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(54) Input/output device with a lamp and a switch having protection against electrostatic discharge and contamination

(57) An input/output device (1) for electrical equipment has a lamp (5) and a switch (3). A circuit board (7) contains a light emitting portion (25) of the lamp and a first and second trace portion (23) of the switch. A continuous membrane (13) of resilient material extends over the light emitting portion of the lamp and the first and second trace portions of the switch. A light pipe portion (35) of the lamp, capable of transmitting light from the light emitting portion of the lamp, is formed in the membrane. An actuation portion (33) of the switch is also formed in the membrane. The membrane also contains an electrically conductive portion (43) of the switch. When the actuation portion of the switch is deflected by a user's finger or other force, the electrically conductive portion of the switch connects the first and second trace portions of the switch. The continuous membrane protects the electrical equipment from electrostatic discharge and contamination through the input/output device.

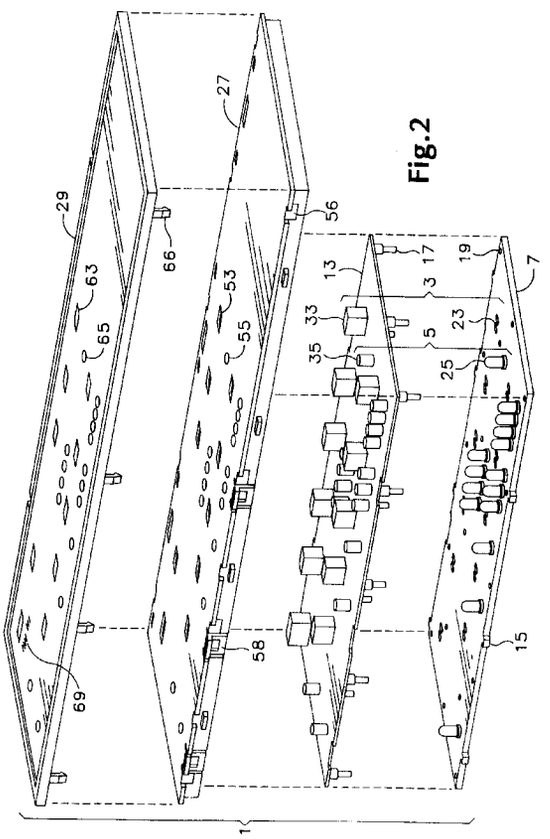

Fig.2

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Description

Field of the Invention

This invention relates to the electronics circuitry field. More particularly, this invention is an input/output device with a lamp and a switch having protection against electrostatic discharge and contamination.

Background of the Invention

Today's electrical equipment commonly contains one or more input/output devices, such as a keyboard, display, mouse, panel, etc, to communicate information to and/or from a user. Often, these input/output devices contain light emitting diodes that indicate that a particular function is operational or enabled. The top surface of the input/output device usually contains holes to allow the top of these light emitting diodes to poke through or be flush with the top surface of the input/output device, so they can be observed by a user. The input/output device also contains holes to allow switches to poke through or be flush with the top surface of the input/output device, so they can be activated by a user.

While it is certainly convenient in many applications for an input/output device to have light emitting diodes and switches available for user observation and activation, this convenience is not without its problems. For example, if a user builds up a static charge by rubbing their feet across a rug, and then touches the light emitting diode, a high voltage electrostatic discharge path from the user to the electrical equipment can be created through the light emitting diode. This high voltage electrostatic discharge path can cause great damage to the electrical equipment, even to the point of rendering it completely inoperable. The holes in the top surface of the input output device form another possible high voltage electrostatic discharge path, and can also provide a way for liquid, dirt, bugs, or other undesirable foreign substances to contaminate or otherwise adversely impact the operation of the electrical equipment.

French Patent No. 2,517,646, laid-open June 10, 1983 discloses an assembly having an LED exposed at the surface of the input/output device. As described above, such a design provides the aforementioned path for electrostatic discharge from the surface of the input/output device to the underlying circuit board, resulting in electrical equipment that is susceptible to damage from electrostatic discharge.

