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(54) **BLOOD PRESSURE MONITOR CUFF, METHOD FOR MANUFACTURING THE SAME, AND BLOOD PRESSURE MONITOR**

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(57) **ABSTRACT**

(21) Appl. No.: **15/908,734**

A blood pressure monitor cuff is formed by stacking an outer circumferential layer arranged on a side opposite to that of a measurement site and a fluid bladder arranged on the measurement site side. The outer circumferential layer and the fluid bladder are formed of an elastomer material. Two edge portions in a lengthwise direction of the outer circumferential layer protrude in a thickness direction toward the measurement site. The fluid bladder includes a base layer that opposes the outer circumferential layer and a top layer overlapping with the base layer, and the edge portions of the base layer and the top layer are welded together forming a bladder shape. Additional sheets are welded in the thickness direction to the welded edge portions of the top layer and the base layer. The fluid bladder is arranged between the two edge portions of the outer circumferential layer in the width direction.

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**Foreign Application Priority Data**

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Dec. 26, 2016 (JP) ..... 2016-251972

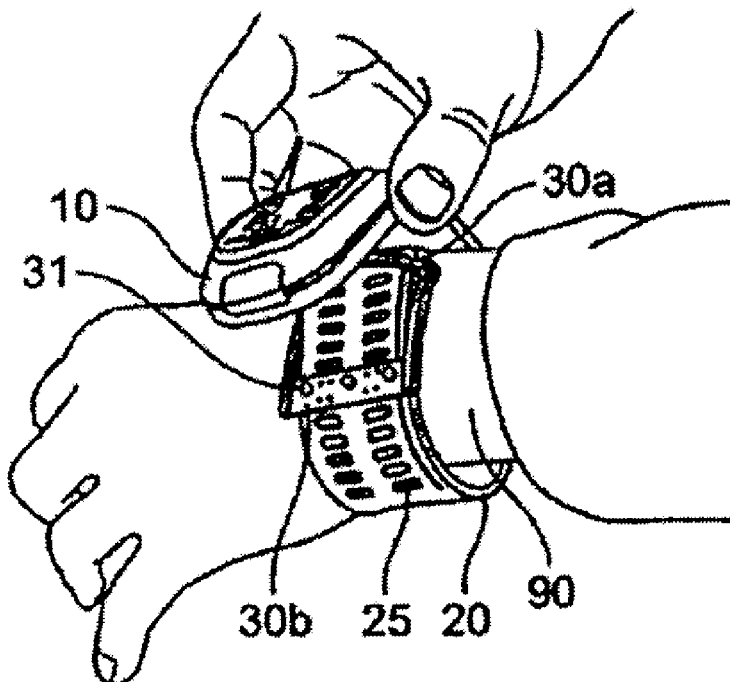


FIG. 1A

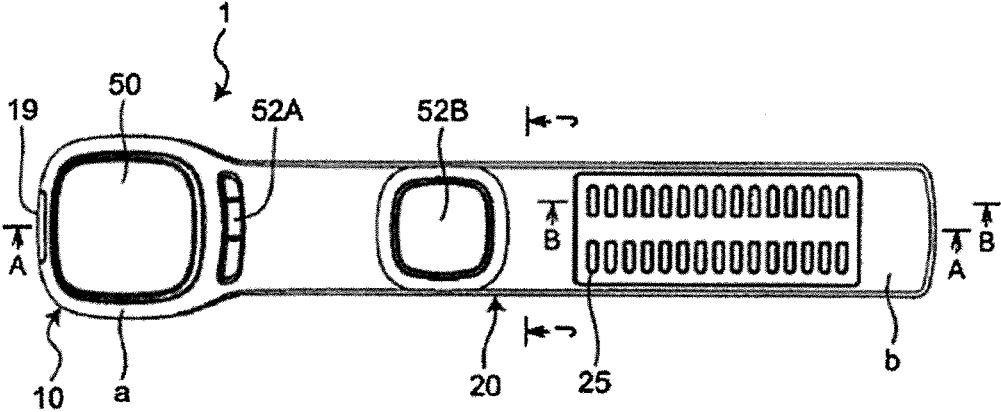


FIG. 1B

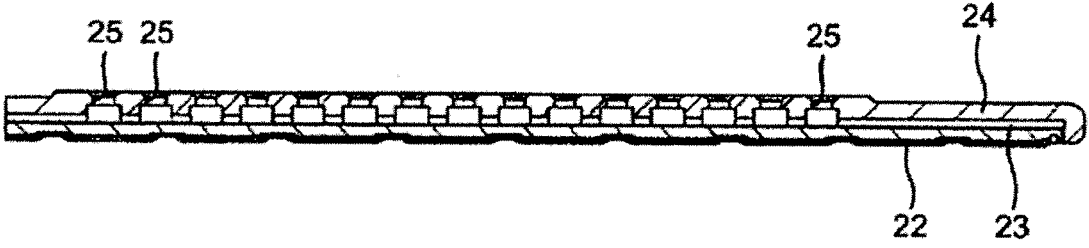


FIG. 1C

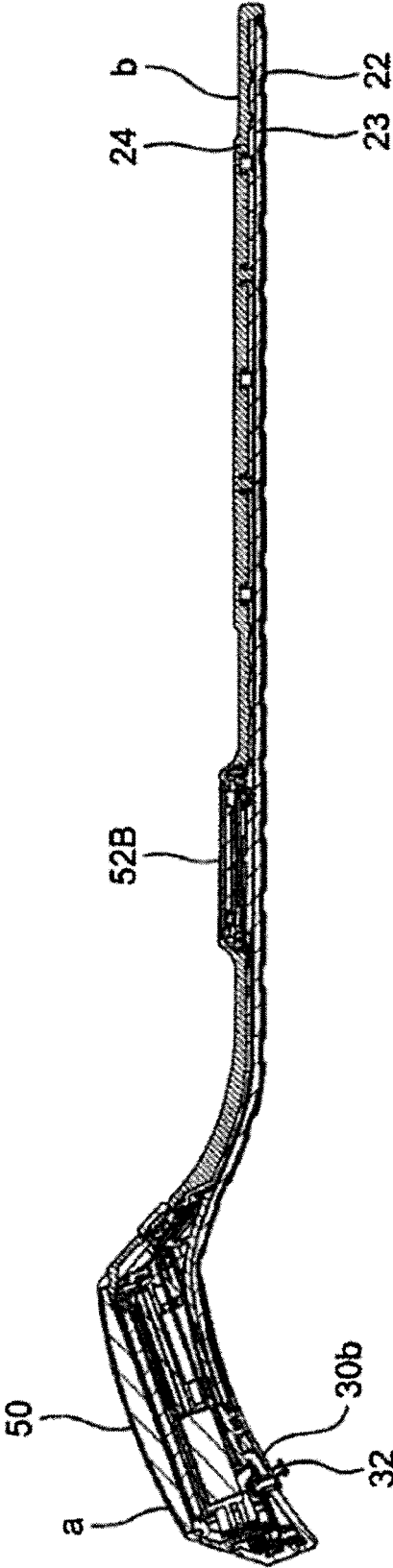




FIG. 3

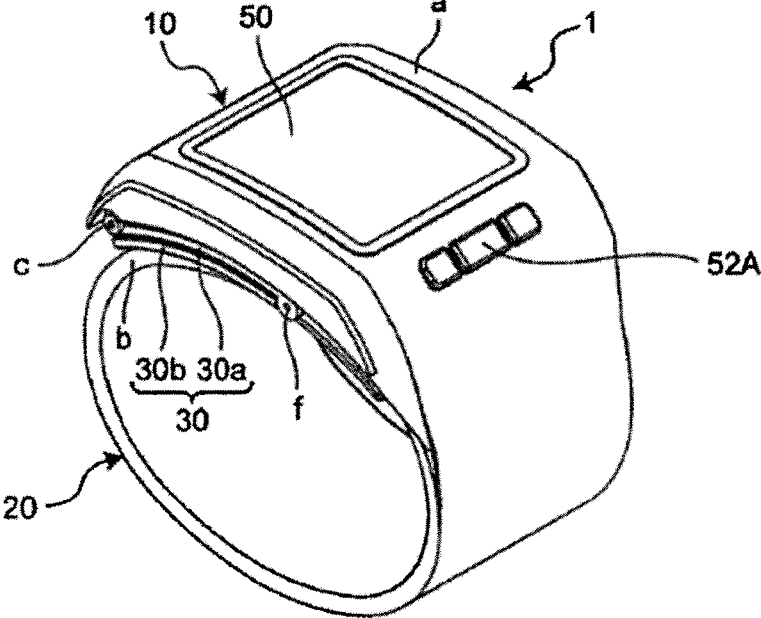


FIG. 4

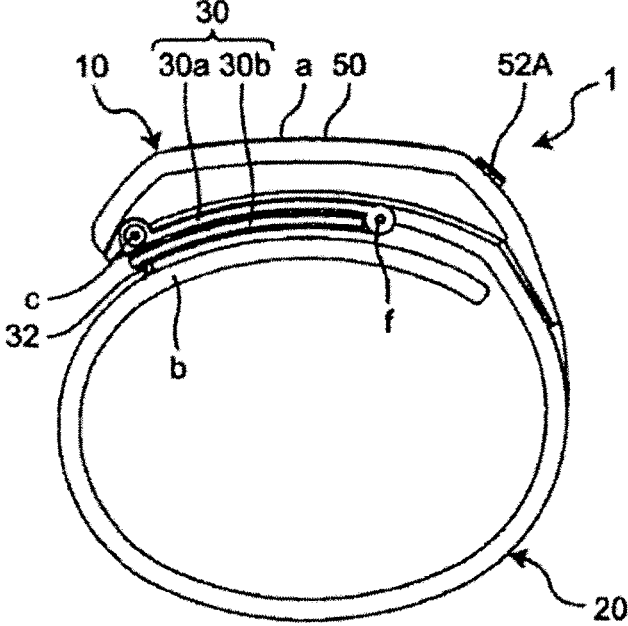


FIG. 5

