data entry panel which can be distorted or rolled/folded from its functional shape to permit storage in a small compartment/manner in the data processing unit, yet be deployable at will, inexpensive and reliable.

### Brief Summary of the Invention

The present invention comprises a data entry panel or keyboard which is full size to permit normal data entry of present day configuration while permitting the keyboard to also be reduced in size when not in use.

The keyboard comprises a plurality of layers of flexible material, typically joined at least at their periphery, to provide an inflatable pad, of standard keyboard quality and size and with standard keyboard function features. The pad/keyboard may be

inflated for use with a pressurized air or fluid, or may be filled with a compressible foam for certain uses, the pressure in the keyboard being regulatable to the user's taste, is waterproof, floatable, has few parts, and is safe for children.

The upper layer may be comprised of a molded keypad having formed keys, the molding/forming operation effecting the thickness of the layer to facilitate distortion of the keys when pressed. The upper layer may be clear material, and an array of solar cells may be disposed thereunder, so as to provide electrical energy to the system from the keyboard itself.

The bottom side of the upper layer around each formed key, has a conductive trace which is connected to a circuit portion which is in communication with an electrical device, computer or the like.

The bottom layer is comprised of a flexible resilient sheet of plastic material having corresponding conductive traces in juxtaposition with the conductive traces defining the periphery of the keys on the bottomside of the upper layer of flexible material.

The corresponding conductive traces are connected to the circuit which is in communication with the electrical device, computer or the like. The circuit passes through the peripheral wall of the keyboard, and may have an inflation lumen arranged therewith, to provide means for directing pressurized fluid to the space between the upper and lower layers thereof. The upper and

lower layers of material are molded, bonded or heat sealed at their common peripheries and at several spots between keys, to prevent shifting of one layer relative to the other layer, adversely effecting the electrical contacts between the conductive traces.

In an alternative embodiment, the conductive traces could be comprised of piezoelectric strips disposed across the inner surface of the upper layer of material, which piezoelectric material creates an electric signal when compressed which is the case when a particular key is depressed. The piezoelectric material is preferably polyvinylidene fluoride, which when it is part of the circuit in conjunction with the keys, permits electrical signals to be established at and by the keys themselves, and is itself flexible. The piezoelectric material has the ability, when used with only one layer itself, or as part of both the upper and lower electrical circuits, configured, to generate voltages in response to vibrations in a manner similar to a microphone, and may also generate acoustical sounds like a loudspeaker, when a voltage is applied across it.

The manufacture of the upper layer may be accomplished by vacuum molding a layer of plastic material over a keypad mold. The material will stretch and reduce its thickness in certain peripheral areas around each key, which permits that key, when depressed, to flex at that thinner periphery. The flexure of that material provides a tactile response to the keyboard operator. By virtue of its ability to buckle in a predetermined manner, and thus to yield at or near a full keystroke, effectively duplicates the tactile characteristic of

conventional keyboard. The pressure within the keyboard forces the keys to return to their erect state after they have been hit and depressed. As they are depressed, the conductive trace in or around the key periphery comes into contact with the proper corresponding conductive trace on the lower layer, thus completing the circuit to send a desired signal to the electrical device, computer, telephone, etc.

The invention thus comprises a keyboard for generating electrical signals from a plurality of keys thereon comprising a first layer of flexible material having the plurality of keys formed thereon, a second layer of flexible material, and a conductive circuit arranged between the first and second layers of flexible material wherein an electrical conduit and an inflation conduit are arranged in communication with the keyboard to permit the inflation of the keyboard and to provide an electrical communication within an external electrical device attached to the keyboard. The conductive circuit comprises a conductive trace arranged on the bottomside of the first layer. The conductive circuit may also comprise a conductive trace arranged on the upperside of the second layer. Each of the keys is flexible so as to permit contact between the conductive traces in the upper and lower layers of flexible material. The first and second layers have common periphery where they are joined. An insulative flexible spacing layer may be disposed between the first and second layers of flexible material. The insulative spacing layer has gaps thereacross between the adjacent keys to define fluid pressure channels. The fluid pressure channels and the conductive traces

