(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 October 2014 (02.10.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/160302 A1

(51) International Patent Classification:
H01H 13/70 (2006.01)

(21) International Application Number:
PCT/US2014/026275

(22) International Filing Date:
13 March 2014 (13.03.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/782,131 14 March 2013 (14.03.2013) US
14/203,959 11 March 2014 (11.03.2014) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

[Continued on next page]

(54) Title: A MEMBRANE SWITCH WITH A GAS PERMEABLE, LIQUID IMPERMEABLE LAYER

(57) Abstract: The present disclosure is directed in various embodiments to membrane switches generally. More specifically, a membrane switch is provided that may be exposed to sterilization processes, including vacuum processes without damaging the switch. Thus, the inventive membrane switch comprises a gas permeable, liquid impermeable membrane layer. In various embodiments, the membrane switch may be used in rotational atherectomy systems. However, the membrane switch of the present invention has wide application beyond rotational atherectomy.

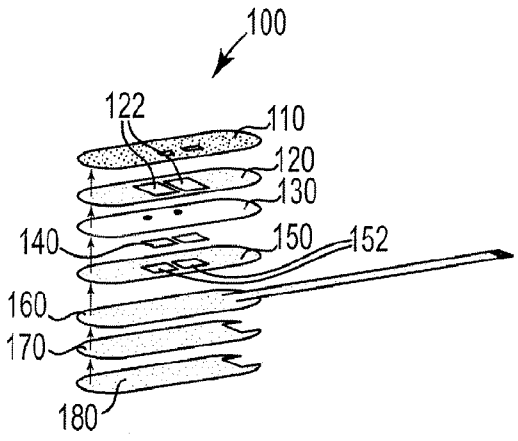

Fig. 1

WO 2014/160302 A1

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

A MEMBRANE SWITCH WITH A GAS PERMEABLE, LIQUID IMPERMEABLE LAYER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to App. Ser. No. 61/782,131, entitled "Devices, Systems and Methods for a Membrane Switch with Permeable Layer," filed March 14, 2013, the entire contents of which are hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] The present disclosure generally relates to devices and systems relating to membrane switches. More specifically, a membrane switch is provided that may be exposed to sterilization processes, including vacuum processes without damaging the switch.

DESCRIPTION OF THE RELATED ART

[0003] Generally, various embodiments of the present invention comprise an improved membrane switch. As the skilled artisan will readily recognize, membrane switches are well known. Thus, the known membrane switch may be described as "a momentary switch device in which at least one contact is on, or made of, a flexible substrate.."

[0004] The known membrane switch typically has 4 or more layers but may have more or fewer. The top layer of a membrane switch is the graphic interface between the user and the machine. The other critical layer is a printed circuit. This can also be a flex circuit made of copper and polyimide material. The layers are normally assembled using pressure sensitive adhesives although inexpensive designs can be held together through other mechanical means such as a keyboard housing. Contact between two traces can be made through a printed shorting pad or through a metal dome that stands on legs.

[0005] Membrane switches may be backlit in certain embodiments. There are three standard methods for back lighting membrane switches.

[0006] The first option is using Light Emitting Diodes (LEDs) to back light. However, LEDs create bright spots and are not suitable for overall back lighting of a panel, but rather as indicator lights. LEDs can either be surface-mounted to the circuit layer or be placed on a separate LED layer.

[0007] A second option is optical fiber. In a typical design, two or more layers of woven fiber-optic cloth are used to form a rectangular light-emitting area. The fibers coming off one end are then bundled into a circular ferrule and coupled to one or more LED light sources. Remote light sources offer 10,000 to 100,000 hours of life. Optical fibers are not affected by extremes in humidity (0% to 100%) or temperature (-40 to +85 deg C).

[0008] The third standard option is to use electroluminescent (EL) lamps. They are lower priced compared to fiber optics and offer additional design flexibility. The color of light emitted from an EL lamp can vary depending on the phosphors that are used. Some common colors are blue/green and yellow/green, white, blue and orange. EL lamps have a half life of approximately 3000–8000 hours depending upon the quality of the phosphor. Once they reach their half life, the brightness starts to fade rapidly. EL lamps are thus not a good choice if the lamp is on for an extended period of time. Fading or flashing could double the life of the lamp.

[0009] As noted herein, applications for layered membrane switches are numerous, including but certainly not limited to rotational atherectomy systems.