U.S. Patent No. 5,149,923, September 22, 1992 discloses a backlit keypad for use with compact and portable cellular telephone systems. A partially translucent overlay layer of flexible material includes raised keys backlit by a light source extending through the substrate on which the keypad is mounted. An electrically conductive intermediate layer is compressed by the activation of the overlay layer. This design effectively isolates the light source from electrostatic discharge, but places the light source so far from the upper surface of the keypad that illumination from the light source would be attenuated and insufficient to communicate information effectively in a panel. In addition, this keypad is expensive to manufacture.

U.S. Patent No. 4,458,123, July 3, 1984 discloses an attachment for incorporating discrete electrical components, including LEDs, in a switch panel. A pair of holes is formed in the switch panel and leads from the LED extend through theses holes and into contact with the electrical circuit on the substrate of the switch panel. If the LED is positioned near or exposed at the surface of the panel, the panel is susceptible to damage from electrostatic discharge, as described above.

German Patent DE 35 41 776 A1, May 27, 1987 discloses a switch panel with a cover over the underlying circuit board. The cover does not completely enclose the LED, which is near the surface of the panel and the LED and circuit board are thus susceptible to damage from electrostatic discharge.

European Publication 0 358 885 A1, March 21, 1990 discloses a cover mat for printed circuit boards having protruding components, such as LEDs. The cover mat is formed of electrically insulating plastic. Stampings are formed in the cover mat in the region of the display elements or LEDs and act as mounting domes, which can be inserted into passages or apertures of the control panel associated with the LED. These mounting domes serve to cover the LED and to insulate the LED and the circuit board to which it is attached from electrostatic discharge. Additionally, button domes are formed in the cover mat and provide switches for the control panel. A separate actuating element or button is provided to extend through an aperture in the control panel associated with the button dome. While this disclosure addresses the need for insulating LEDs from electrostatic discharge, the cover mat and control panel assembly are not manufactured easily, because a separate mechanical component, in the form of a separate button or actuating element, is provided to cooperate with the control panel and button dome or switch member to provide a switch that can be depressed by the operator. This requires fabrication of an element entirely separate from the control panel, circuit board, cover mat, and switch member formed therein.

Summary of the Invention

An input/output device for electrical equipment has a lamp and a switch. A circuit board contains a light emitting portion of the lamp and a first and second trace portion of the switch. A continuous membrane of resilient material extends over the light emitting portion of the lamp and the first and second trace portions of the switch. A light pipe portion of the lamp, capable of transmitting light from the light emitting portion of the lamp, is formed in the membrane. An actuation portion of the switch is also formed in the membrane. The membrane

also contains an electrically conductive portion of the switch. When the actuation portion of the switch is deflected by a user's finger or other force, the electrically conductive portion of the switch connects the first and second trace portions of the switch. The continuous membrane protects the electrical equipment from electrostatic discharge and contamination through the input/output device.

Description of the Drawings

Fig. 1 shows an isometric view of the input/output device of the preferred embodiment of the invention.

Fig. 2 shows a rotated and exploded view of the input/output device of the preferred embodiment of the invention.

Fig. 3 shows a fragmentary section view, taken along line A-A of Fig. 1, of the lamps and switches of the input/output device of the preferred embodiment of the invention.

Fig. 4 shows an enlarged view, taken along line B-B of Fig. 3, of a lamp and a switch of the input/output device of the preferred embodiment of the invention.

Fig. 5 shows how the input/output device of the preferred embodiment is manufactured.

Detailed Description of the Preferred Embodiment

Fig. 1 shows an input/output device according to the preferred embodiment of the present invention. For purposes of this invention, the term "input/output device" shall mean any keyboard, keypad, display, panel, mouse, or other device capable of communicating information to and from a user. In the preferred embodiment, the input/output device is shown as panel 1. Panel 1 is preferably a portion of electrocardiograph 100, although it could be a portion of other types of electronic equipment, such as a computer, audio equipment, video equipment, instrumentation, etc, and still fall within the spirit and scope of the invention. Panel 1 includes at least one switch 3 and at least one lamp 5.