extend through a common conduit across the periphery the keyboard. The conduit is arranged to mate with a combination inflation lumen and electrical line to permit the supply of pressurized fluid to the keyboard and to permit the transmission of electrical signals from the keyboard. A valve may be arranged in said inflation conduit, to permit the keyboard to stay inflated during use without constant repressurization. The conductive circuit may comprise an arrangement of piezoelectric material on the flexible material to generate a signal when a key on the flexible material is distorted or pressed. The flexible layers are arranged to form a cavity filled with a non-conducting fluid or foam. The valve is arranged in a socket attached in said periphery of the keyboard. At least one of the keys on the keyboard has a flexible, annular wall portion which is thinner than the rest of the at least one key, so that when one of the keys has an external force applied thereto, the annular wall portion associated with that key yields, causing corresponding motion of the conductive circuit, thereby causing energization of the conductive circuit. The conductive circuit comprises conductive traces arranged circumferentially adjacent the thinner wall portions on first layer of flexible material forming the keys. The conductive traces may also be disposed on the second layer, arranged to be in electrical contact with the conductive traces on the first layer when the keys are pressed and the first layer is flexed to accommodate digit pressure thereon. When one of the keys is subject to digit pressure, corresponding deformation of the wall portion associated with that key provides a tactile response to a user.



The invention includes a method of transmitting an electrical signal to an electrical device from an inflated device, comprising steps of arranging a pair of flexible layers adjacent to one another in an overlapping relationship, providing an electrical circuit on one of the flexible layers, sealing together the edges of the flexible layers so as to form a cavity therebetween, inflating the cavity between the flexible layers with a pressurized fluid so as to spread apart the flexible layers and provide a spaced relationship therebetween, thus forming the inflated device, and pressing a key projecting from one of the layers so as to deform the key and cause an electrical circuit on one of the layers to generate a particular desired electrical signal for subsequent transmission to the electrical device. The method includes the step of deflating the fluid filled cavity so as to minimize the volume of the inflated device utilizes.

The invention also includes a flexible keyboard for generating electrical signals for transmission to an electrical device for control thereof, comprising a first layer of flexible material comprising a plurality of flexible keys formed thereon, a second layer of flexible material comprising a base of the keyboard, the first and second layers being arranged to define a cavity therebetween, an arrangement of conductive material juxtaposed with respect to the first layer so as to establish an electrical signal within that conductive material for transmission to the electrical device to be controlled on a key of the first layer flexible material is depressed, and the cavity being arranged to receive inflation fluid injected under pressure between the first and second layers of said flexible

material defining the cavity to inflate the keyboard so as to keep the keys thereon erect, yet permit their deformation when pressed by a user thereof. The conductive material comprises piezoelectric material which generates an electrical signal when a particular key is depressed wherein the conductive material and the first layer of material are distorted and flexed simultaneously. An elongated wrist rest bag may be inflatably attached to an edge of the keyboard.

### Brief Description of the Drawings

The objects and advantages of the present invention will become more apparent when viewed in conjunction with the following drawings, in which:

Figure 1 is a perspective view of an inflatable keyboard arranged in communication with an electronic device;

Figure 2 is a plan view of part of an inflatable keyboard;

Figure 3 is an exploded view of an inflatable keyboard assembly;

Figure 4 is a cross-sectional view of a key on an inflatable keyboard assembly in its standby mode;

Figure 4a is a cross-sectional view of an alternative embodiment of the embodiment shown in Figure 4;

Figure 5 is a cross-sectional view of a key on an inflatable keyboard assembly in its depressed "contact" mode;

Figure 5a is an alternative embodiment of the device shown in figure 5;

Figure 6 is a perspective view of an embodiment of storage of an inflatable keyboard;

Figure 7 is an end view of a further embodiment of storing an inflatable keyboard;

Figure 8 is a side elevational view, partially in section, of a combination inflation conduit (signal conduit);

Figure 9 is a perspective view of a plug and inflation conduit (signal conduit) for an inflatable keyboard;

Figure 9a is a cross-section view of a connector socket configuration on the inflatable keyboard;

Figure 10 is a cross-sectional view taken along the lines X-X of Figure 9;

Figure 11 is a cross-sectional view of a laminated keytop with a piezoelectric inner liner; and

Figure 12 is a partial plan view of a laminated keytop keypad showing a strip of polyvinylidene fluoride extending under a row of keytops.

### Description of the Preferred Embodiments

Referring now the drawings in detail, and particularly to Figure 1, there is shown a data entry panel or inflatable keyboard 10. The keyboard 10 is comprised of an upper layer 12 and a lower layer 14 of flexible polymeric material such as mylar, vinyl, urethane, PE, polypropylene or rubber, as shown also in Figure 3.

The upper and lower flexible layers 12 and 14 are joined as by welding, at a common periphery 15, to form an inflatable envelope which comprises the keyboard 10. The upper layer 12 has a plurality or appropriately located key pads 16 extending upwardly therefrom.

A plan view of the upper layer 14 is shown in Figure 2, showing the key 16 having interconnected inflation channels 13 disposed therebetween.