[0010] Known applications of layered membrane switches include microwave oven panel, air conditioner control panel, TV remote control etc. Tactile feedback of keys can be provided by embossing the top PET layer or embedding metal snap domes, polyester domes or forming the graphic layer.

[0011] The benefits of membrane switches include ease of cleaning, sealing ability and their low profile. Membrane switch can be used together with other control systems such as

touch screens, keyboards, lighting, and they can also be complicated like the membrane keyboards and switch panels in mobiles and computers.

[0012] Known membrane switches are, however, vulnerable during certain processes, e.g.,. sterilization and the like where vacuum processing is required. The forces generated during, e.g., vacuum processing, are known to damage layered membrane switches. In addition, exposure of the known membrane switches to fluids is a problem resulting in damage to the membrane switch. These vulnerabilities limit the applications in which layered membrane switches may be implemented.

[0013] One environment in which membrane switches may be incorporated includes, without any limitation, rotational atherectomy. A variety of techniques and instruments have been developed for use in the removal or repair of tissue in arteries and similar body passageways. A frequent objective of such techniques and instruments is the removal of atherosclerotic plaques in a patient's arteries. Atherosclerosis is characterized by the buildup of fatty deposits (atheromas) in the intimal layer (under the endothelium) of a patient's blood vessels. Very often over time, what initially is deposited as relatively soft, cholesterol-rich atheromatous material hardens into a calcified atherosclerotic plaque. Such atheromas restrict the flow of blood, and therefore often are referred to as stenotic lesions or stenoses, the blocking material being referred to as stenotic material. If left untreated, such stenoses can cause angina, hypertension, myocardial infarction, strokes and the like.

[0014] Rotational atherectomy procedures have become a common technique for removing such stenotic material. Such procedures are used most frequently to initiate the opening of calcified lesions in coronary arteries. Most often the rotational atherectomy procedure is not used alone, but is followed by a balloon angioplasty procedure, which, in turn, is very frequently followed by placement of a stent to assist in maintaining patentcy of the opened artery. For non-calcified lesions, balloon angioplasty most often is used alone to

open the artery, and stents often are placed to maintain patentcy of the opened artery. Studies have shown, however, that a significant percentage of patients who have undergone balloon angioplasty and had a stent placed in an artery experience stent restenosis-i.e., blockage of the stent which most frequently develops over a period of time as a result of excessive growth of scar tissue within the stent. In such situations an atherectomy procedure is the preferred procedure to remove the excessive scar tissue from the stent (balloon angioplasty being not very effective within the stent), thereby restoring the patentcy of the artery.

[0015] Several kinds of rotational atherectomy devices have been developed for attempting to remove stenotic material. In one type of device, such as that shown in U.S. Pat. No. 4,990,134 (Auth), a burr covered with an abrasive abrading material such as diamond particles is carried at the distal end of a flexible drive shaft. The burr is rotated at high speeds (typically, e.g., in the range of about 150,000-190,000 rpm) while it is advanced across the stenosis. As the burr is removing stenotic tissue, however, it blocks blood flow. Once the burr has been advanced across the stenosis, the artery will have been opened to a diameter equal to or only slightly larger than the maximum outer diameter of the burr. Frequently more than one size burr must be utilized to open an artery to the desired diameter.

[0016] U.S. Pat. No. 5,314,438 (Shturman) discloses another atherectomy device having a drive shaft with a section of the drive shaft having an enlarged diameter, at least a segment of this enlarged surface being covered with an abrasive material to define an abrasive segment of the drive shaft. When rotated at high speeds, the abrasive segment is capable of removing stenotic tissue from an artery. Though this atherectomy device possesses certain advantages over the Auth device due to its flexibility, it also is capable only of opening an artery to a diameter about equal to the diameter of the enlarged abrading surface of the drive shaft since the device is not eccentric in nature.