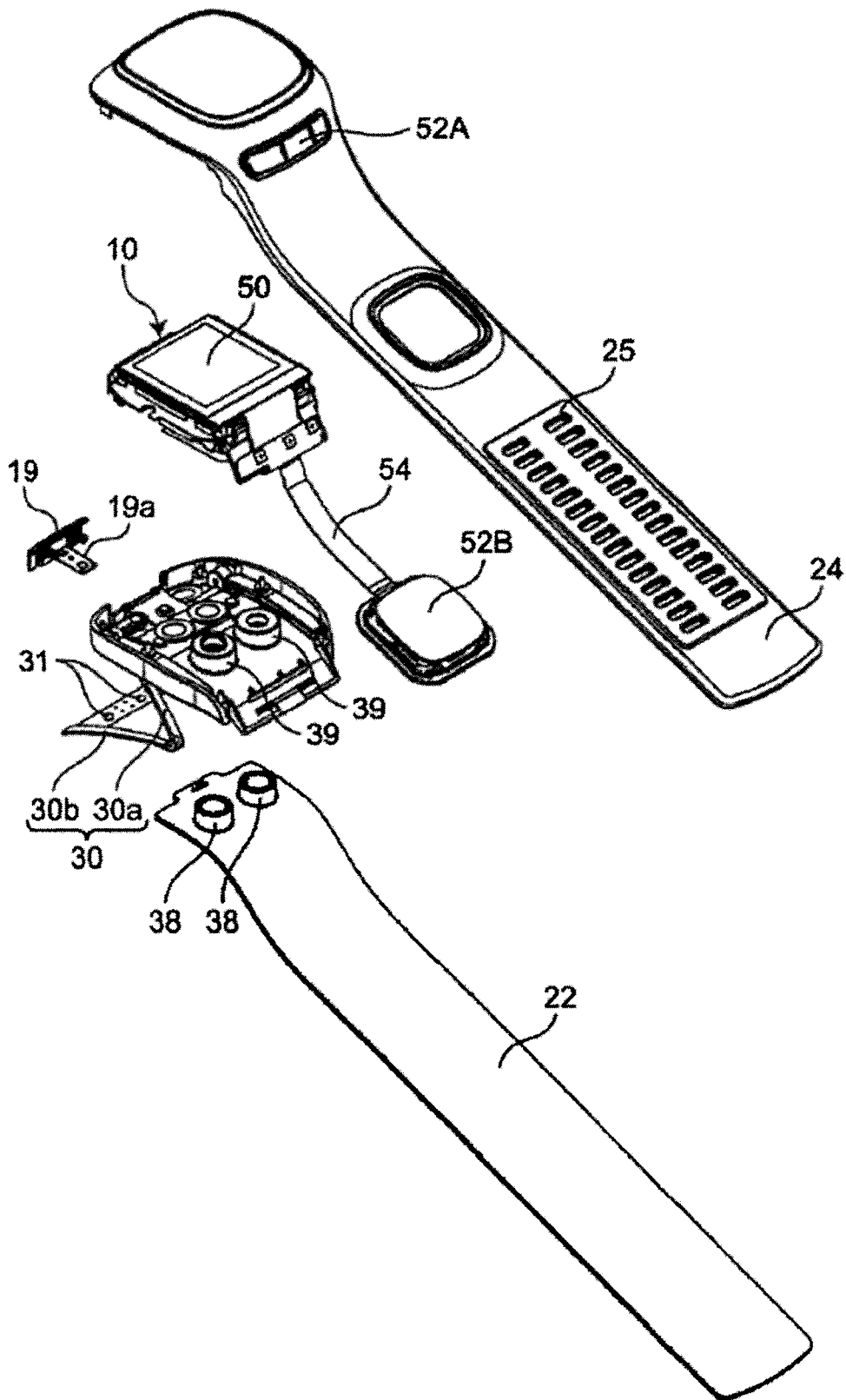


FIG. 6A

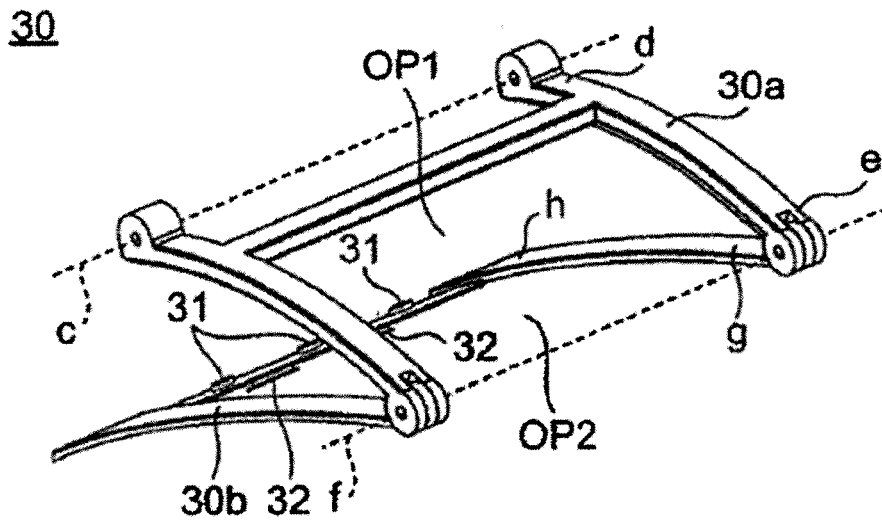


FIG. 6B

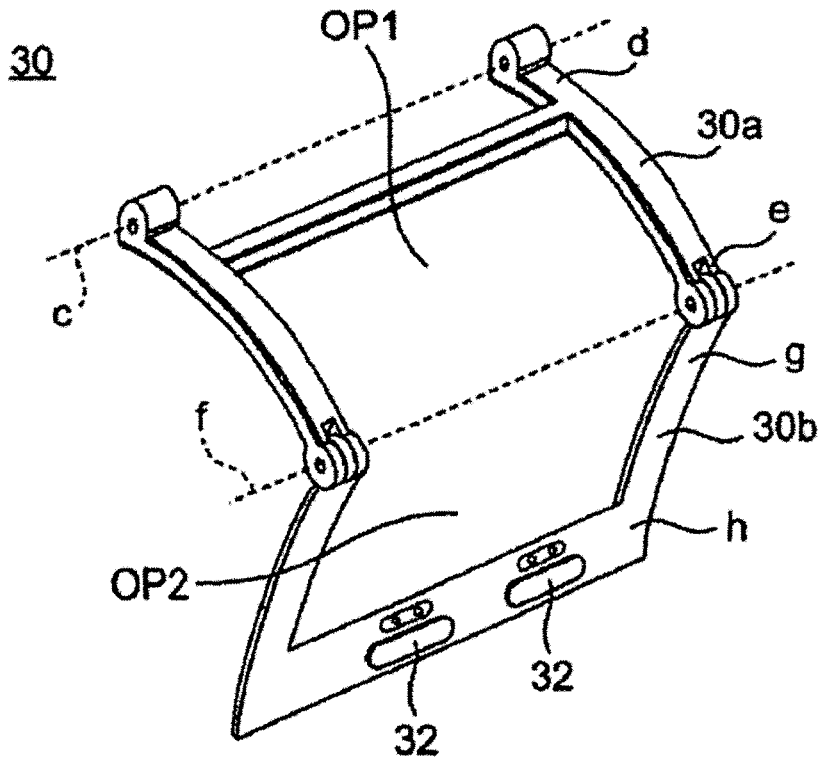


FIG. 7A

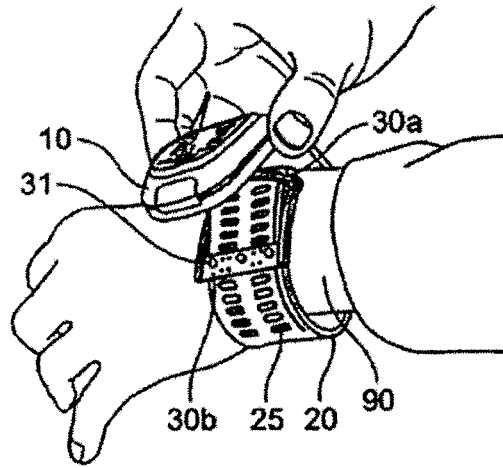


FIG. 7B

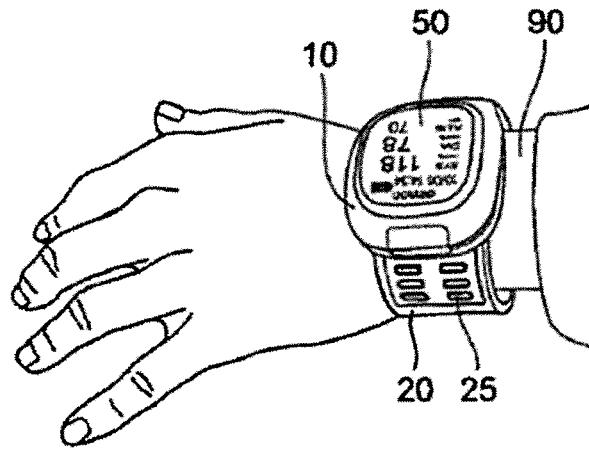


FIG. 7C

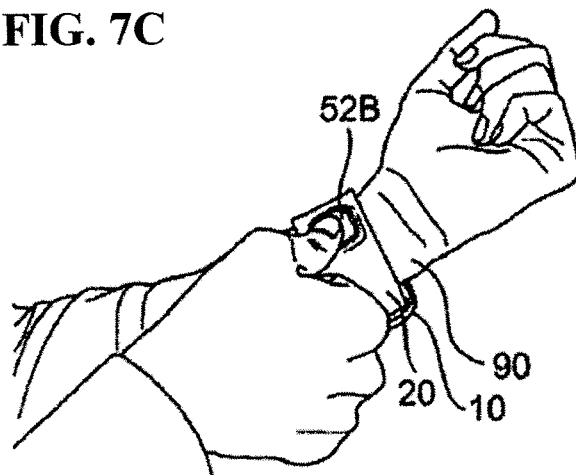




FIG. 8

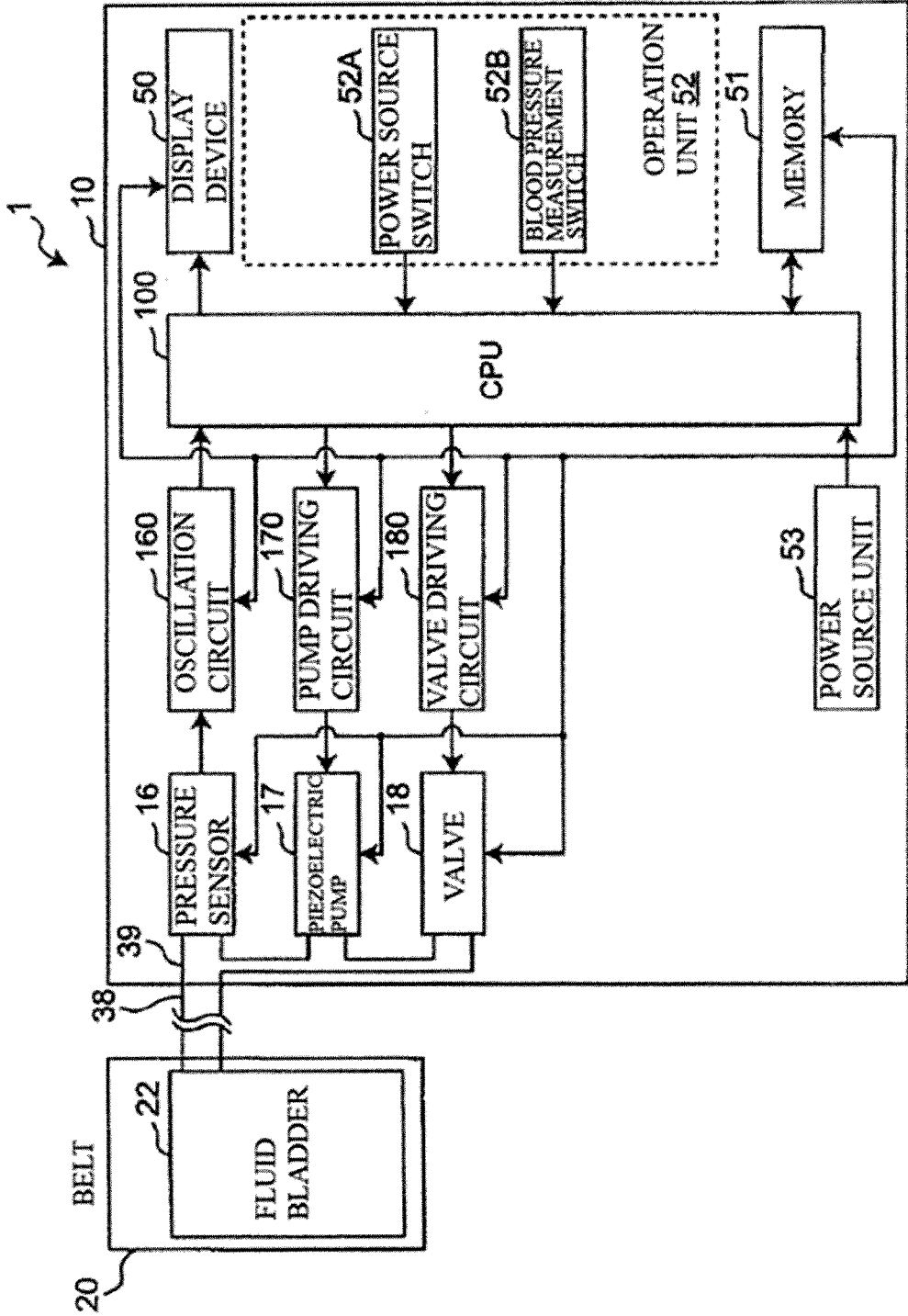