Fig. 2 is a rotated and exploded view of the input/output device according to the preferred embodiment of the invention. Panel 1 contains overlay 29, frame 27, membrane 13, and circuit board 7. Circuit board 7 contains light emitting portion 25 of lamp 5. In the preferred embodiment, light emitting portion 25 is a light emitting diode, although other light emitting devices, such as fluorescent or electro-luminescent devices, could be used and still fall within the spirit and scope of the invention. Circuit board 7 also contains tabs 15 and trace portions 23 of switch 3, and optionally contains other components, connectors, wires, traces, etc.

Membrane 13 is formed over the upper surface of circuit board 7 and continuously extends over at least light emitting portion 25 and trace portions 23. Membrane 13 is preferably formed of a resilient, flexible, at least partially translucent material with electrically insulative properties, such as silicone rubber. Membrane 13 contains light pipe portion 35 of lamp 5, and actuation portion 33 of switch 3. Membrane 13 also contains electrically conductive portion 43 of switch 3, but this portion is hidden from view in Fig. 2 by actuation portion 33. Those skilled in the art will appreciate that electrically conductive portion 43 is not made of the same material as the rest of membrane 13, but instead is made of a conductive elastimer or other conductive material. In the preferred embodiment, the remainder of membrane 13 is translucent or transparent, although those skilled in the art will appreciate that only light pipe portion 35 needs to be translucent or transparent, so that light can be transmitted from light emitting portion 25 up to the surface of panel 1.

Membrane 13 is secured to circuit board 7 by engagement of a plurality of posts 17 formed integrally with and depending from membrane 13 and interference fit into corresponding apertures 19 in circuit board 7.

Membrane 13 serves to seal circuit board 7 and the components carried thereon against contamination and to insulate them against electrostatic discharge from an operator's fingers or other objects contacting panel 1, switch 3, or lamp 5.

Circuit board 7 and membrane 13 are secured to frame 27 by engagement between tabs 15 in circuit board 7 and retaining snaps 58 in frame 27, thereby capturing membrane 13 in between. Light pipe portion 35 and actuation portion 33 of membrane 13 go through apertures 55 and 53, respectively, in frame 27. Overlay 29 is secured to frame 27 by engagement between tabs 66 in overlay 29 and slots 56 in frame 27. Light pipe portion 35 and actuation portion 33 of membrane 13 go through apertures 65 and 63, respectively, in overlay 29. In the preferred embodiment, overlay 29 contains textual information 69 describing the function of various switches and/or lights on panel 1. Overlay 29 is preferably localized for a particular country and language, and is easily affixable to frame 27. This provides the flexibility of having overlay 29, containing textual information 69 written in a specific language, added to the remainder of panel 1 very late in the manufacturing process, or even in the field. A first alternate embodiment has been contemplated where textual information is either not required or is written directly on frame 27 or on light pipe portion 35 or actuation portion 33 of membrane 13. In this embodiment, panel 1 does not contain overlay 29. A second alternate embodiment has been contemplated where textual information is either not required or is written directly on membrane 13. In this embodiment, panel 1 does not contain overlay 29 or frame 27. Overlay 29 can also be easily removed by the user for cleaning with conventional soap and water.

Fig. 3 shows a fragmentary section view, taken along line A-A of Fig. 1, of the lamps and switches of the input/output device of the preferred embodiment of the invention, and Fig. 4 shows an enlarged view taken along line B-B of Fig. 3. Referring now to Fig. 4, the operation

of lamp 5 and switch 3 will now be discussed. When sufficient current is applied to light emitting portion 25 of lamp 5, light (preferably visible light, but optionally infrared or other non-visible light) emanates from light emitting portion 25. This light is transmitted through light pipe portion 25, thereby enunciating information to a user, either visibly or via detection by an infrared receiver.

Fig. 4 shows switch 3 in an open position, since electrically conductive portion 43 is not in contact with trace portions 23. When actuation portion 33 of switch 3 is deflected downwardly by a user or other force, air pocket 21 is compressed, and electrically conductive portion 43 contacts trace portions 23. This contact between electrically conductive portion 43 and trace portions 23 completes the circuit between trace portions 23.