[0017] U.S. Pat. No. 6,494,890 (Shturman) discloses a known atherectomy device having a drive shaft with an enlarged eccentric section, wherein at least a segment of this enlarged section is covered with an abrasive material. When rotated at high speeds, the abrasive segment is capable of removing stenotic tissue from an artery. The device is capable of opening an artery to a diameter that is larger than the resting diameter of the enlarged eccentric section due, in part, to the orbital rotational motion during high speed operation. Since the enlarged eccentric section comprises drive shaft wires that are not bound together, the enlarged eccentric section of the drive shaft may flex during placement within the stenosis or during high speed operation. This flexion allows for a larger diameter opening during high speed operation, but may also provide less control than desired over the diameter of the artery actually abraded. In addition, some stenotic tissue may block the passageway so completely that the Shturman device cannot be placed therethrough. Since Shturman requires that the enlarged eccentric section of the drive shaft be placed within the stenotic tissue to achieve abrasion, it will be less effective in cases where the enlarged eccentric section is prevented from moving into the stenosis. The disclosure of U.S. Pat. No. 6,494,890 is hereby incorporated by reference in its entirety.

[0018] U.S. Pat No. 5,681, 336 (Clement) provides a known eccentric tissue removing burr with a coating of abrasive particles secured to a portion of its outer surface by a suitable binding material. This construction is limited, however because, as Clement explains at CoI. 3, lines 53-55, that the asymmetrical burr is rotated at "lower speeds than are used with high speed ablation devices, to compensate for heat or imbalance." That is, given both the size and mass of the solid burr, it is infeasible to rotate the burr at the high speeds used during atherectomy procedures, i.e., 20,000-200,000 rpm. Essentially, the center of mass offset from the rotational axis of the drive shaft would result in development of significant centrifugal

force, exerting too much pressure on the wall of the artery and creating too much heat and excessively large particles.

[0019] Generally atherectomy devices utilize a guidewire that extends distally from the distal end of the drive shaft to assist a practitioner in guiding the device through the patient's vasculature and to a desired location for removal of plaque or fatty tissue buildup. A guidewire, whether a new wire or a replacement wire, must be loaded into the atherectomy device such that it is controllable from a proximal end of the atherectomy device by the practitioner. Prior references that disclose methods and devices for loading a tubular member into a device include U.S. Pat. No. 3,370,150 (Nordgren); U.S. Pat. No. 4,851,694 (Rague); U.S. Pat. No. 5,540,649 (Bonnell); U.S. Pat. No. 5,779,623 (Bonnell); U.S. Pat No. 6,828,523 (Gysi); U.S. Pat. Pub. No. 2004/0254566 (Plicchi); U.S. Pat. Pub. No. 2006/0161043 (Neumann); U.S. Pat. Pub. No. 2007/0299305 (Murakami); and U.S. 2009/0326449 (Wang), all of which are incorporated herein by reference. These prior art disclosures generally teach in relevant part, devices and systems enabling two-way axial translation of a tubular member using motorized rollers wherein one of the rollers is spring loaded (biased toward the opposite rollers) to increase fit and contact with the tubular member. Additionally, U.S. Pat. Pub. No. 2010/0234873 (Nagano), which is incorporated herein by reference, discloses a drive device for driving a linear body having flexibility, wherein the force applied to drive the linear body only in an axial direction and the pressure applied to a spring is determined and adjusted by a control unit. U.S. Pat. Pub. No. 2012/0232476 (Bhat), which is incorporated herein by reference, discloses a steering system having two radially oppositely arranged driving wheels for steering a tubular member, the drive wheels having a plurality of rollers distributed around a wheel rotation axis of the drive wheels. U.S. Pat. No. 7,955,252 (Suzuki), which is incorporated herein by reference, discloses a treatment tool insertion-retraction and rotating device, the device having a holding member disposed between the

treatment tool and a pair of rollers. U.S. Pat. No. 6,786,727 (Irion), which is incorporated herein by reference, discloses a holding device with a fixed gear arrangement with bevel gears to apply a fixed pressure onto an instrument. U.S. Pat. Pub. 2012/0071821 (Yu), which is incorporated herein by reference, discloses a device and method for manipulating an elongated member by actuating rotary members in opposite linear directions to generate rotational motion and actuating rotary members in opposite rotational directions to generate linear motion.

[0020] Thus, a need exists in the art generally for a layered membrane switch and further comprising a gas permeable, but liquid impermeable, polymer. This polymer solves several nagging problems currently experienced by layered membrane switches. More specifically, rotational atherectomy devices and systems have need of a layered membrane switch and further comprising a gas permeable, but liquid impermeable, polymer. The present invention addresses these, among other, needs.