FIG. 9

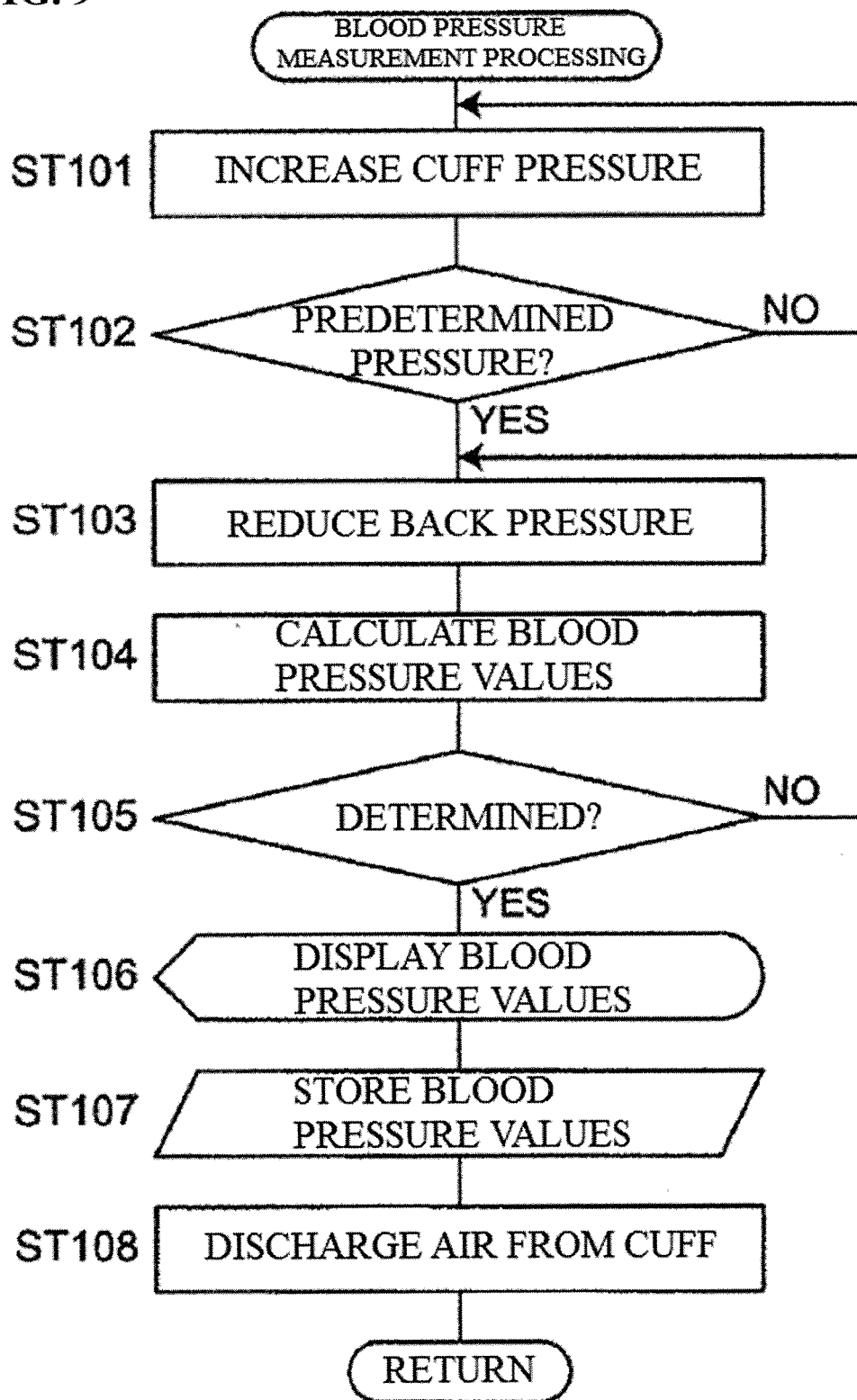


FIG. 10A

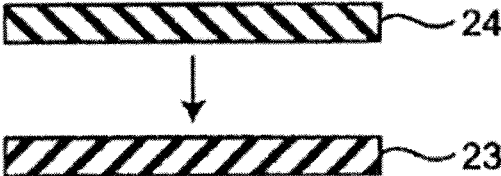


FIG. 10B

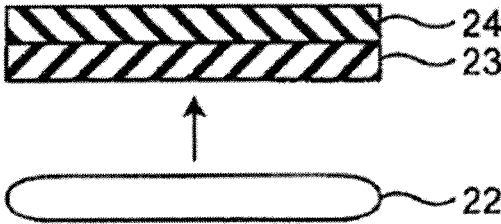


FIG. 10C



FIG. 11A

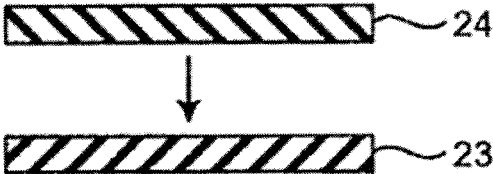


FIG. 11B

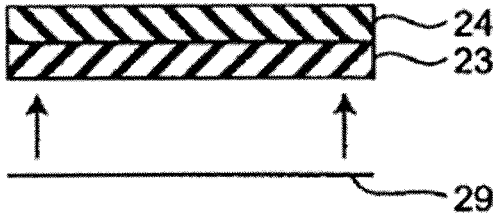


FIG. 11C

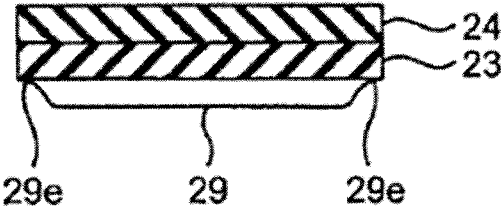