Fig. 5 shows how the input/output device of the preferred embodiment is manufactured. Circuit board 7 is manufactured/populated in a conventional manner in step 210. Steps 220-240 manufacture membrane 13 in the following manner. Conductive elastimer used to make portions 43 of switch 3 is placed in nest areas in the membrane mold in step 220. An insulating elastimer, such as silicone rubber, is then placed in the membrane mold in step 230. When the membrane mold is heated in step 240, the conductive elastimer chemically and mechanically bonds with the insulating elastimer. The insulating elastimer forms light pipe portion 35, actuation portion 33, posts 17, and the remainder of membrane 13.

Membrane 13 is attached to circuit board 7 in step 250 by fitting posts 17 into apertures 19 (Fig. 2). Frame 27 is manufactured conventionally using resin transfer techniques in step 260. Frame 27 is attached to membrane 13 and circuit board 7 in step 270 by inserting tabs 15 in circuit board 7 into retaining snaps 58 in frame 27. Light pipe portion 35 and actuation portion 33 of membrane 13 are inserted through apertures 55 and 53, respectively, in frame 27. Overlay is manufactured conventionally using resin transfer techniques in step 280. Overlay 29 is secured to frame 27 in step 290 by engagement between tabs 66 in overlay 29 and slots 56 in frame 27. Light pipe portion 35 and actuation portion 33 of membrane 13 go through apertures 65 and 63, respectively, in overlay 29.

Claims

1. An input/output device (1) having a lamp (5) and a switch (3), comprising:
   a circuit board (7) containing a light emitting portion (25) of said lamp and a first and a second trace portion (23) of said switch;
   a continuous membrane (13) of resilient material extending over said light emitting portion of said lamp and said first and second trace portions of said switch;
   a light pipe portion (35) of said lamp formed in said membrane, said light pipe portion capable of transmitting light from said light emitting portion of said lamp;
   an actuation portion (33) of said switch formed in said membrane; and
   an electrically conductive portion (43) of said switch formed in the membrane, said electrically conductive portion of said switch capable of connecting said first and second trace portions of said switch when said actuation portion of said switch is deflected.

2. The input/output device of claim 1, wherein said continuous membrane is silicone rubber.

3. The input/output device of claim 1, wherein said continuous membrane is translucent.

4. The input/output device of claim 1, wherein said continuous membrane is transparent.

5. The input/output device of claim 1, wherein said light emitting portion of said lamp is a light emitting diode.

6. The input/output device of claim 1, wherein said light emitting portion of said lamp is an electro-luminescent device.

7. The input/output device of claim 1, further comprising:
   a frame (27) extending over said continuous membrane, said frame having a first aperture (55) for said light pipe portion and a second aperture (53) for said actuation portion.

8. The input/output device of claim 7, further comprising:
   an overlay (29) extending over said frame, said overlay having a third aperture (65) for said light pipe portion and a fourth aperture (63) for said actuation portion.