BRIEF SUMMARY OF THE INVENTION

[0021] The present system is directed in various embodiments to membrane switches generally. More specifically, a membrane switch is provided that may be exposed to sterilization processes, including vacuum processes without damaging the switch. Thus, the inventive membrane switch comprises a gas permeable, liquid impermeable membrane layer. In various embodiments, the membrane switch may be used in rotational atherectomy systems. However, the membrane switch of the present invention has wide application beyond rotational atherectomy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. 1 illustrates an exploded view of one embodiment of the present invention.

DETAILED DESCRIPTION

[0023] While the invention is amenable to various modifications and alternative forms, specifics thereof are shown by way of example in the drawings and described in detail herein. It should be understood, however, that the intention is not to limit the invention to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention.

[0024] The present invention provides a layered membrane switch and further comprising a gas permeable, but liquid impermeable, membrane layer. This membrane layer may comprise a polymer and solves several nagging problems currently experienced by layered membrane switches.

[0025] First, the present invention allows for the layered membrane switch with the gas permeable and liquid impermeable membrane layer to be exposed to processes such as sterilization and/or vacuum processes that create forces that would otherwise damage known layered membrane switches.

[0026] Second, the present invention allows the layered membrane switch with gas permeable and liquid impermeable membrane layer to be exposed to liquids. Such exposure damages currently known layered membrane switches.

[0027] Third, the present invention allows gases to penetrate the layered membrane switch.

[0028] Among other things, the addition of the gas permeable and liquid impermeable membrane layer to the layered membrane switch to create the present invention allows equalization of internal switch pressures with the external pressures outside of the switch, while resisting exposure of the internal switch membrane materials and components to damaging fluids.

[0029] Various embodiments of the present invention comprising a membrane switch may be incorporated into the control electronics of a rotational atherectomy system as described generally in U.S. Pat. No. 6,494,890, entitled "ECCENTRIC ROTATIONAL ATHERECTOMY DEVICE," which is incorporated herein by reference. Additionally, the disclosure of the following co-owned patents or patent applications are herein incorporated by reference in their entireties: U.S. Pat. No. 6,295,712, entitled "ROTATIONAL ATHERECTOMY DEVICE"; U.S. Pat No. 6,132,444, entitled "ECCENTRIC DRIVE SHAFT FOR ATHERECTOMY DEVICE AND METHOD FOR MANUFACTURE"; U.S. Pat. No. 6,638,288, entitled "ECCENTRIC DRIVE SHAFT FOR ATHERECTOMY DEVICE AND METHOD FOR MANUFACTURE"; U.S. Pat. No. 5,314,438, entitled "ABRASIVE DRIVE SHAFT DEVICE FOR ROTATIONAL ATHERECTOMY"; U.S. Pat. No. 6,217,595, entitled "ROTATIONAL ATHERECTOMY DEVICE"; U.S. Pat. No. 5,554,163, entitled "ATHERECTOMY DEVICE"; U.S. Pat. No. 7,507,245, entitled "ROTATIONAL ANGIOPLASTY DEVICE WITH ABRASIVE CROWN"; U.S. Pat. No. 6,129,734, entitled "ROTATIONAL ATHERECTOMY DEVICE WITH RADIALLY EXPANDABLE PRIME MOVER COUPLING"; U.S. Pat. No. 8,597,313, entitled "ECCENTRIC ABRADING HEAD FOR HIGH-SPEED ROTATIONAL ATHERECTOMY DEVICES"; U.S. Pat No. 8,439,937, entitled "SYSTEM, APPARATUS AND METHOD FOR OPENING AN OCCLUDED LESION"; U.S. Pat. Pub. No. 2009/0299392, entitled "ECCENTRIC ABRADING ELEMENT FOR HIGH-SPEED ROTATIONAL ATHERECTOMY DEVICES"; U.S. Pat. Pub. No. 2010/0198239, entitled "MULTI-MATERIAL ABRADING HEAD FOR ATHERECTOMY DEVICES HAVING LATERALLY DISPLACED CENTER OF MASS"; U.S. Pat. Pub. No. 2010/0036402, entitled "ROTATIONAL ATHERECTOMY DEVICE WITH PRE-CURVED DRIVE SHAFT"; U.S. Pat. Pub. No. 2009/0299391, entitled "ECCENTRIC ABRADING AND