The upper layer 12 has the key 16 formed so as to permit their flexure and compressibility relative to the lower layer 14. The keys 16 may be formed on a vacuum mold, not shown, which causes portions of that upper layer 12 comprising that key 16 to stretch

more than other portions of the key 16, such as circumferential wall sections 18 which are therefore thinner, thus making that section more flexible, permitting it to be depressed, as shown in Figure 5 and 5a, yet retaining a relatively stiff and hard keytop 19 that enhances tactility and maintains stability of its electrical system.

Each key 16 may have an upper conductive trace 20 around at least a portion of the inner side of each flexible wall section 18 as shown in Figures 4 and 5. Each upper conductive trace 20 is connected to and completes an electrical circuit 22 arranged on the bottomside of the upper layer 12, as shown in Figures 3, 11 and 12, and which is in electrical communication with a conduit 24 to a controlled electronic device 26 into which the keyboard 10 feeds, as shown in Figure 1.

The bottom or lower layer 14 has a lower conductive trace 28 in conductive juxtaposition with its respective upper conductive trace 20 for each key 16 on the keyboard 10. Each lower conductive trace 28 is connected to or is part of an electrical circuit 30 arranged on the topside of the lower layer 14, as shown in Figure 4. The embodiments shown in figures 4a and 5a show a conductive trace 23 on an annular rim 29 of a key 16 on the upper layer 12 of flexible material. That rim 29 is that portion of the upper layer 14 of the key 16 which actually does the most bending or flexing, going from an "L" shape in cross-section, to a "U" shape as may be seen in the Figures.

A thin layer of insulative material 32, may be disposed between the upper and lower layers 12 and 14, as shown in Figures 4 and 5. The insulative material 32 may be arranged so as to have gaps thereacross, defining the inflation channels 13 between adjacent keys 16, as shown in Figure 2, while allowing bonding between the upper and lower layers 12 and 14, and also preventing short circuits therebetween.

The electrical circuits 22 and 30 feed through a plug 25 and the conduit 24 and into the device 26, which itself may be a computer system, monitor, telephone switchboard, radio, cellular telephone, toy or the like. The plug 25 and conduit 24, shown more explicitly in Figures 8 and 9, may also include an inflation lumen 36 in addition to a pair of electrical conduits 38 and 40 adapted to mate with the electrical circuits 22 and 30 of the keyboard 10. Each conduit 38 and 40 may also comprise contacts on plug 25 as shown in Figure 10, which may mate with receiving socket 41, shown in Figure 9a, in the keyboard 10, while sealing like a plug or a stopper. The socket 41 has the upper circuit 22 and the lower circuit 30, as shown in Figure 9a, which mates with the plug 25 to provide proper fluid pressure and electrical communication between the conduit 24 and the keyboard 10.

The embodiment shown in Figure 11 and 12 utilizes a strip, patch or annular arrangement of piezoelectric material 60 in each key on the innerside of the upper layer 12 of flexible material. The piezoelectric material 60, made from polyvinylidene fluoride or the

like, when arranged in secure contact with the flexible material of the upper layer 12, itself flexes, thereby generating an electrical signal by itself, from that particular key 16 which has been depressed, thus sending the signal through the conductive traces, to the monitor or equipment being controlled by the keyboard.

An electrical air pump 44 may be in fluid communication with the inflation lumen 36 as shown in Figures 8 and 9, to provide ongoing fluid/air pressure, as needed to maintain a constant pressure within the keyboard 10 itself, or the pump 44 may be powered by solar cells 62 disposed beneath the upper layer 12 of flexible material, as shown in Figure 3, when such upper material is transparent. The solar cells 62 would be connected through proper circuitry, not shown, similar to the traces aforementioned, and may be attached via the connector 25 to the electrical device 26. A valve 46, such as a duckbill type valve, may be disposed within the receiving socket or in the distal end of the plug 25 as shown on Figure 8, to keep air from escaping the keyboard 10 until it is desired to unplug the unit or disassemble it, however, the required volume of air is small, and oral fillup is also suitable. The pressure of air (or foam) within the keyboard 10 may be regulated or controlled by the pump and valve 46 to permit adjustment of tactile response or to adjust hardness of the keyboard 10 to the taste of the user.

In manufacture of the keyboard 10, the upper layer 12 may be made from a vacuum molding process whereby a sheet of flexible heat moldable plastic is drawn over a keypad mold. The material

stretches and thins in certain areas, as aforementioned, to provide the desired flexibility therewith. After the conductive traces/circuitry which may be applied by masked vacuum metalization or the application by printing of suitable conductive inks such as silver bearing inks is attached to their respective sides of the upper and lower layers 12 and 14 of the flexible material together with the insulation, their common peripheries 15 are heat sealed or welded, thus defining an inflatable pad which is capable of being rolled-up or folded along crease lines 47, after deflation, as respectively shown in Figures 6 and 7.