9. The input/output device of claim 1, wherein said input/output device is usable to operate electronic equipment.

10. The electronic equipment of claim 9, wherein said electronic equipment is an electrocardiograph (100).

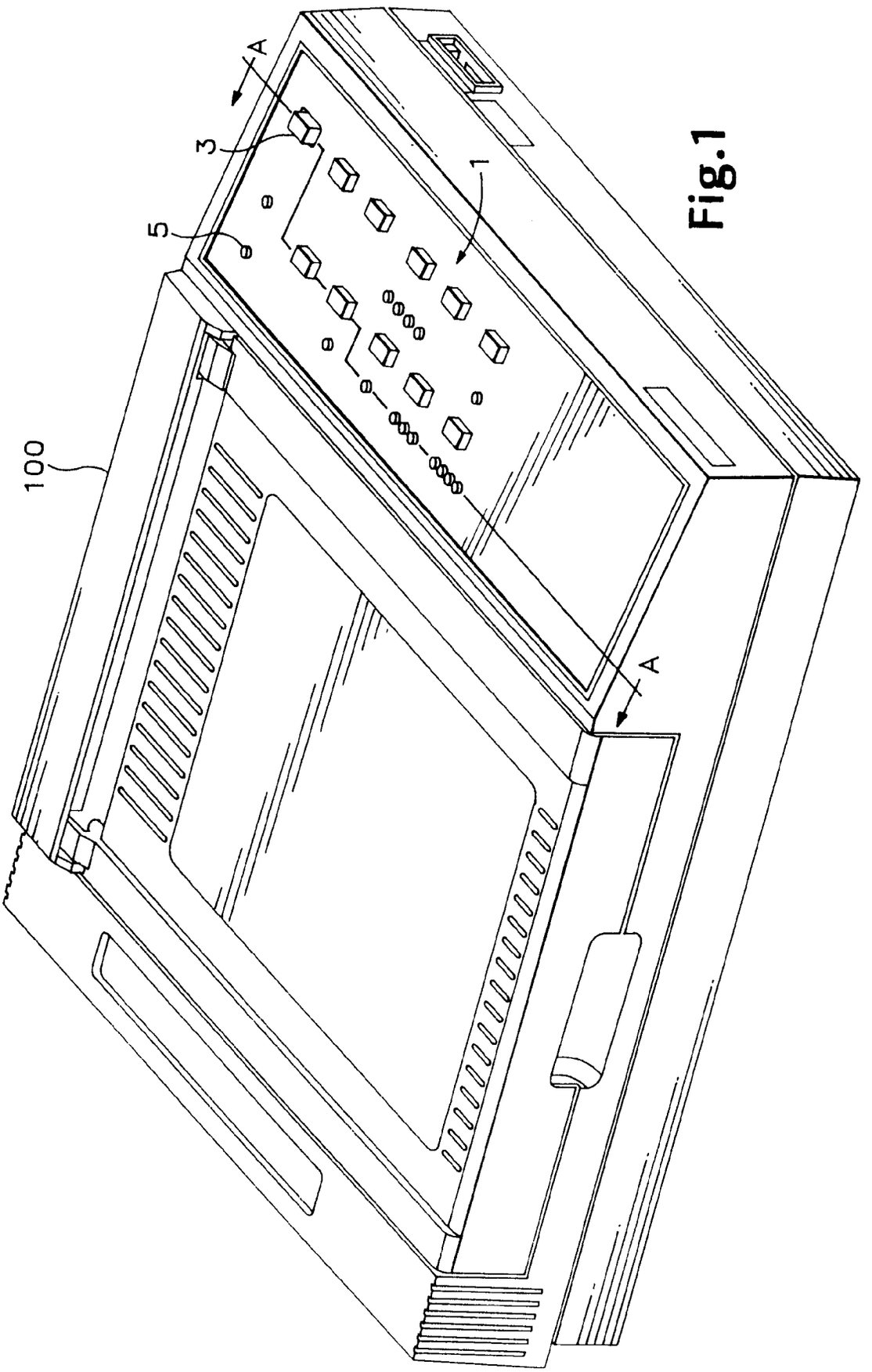

Fig.1

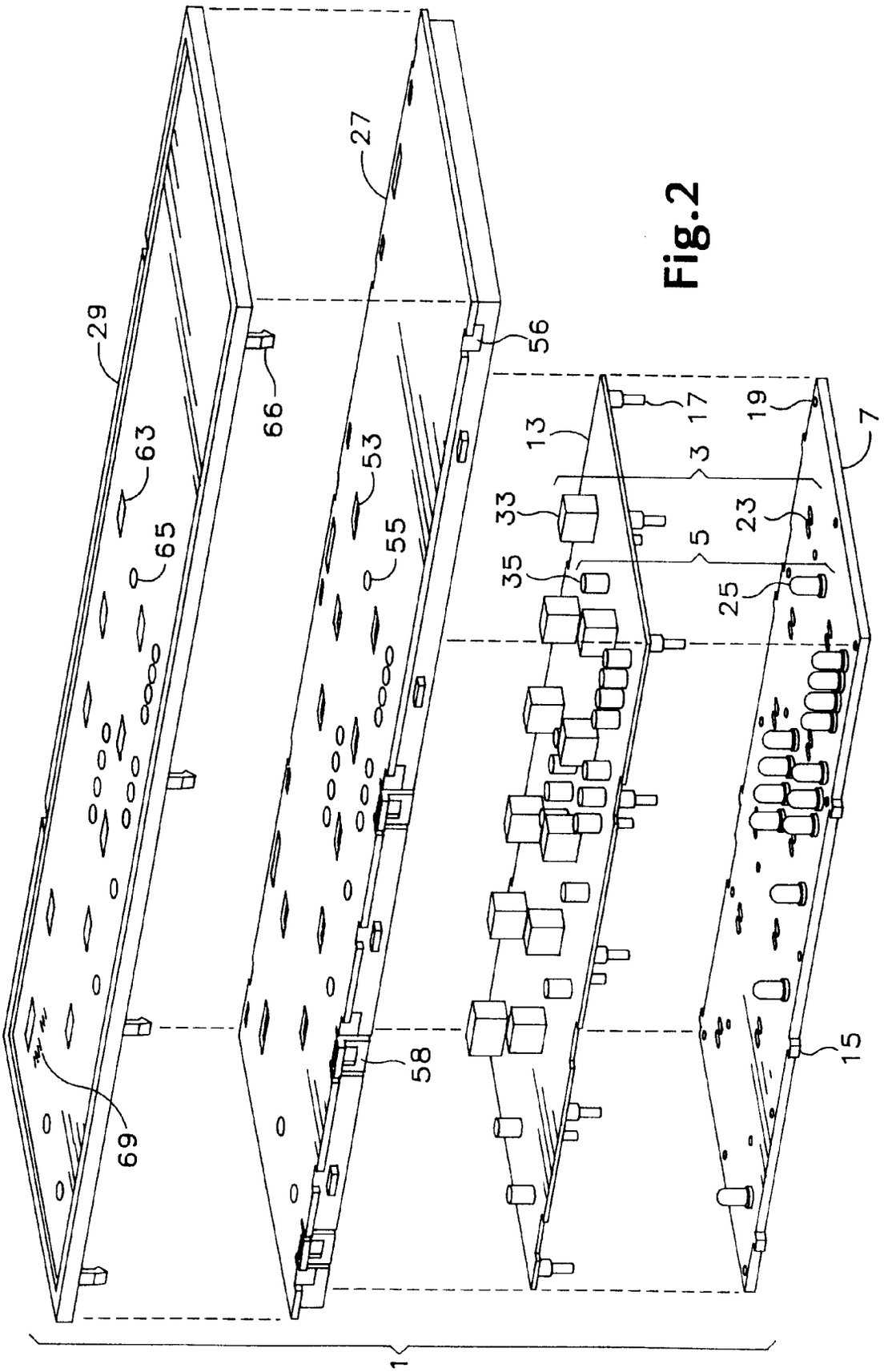

Fig.2

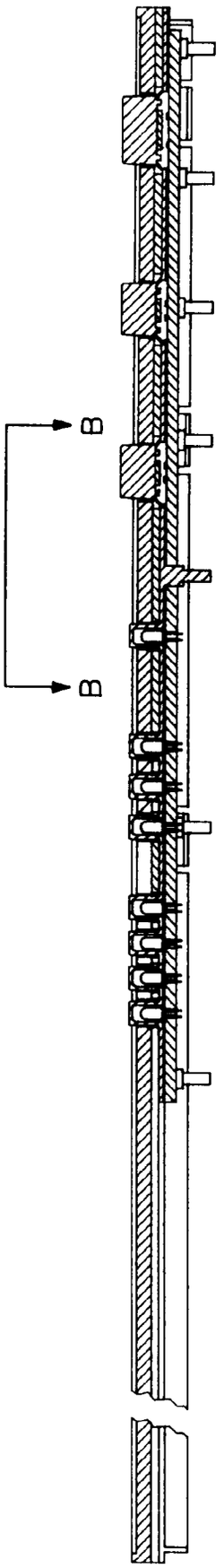

Fig.3