CUTTING HEAD FOR HIGH-SPEED ROTATIONAL ATHERECTOMY DEVICES"; U.S. Pat. Pub. No. 2010/0100110, entitled "ECCENTRIC ABRADING AND CUTTING HEAD FOR HIGH-SPEED ROTATIONAL ATHERECTOMY DEVICES"; U.S. Design Pat. No. D610258, entitled "ROTATIONAL ATHERECTOMY ABRASIVE CROWN"; U.S. Design Pat. No. D6107102 , entitled "ROTATIONAL ATHERECTOMY ABRASIVE CROWN"; U.S. Pat. Pub. No. 2009/0306689, entitled "BIDIRECTIONAL EXPANDABLE HEAD FOR ROTATIONAL ATHERECTOMY DEVICE"; U.S. Pat. Pub. No. 2010/0211088, entitled "ROTATIONAL ATHERECTOMY SEGMENTED ABRADING HEAD AND METHOD TO IMPROVE ABRADING EFFICIENCY"; U.S. Pat. Pub. No. 2013/0018398, entitled "ROTATIONAL ATHERECTOMY DEVICE WITH ELECTRIC MOTOR"; and U.S. Pat. No. 7,666,202, entitled "ORBITAL ATHERECTOMY DEVICE GUIDE WIRE DESIGN." It is contemplated by this invention that the features of one or more of the embodiments of the present invention may be combined with one or more features of the embodiments of atherectomy devices described therein; specifically the membrane switch of the present invention may be incorporated into the handle electronics and control systems of the rotational atherectomy systems described in the references above.

[0030] FIG. 1 illustrates an exploded view of an exemplary embodiment 100 of the present invention, with the arrows indicating the adhesion of adjacent layers following assembly. Thus, the following layers are provided, as illustrated from top layer 110 to the bottom layer 180, each layer affixed to the most adjacent layer(s) with adhesives or the equivalent and as will be readily understood by the skilled artisan:

[0031] Graphic overlay layer 110, illustrated as the top most layer.

[0032] Graphic mounting layer 120, affixed to the graphic overlay layer 110 and further comprising two actuator cutouts 122.

[0033] Dome holder layer 130, affixed to the graphic mounting layer 120. Thus, graphic mounting layer 120 is effectively sandwiched between adjacent graphic overlay layer 110 and adjacent dome holder layer 130.

[0034] Dome spacers 140, as illustrated two dome spacers 140, affixed to the tail filler layer 150, tail filler layer 150 further comprising two dome spacer cutouts 152, wherein each dome spacer 140 is aligned with a dome spacer cutout 152, and wherein the tail filler layer 150 is affixed to the dome holder layer 130.

[0035] Actuable circuit layer 160 comprising required actuable switching circuitry as known by the skilled artisan, wherein the dome spacer cutouts 152 and dome spacers 140 are aligned with actuable circuitry, the circuit layer 160 affixed to the tail filler layer 150.

[0036] Gas permeable and liquid impermeable membrane layer 170, affixed to the adjacent circuit layer 160 and to the adjacent mounting adhesive layer 180. Thus, circuit layer 160, as illustrated is sandwiched between the tail filler layer 150 and the gas permeable and liquid impermeable membrane layer 170.

[0037] Mounting adhesive layer 180, affixed to the adjacent gas permeable, liquid impermeable membrane layer 170. Accordingly, the gas permeable, liquid impermeable membrane layer 170 is sandwiched between adjacent mounting adhesive layer 180 and adjacent circuit layer 160.

As illustrated, the exemplary and assembled membrane switch 100 thus comprises:

a graphic overlay layer 110;

a graphic mounting layer 120 disposed below the graphic overlay layer 110 and affixed thereto;

a dome holder layer 130 disposed below the graphic mounting layer 120 and affixed thereto;

a tail filler layer 150 disposed below the dome holder layer 130 and affixed thereto;

an actuable circuit layer 160 disposed below the tail filler layer 150 and affixed thereto;

a gas permeable, liquid impermeable membrane layer 170 disposed below the actuable circuit layer 160 and affixed thereto; and

a mounting adhesive layer 180 disposed below the gas permeable, liquid impermeable membrane layer 170 and affixed thereto.

[0038]

[0039] The skilled artisan will readily recognize alternative arrangements for the exemplary membrane switch 100, including modifying the location of the gas permeable, liquid impermeable membrane layer 170 within the exemplary switch 100, as well as providing more than one gas permeable, liquid impermeable membrane layer 170 within exemplary switch 100. Each such alternative is within the scope of the present invention.