The keyboard 10 without pressurized fluid (or foam) therewithin thus permits it to be folded or rolled-up and maintained or stored in a minimum volume, ready to be expanded and utilized in a manner similar to a full size keyboard, the flexure of the keys 16 providing a tactile feedback as the material snaps or flexes from its erect to its depressed configuration.

In a further embodiment with a pressurized medium, Figure 7 shows in side view in phantom, a wrist rest 51 comprised of an elongated, inflatable pillow-like bag which may be in fluid communication with the pressurized keyboard to permit a user to rest his/her wrists thereon when inputting data into the keyboard 10. The rest bag 51 is hingedly attached to the proximal edge of the keyboard 10 to prevent injury to the user of the device.



We claim:

1. An electrical signal generating keyboard for generating electrical signals from a plurality of keys thereon comprising:
  - a first layer of flexible material having said plurality of keys formed thereon;
  - a second layer of flexible material; and
  - a conductive circuit arranged between said first and second layers of flexible material; wherein an electrical conduit and an inflation conduit are arranged in communication with said keyboard to permit the inflation of said keyboard and to provide an electrical communication with an external electrical device attached to said keyboard.
2. A keyboard as recited in Claim 1, wherein said conductive circuit comprises a conductive trace arranged on the bottomside of said first layer.
3. A keyboard as recited in Claim 2, wherein said conductive circuit comprises a conductive trace arranged on the upperside of said second layer.
4. A keyboard as recited in Claim 3, wherein each of said plurality of keys is flexible so as to permit contact between said conductive traces in said upper and lower layers of flexible material.

5. A keyboard as recited in Claim 3, wherein said first and second layers have common periphery where they are joined.
6. A keyboard as recited in Claim 3, wherein an insulative flexible spacing layer is disposed between said first and second layers of flexible material.
7. A keyboard as recited in Claim 6, wherein said insulative spacing layer has gaps thereacross between the adjacent keys to define fluid pressure channels.
8. A keyboard as recited in Claim 1, wherein a valve is arranged in said inflation conduit, to permit said keyboard to stay inflated during use without constant repressurization.
9. A keyboard as recited in Claim 1, wherein said conductive circuit comprises an arrangement of piezoelectric material on said flexible material generating a signal when a key on said flexible material is distorted or pressed.
10. A keyboard as recited in Claim 1, wherein said flexible layers are arranged to form a cavity filled with a non-conducting foam.
11. A keyboard as recited in Claim 8, wherein said valve is arranged in a socket attached in said periphery of said keyboard.

12. A keyboard as recited in Claim 1, wherein at least one of said keys on said keyboard has a flexible, annular wall portion which is thinner than the rest of said at least one key, so that when one of the said at least one keys has an external force applied thereto, the annular wall portion associated with that key yields, causing corresponding motion of said conductive circuit, whereby causing energization of said conductive circuit.
13. A keyboard as recited in Claim 12, wherein said conductive circuit comprises conductive traces arranged circumferentially adjacent said thinner wall portions on first layer of flexible material forming said keys.
14. A keyboard as recited in Claim 13, wherein said conductive traces are also disposed on said second layer, arranged to be in electrical contact with said conductive traces on said first layer when said keys are pressed and said first layer is flexed to accommodate digit pressure thereon.
15. A keyboard as recited in Claim 14, wherein when one of said at least one key is subject to digit pressure, corresponding deformation of the wall portion associated with that key provides a tactile response to a user.

16. A method of transmitting an electrical signal to an electrical device from an inflated device, comprising steps of:

arranging a pair of flexible layers adjacent to one another in an overlapping relationship;

providing an electrical circuit on one of said flexible layers;

sealing together the edges of said flexible layers so as to form a cavity therebetween;

inflating said cavity between said flexible layers with a pressurized fluid so as to spread apart said flexible layers and provide a spaced relationship therebetween, thus forming the inflated device; and

pressing a key projecting from one of said layers so as to deform said key and cause an electrical circuit on one of said layers to generate a particular desired electrical signal for subsequent transmission to the electrical device.

17. The method of transmitting an electrical signal as recited in Claim 16, including the step of:

deflating said fluid filled cavity so as to minimize the volume of said inflated device utilizes.