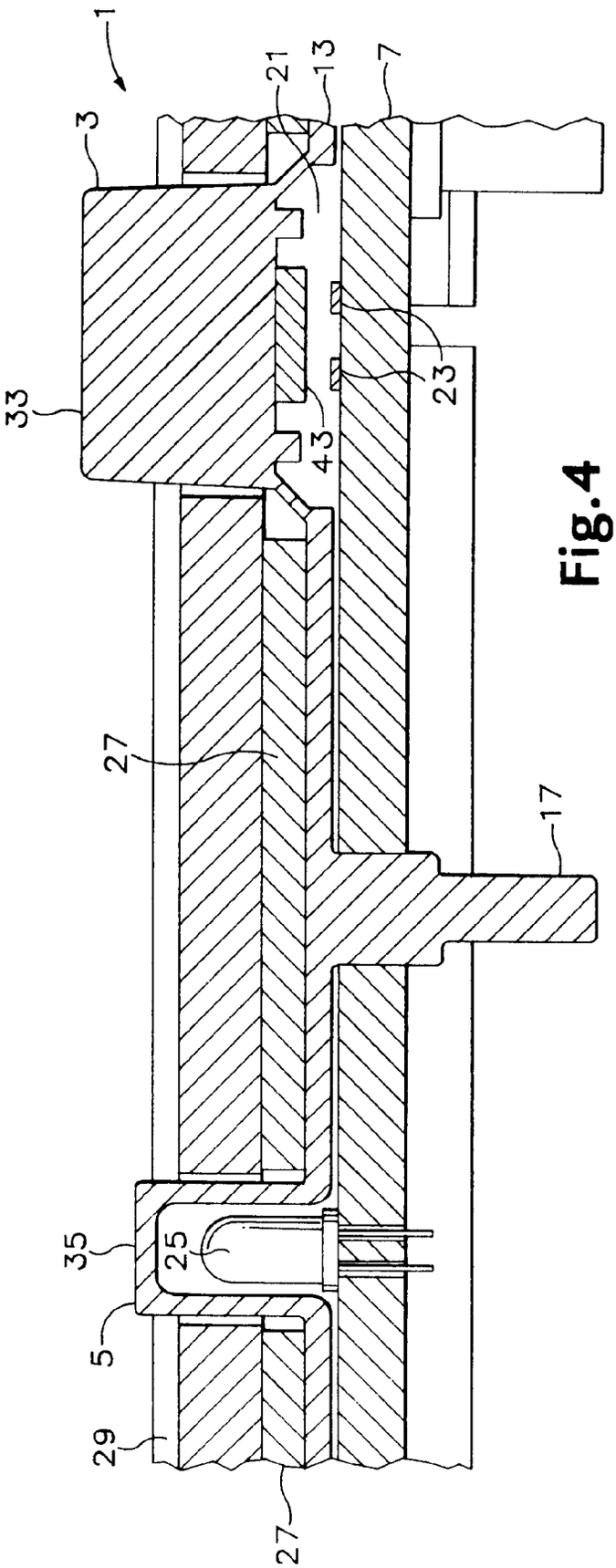

Fig.4

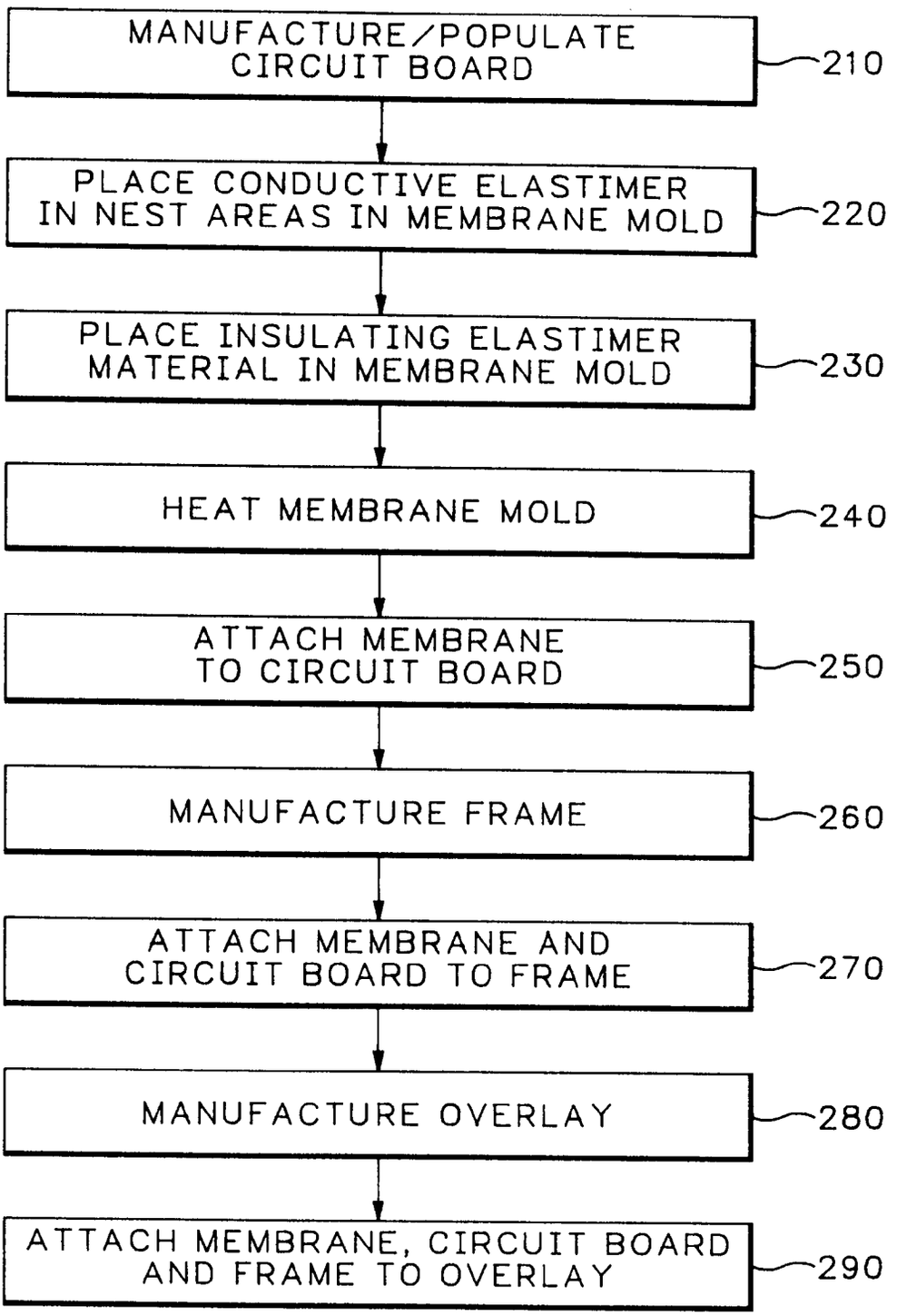
MANUFACTURE/POPULATE CIRCUIT BOARD
210
PLACE CONDUCTIVE ELASTIMER IN NEST AREAS IN MEMBRANE MOLD
220
PLACE INSULATING ELASTIMER MATERIAL IN MEMBRANE MOLD
230
HEAT MEMBRANE MOLD
240
ATTACH MEMBRANE TO CIRCUIT BOARD
250
MANUFACTURE FRAME
260
ATTACH MEMBRANE AND CIRCUIT BOARD TO FRAME
270
MANUFACTURE OVERLAY
280
ATTACH MEMBRANE, CIRCUIT BOARD AND FRAME TO OVERLAY
290

Fig.5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 5266

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-4 636 593 (MOTOROLA INC) 13 January 1987 * column 2, line 13 - column 3, line 22; figures 1,3,4 *	1-3,6,7	H01H13/70
A	GB-A-2 065 373 (SHIN-ETSU) 24 June 1981 * page 1, line 70 - line 93; figures 2,5 *	1-4	
A	GB-A-1 312 740 (STANDARD TELEPHONES AND CABLES) 4 April 1973 * figure *	1	
A	FR-A-2 517 846 (THOMSON.CSF) 10 June 1983 * figure 2 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 January 1996	Janssens De Vroom, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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