[0040] Turning to the gas permeable, liquid impermeable membrane layer 170, the material utilized for membrane layer 170 must exhibit the properties of being both liquid impermeable and gas permeable. Thin expanded plastic membranes may exhibit these two properties, having generally a thickness that is less than 2 millimeters while further comprising microscopically minute pores which are small enough to permit the passage of gases therethrough, but not liquid molecules, e.g., and without limitation, water molecules. Some exemplary thin expanded plastic membranes include expanded polyurethane films, polytetrafluorethylene (PTFE), polypropylene and polyethylene. Other materials may readily present themselves to the skilled artisan, each such gas permeable, liquid impermeable material is within the scope of the present invention.

[0041] The present invention should not be considered limited to the particular examples described above, but rather should be understood to cover all aspects of the invention. Various modifications, equivalent processes, as well as numerous structures to which the present invention may be applicable will be readily apparent to those of skill in the art to which the present invention is directed upon review of the present specification.

WHAT IS CLAIMED IS:

1. A membrane switch, comprising an actuable circuit layer and a gas permeable, liquid impermeable membrane layer adjacent to and affixed to the circuit layer.

2. The membrane switch of claim 1, the membrane switch of claim 1 further comprising a mounting adhesive layer adjacent to and affixed to the gas permeable, liquid impermeable membrane layer, the gas permeable, liquid impermeable membrane layer sandwiched between the mounting adhesive layer and the actuable circuit layer.

3. The membrane switch of claim 1, the gas permeable, liquid impermeable membrane layer comprises a thin expanded plastic having microscopic pores that prevent liquid molecules from passing therethrough while allowing gas molecules to pass therethrough.

4. The membrane switch of claim 3, wherein the thickness of the thin expanded plastic is less than two millimeters.

5. The membrane switch of claim 3, wherein the thin expanded plastic comprises polyurethane.

6. The membrane switch of claim 3, wherein the thin expanded plastic comprises polypolytetrafluorethylene.

7. The membrane switch of claim 3, wherein the thin expanded plastic comprises polypropylene.

8. The membrane switch of claim 3, wherein the thin expanded plastic comprises polyethylene.

9. The membrane switch of claim 2, further comprising:

a graphic overlay layer;

a graphic mounting layer disposed below the graphic overlay layer and affixed thereto;

a dome holder layer disposed below the graphic mounting layer and affixed thereto;

a tail filler layer disposed below the dome holder layer and affixed thereto;

the actuable circuit layer disposed below the tail filler layer and affixed thereto;

the gas permeable, liquid impermeable membrane layer disposed below the actuable circuit layer and affixed thereto; and

the mounting adhesive layer disposed below the gas permeable, liquid impermeable membrane layer and affixed thereto.

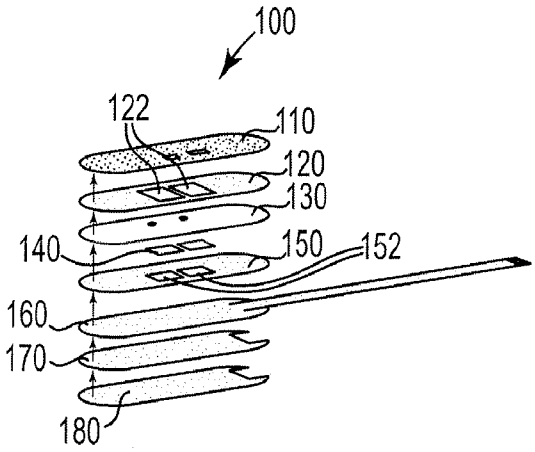

Fig. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/026275

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H01H 13/70 (2014.01)
USPC - 200/515
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)
IPC(8) - A61B 17/00; H01H 13/70, 13/702, 13/712, 13/785; H02J 7/00 (2014.01)
USPC - 200/5A, 306, 512, 515

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - H01H 13/702 (2014.02)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, Google Patent, Google

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 6,144,003 A (KAMISHIMA) 07 November 2000 (07.11.2000) entire document	1-8 ----- 9
Y	US 4,958,148 A (OLSON) 18 September 1990 (18.09.1990) entire document	9
A	US 4,580,018 A (YOSHIHARA) 01 April 1986 (01.04.1986) entire document	1-9

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published 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; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 June 2014	18 JUL 2014
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized ..... Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)