18. A flexible keyboard for generating electrical signals for transmission to an electrical device for control thereof, comprising:
- a first layer of flexible material comprising a plurality of flexible keys formed thereon;
  - a second layer of flexible material comprising a base of said keyboard, said first and second layers being arranged to define a cavity therebetween;
  - an arrangement of conductive material juxtaposed with respect to said first layer so as to establish an electrical signal within that conductive material for transmission to said electrical device to be controlled on a key of said first layer flexible material is depressed; and
  - said cavity being arranged to receive inflation fluid injected under pressure between said first and second layers of said flexible material defining a said cavity to inflate said keyboard so as to keep said keys thereon erect, yet permit their deformation when pressed by a user thereof.
19. A keyboard as recited in Claim 18, wherein said conductive material comprises piezoelectric material which generates an electrical signal when a particular key is depressed wherein said conductive material and said first layer of material are distorted and flexed simultaneously.
20. A keyboard as recited in Claim 19, including an elongated wrist rest bag inflatably attached to an edge of said keyboard.

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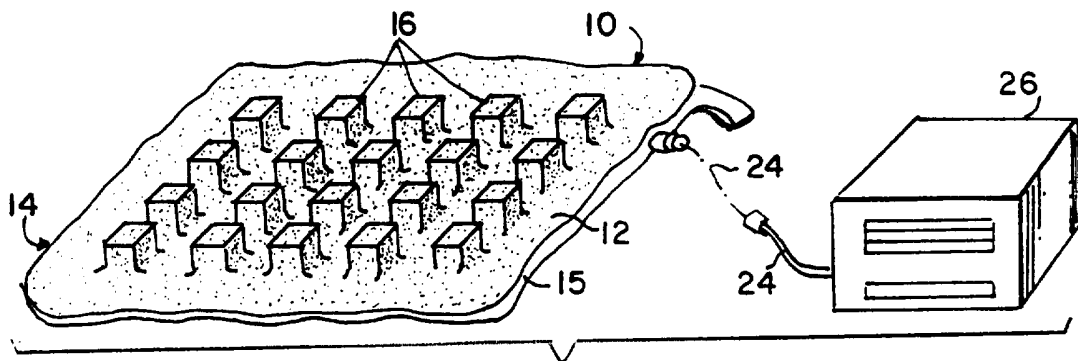


FIG. 1

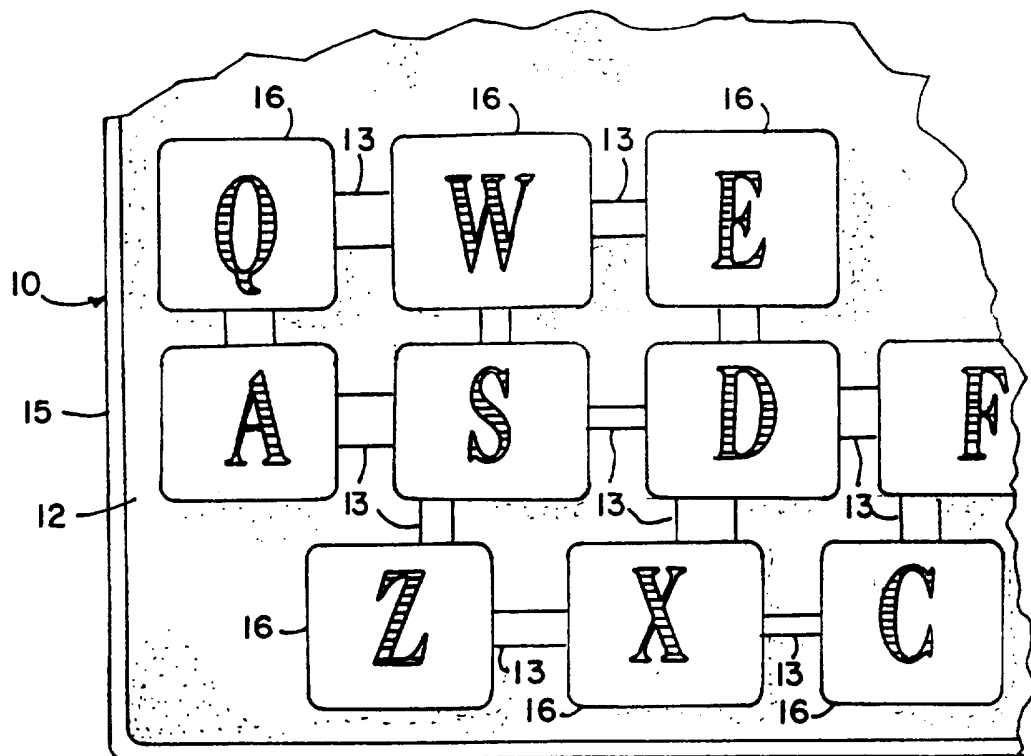


FIG. 2

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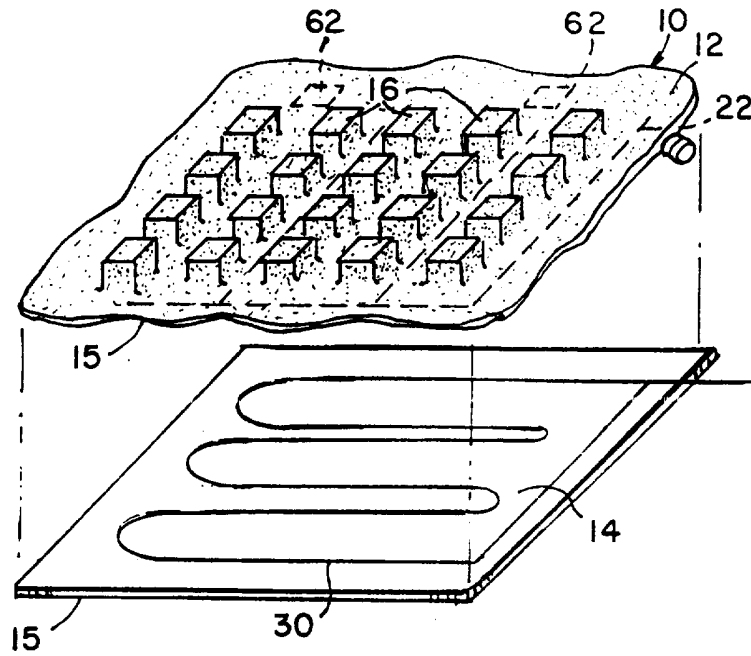


FIG. 3

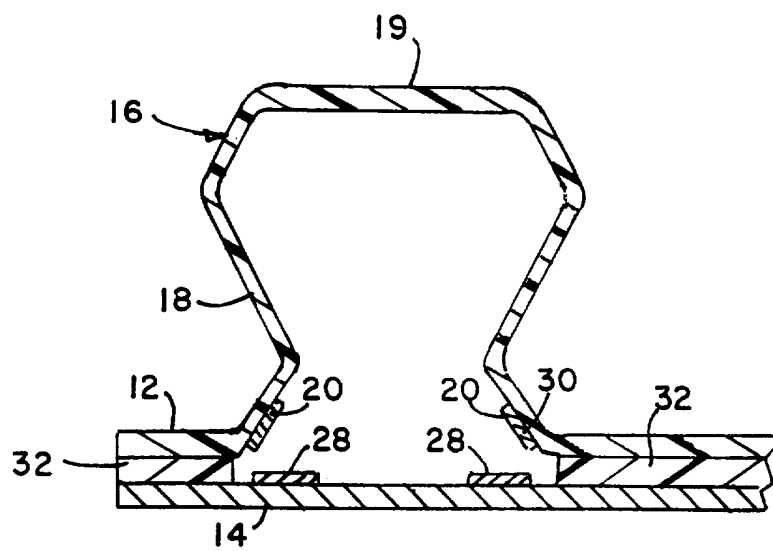


FIG. 4

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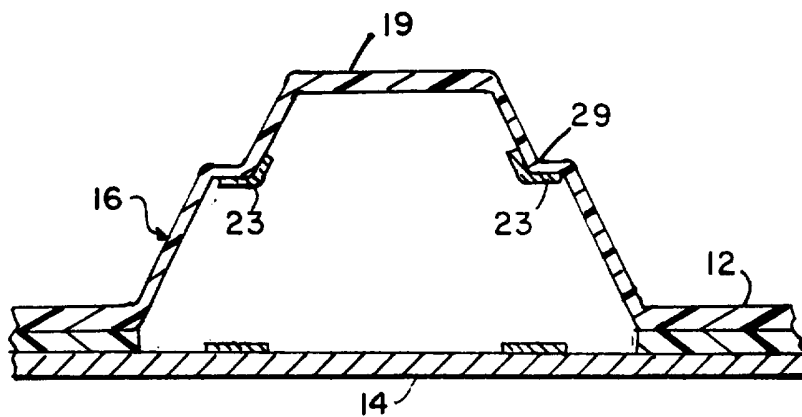


FIG. 4a

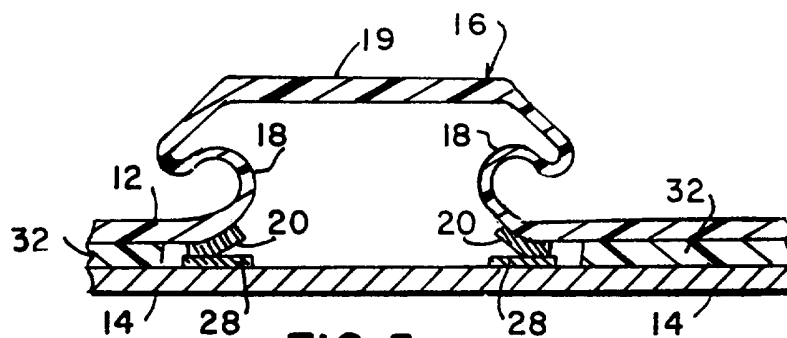


FIG. 5

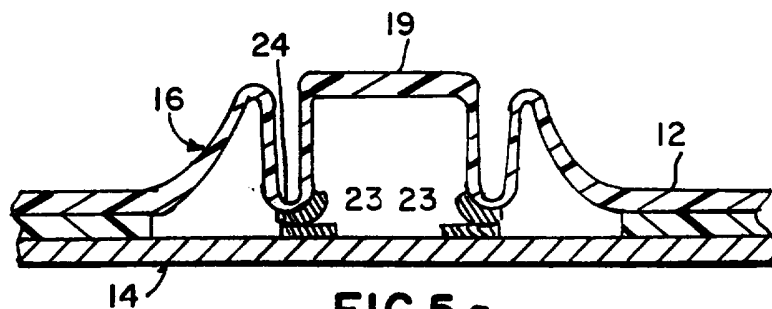
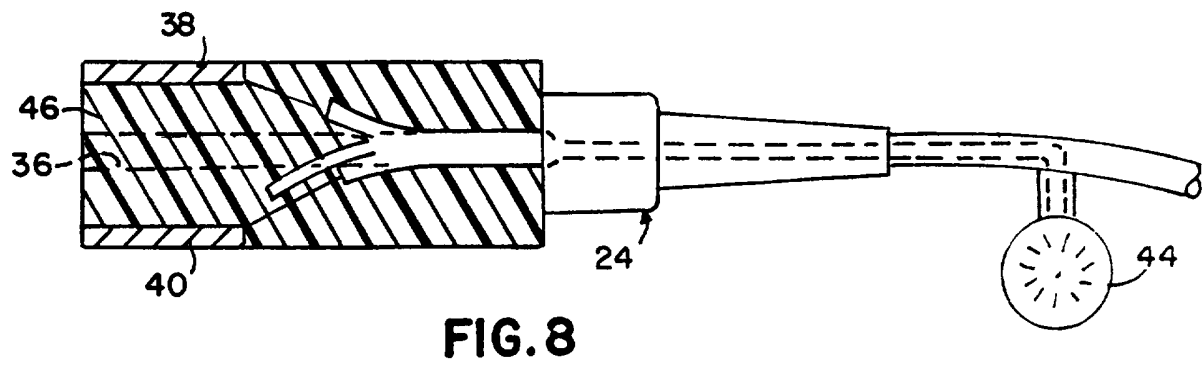
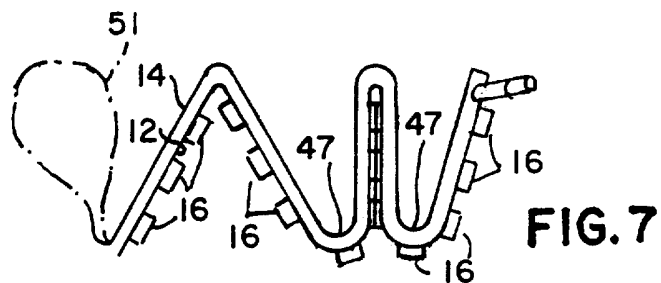
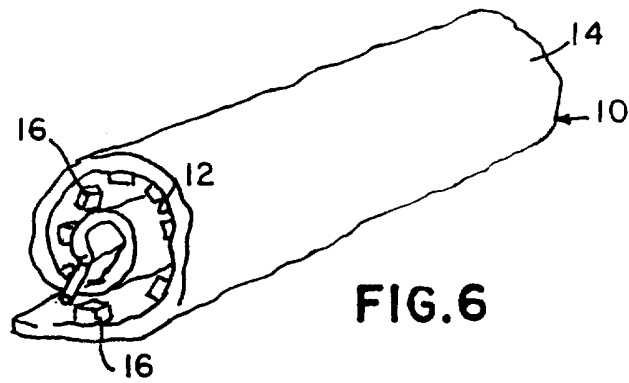


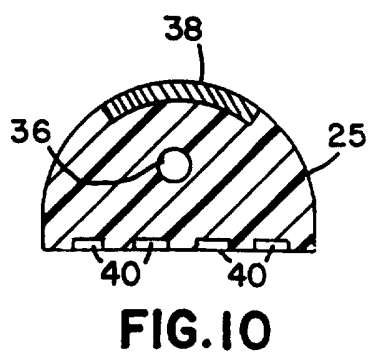
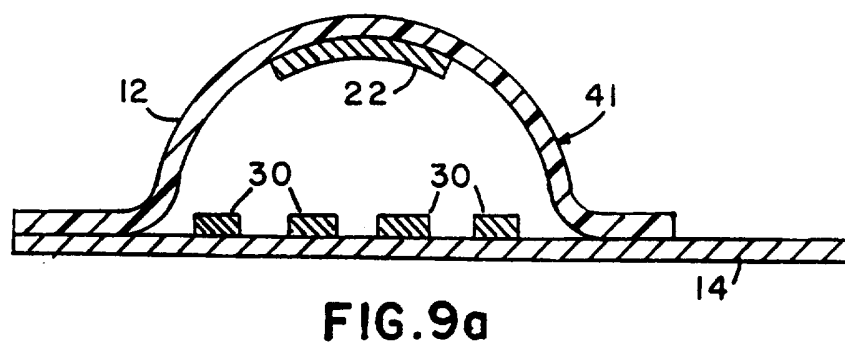
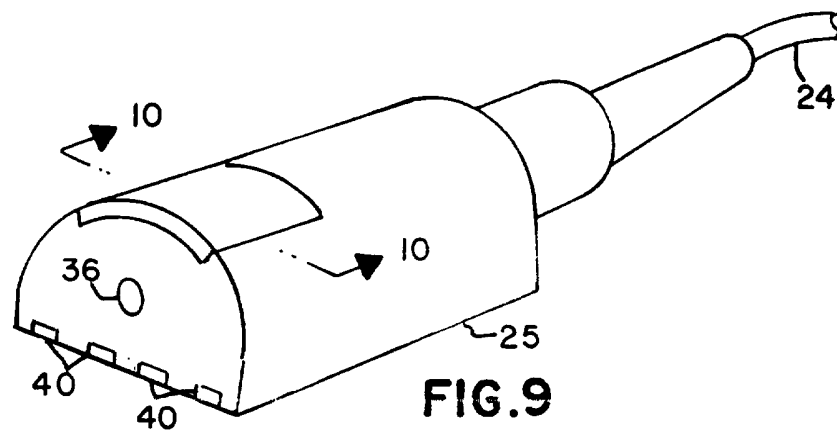
FIG. 5a



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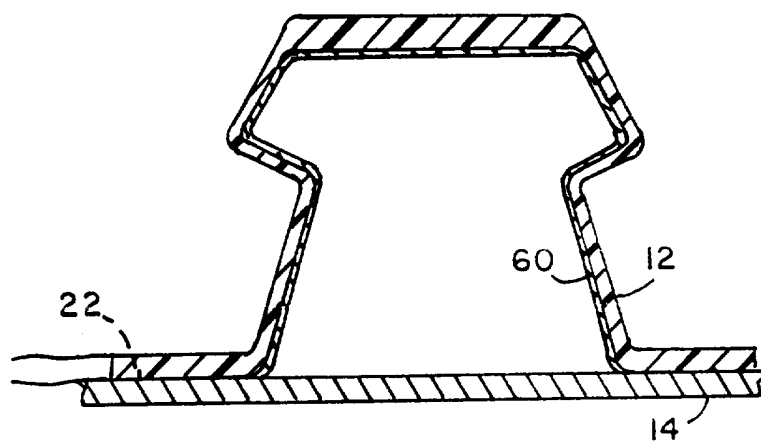


FIG. 11

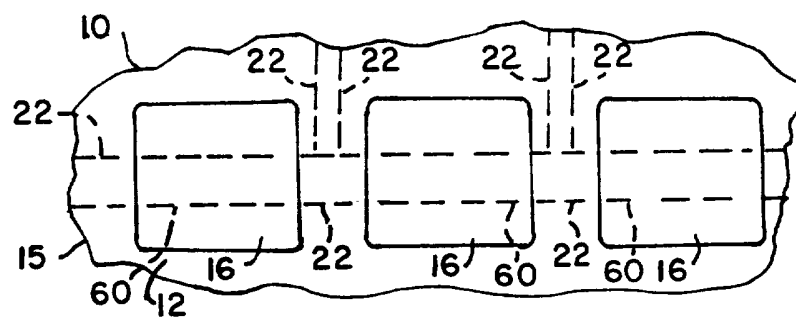


FIG. 12

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US95/12824

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :H03K 17/94

US CL :341/22; 400/481,491.1

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 341/20-22, 34; 200/5A; 235/145R; 400/472, 479.1, 481, 491, 491.1, 87; 345/168-169; 364/708.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
NONE

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
&	US, A, 5,459,461 (CROWLEY ET AL.) 17 October 1995.	1-20

☐

Further documents are listed in the continuation of Box C.

☐

See patent family annex.

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