FIG. 12A

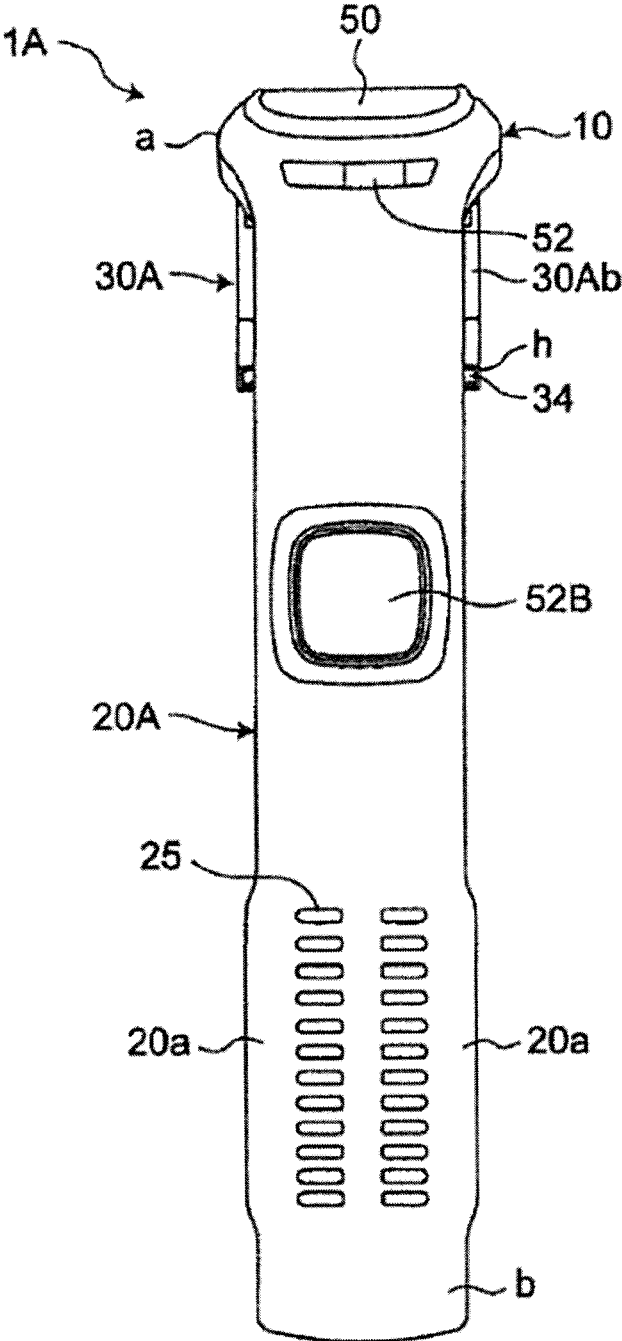


FIG. 12B

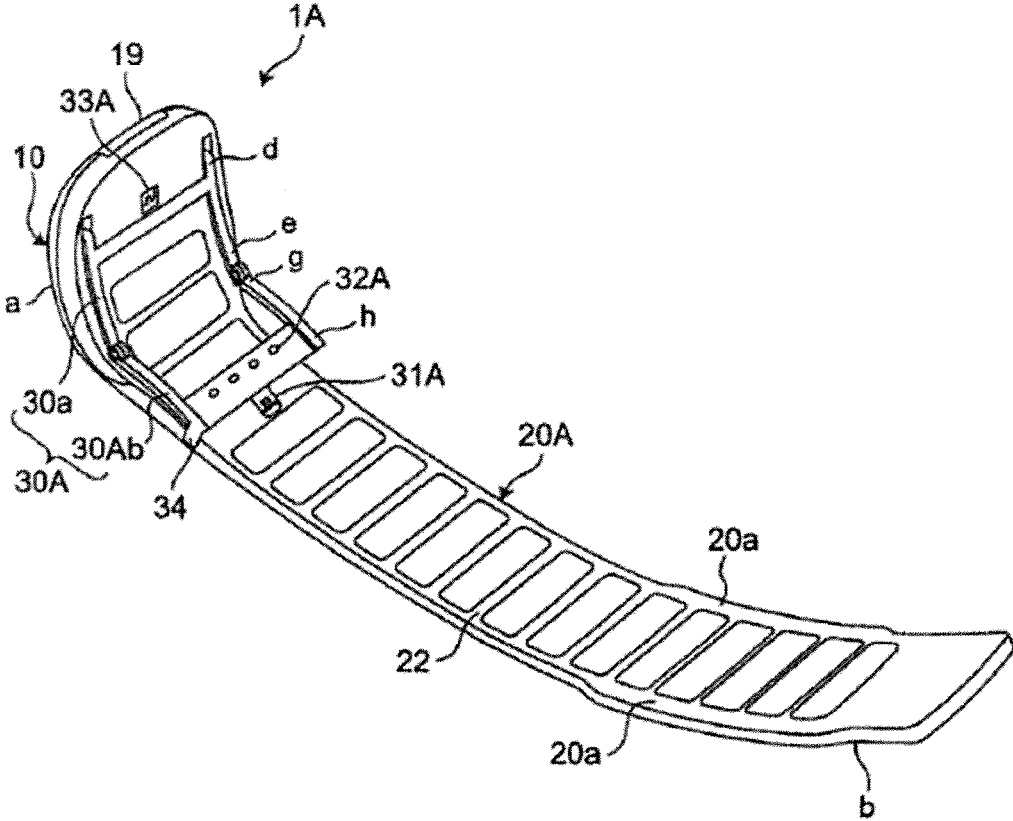


FIG. 12C

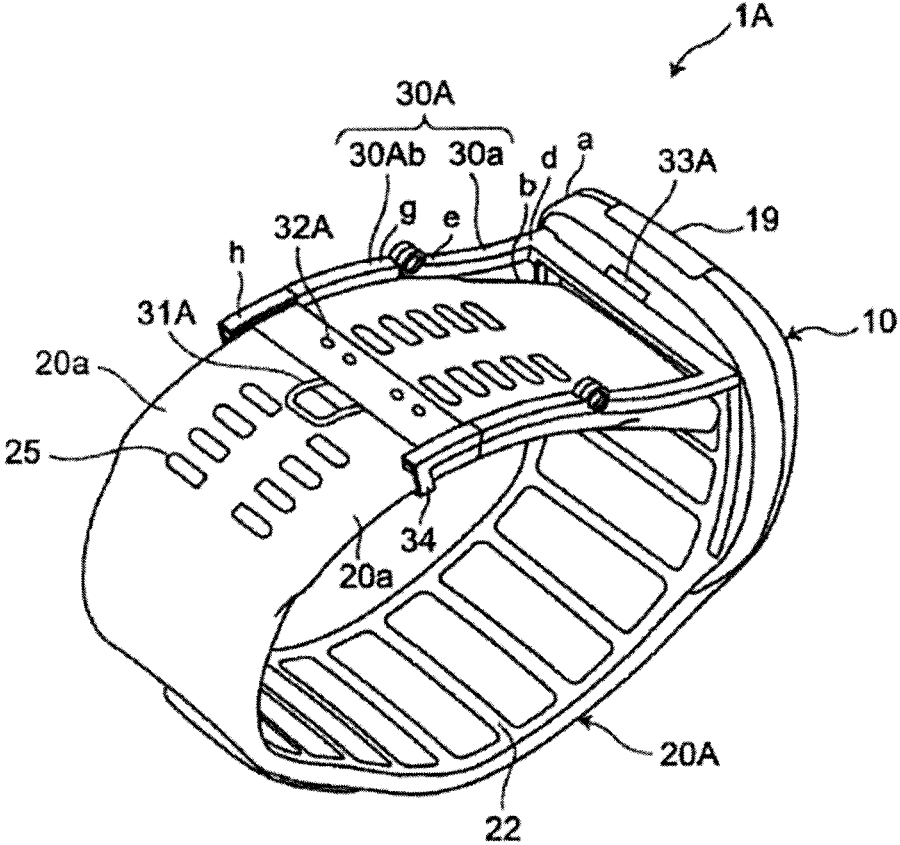


FIG. 13A

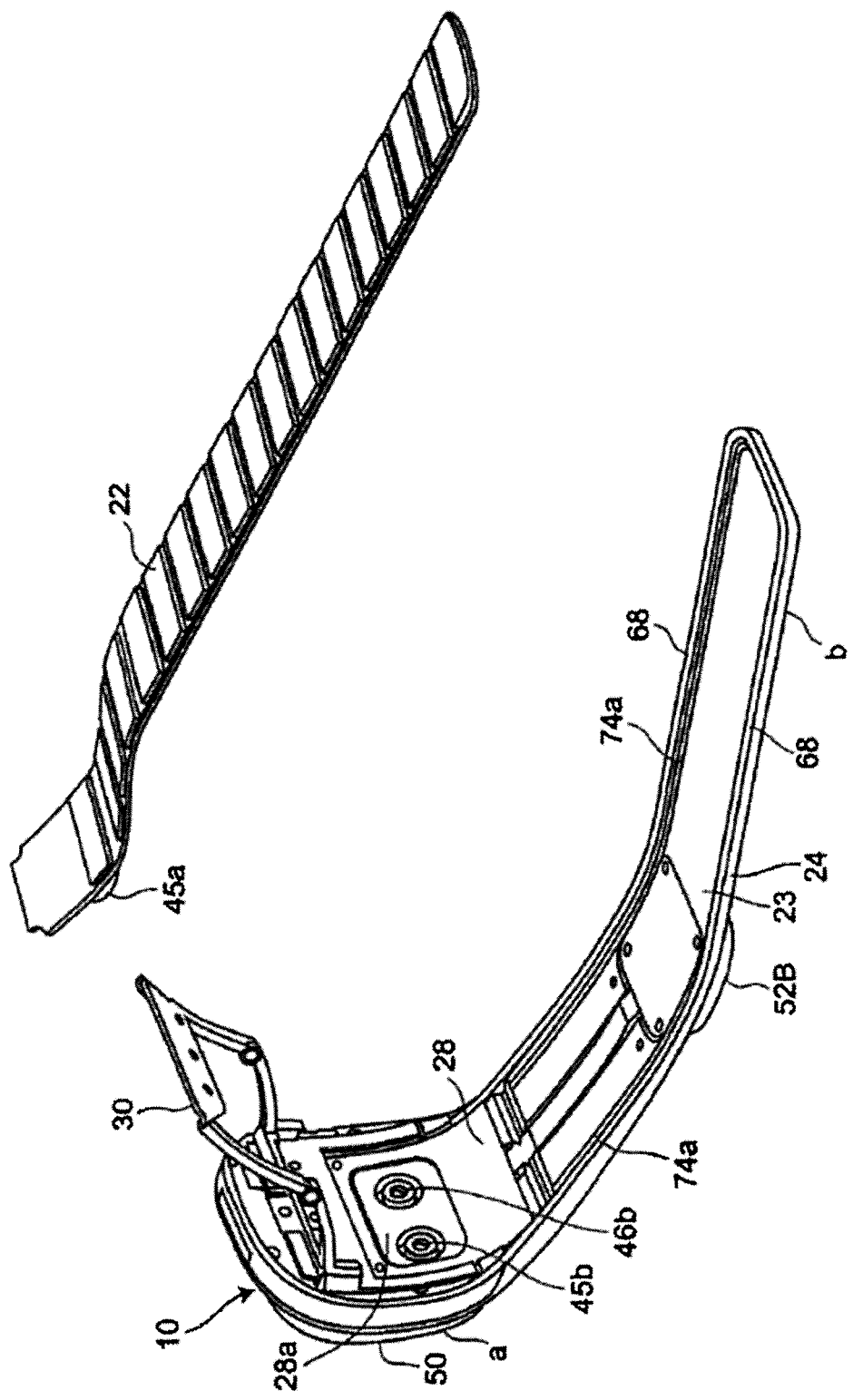




FIG. 13B

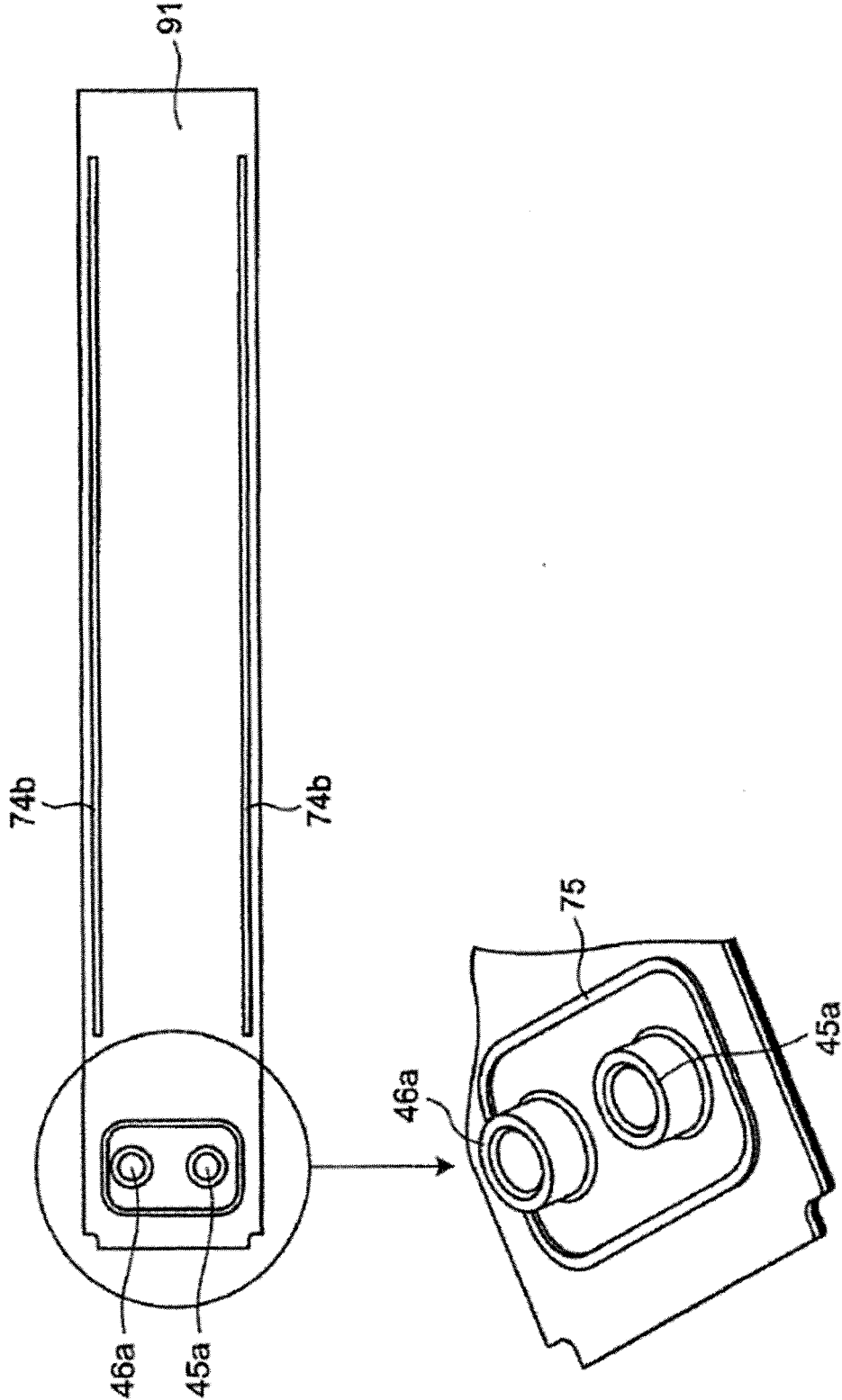


FIG. 13C

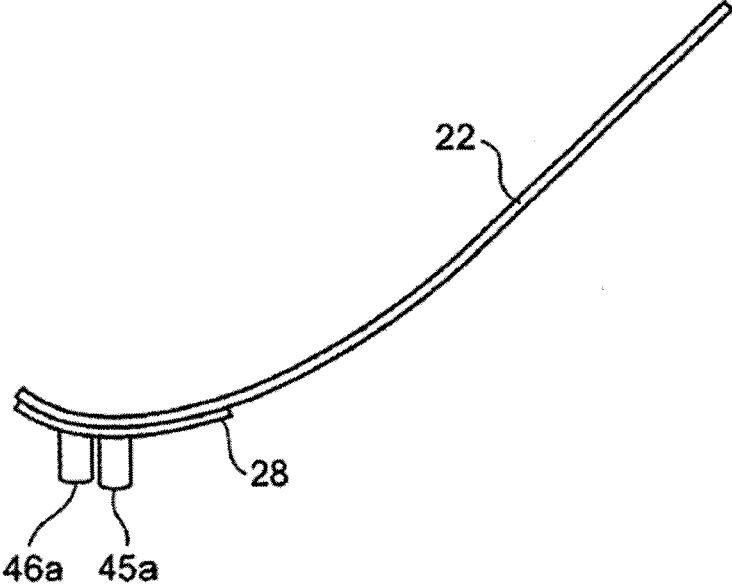


FIG. 13D

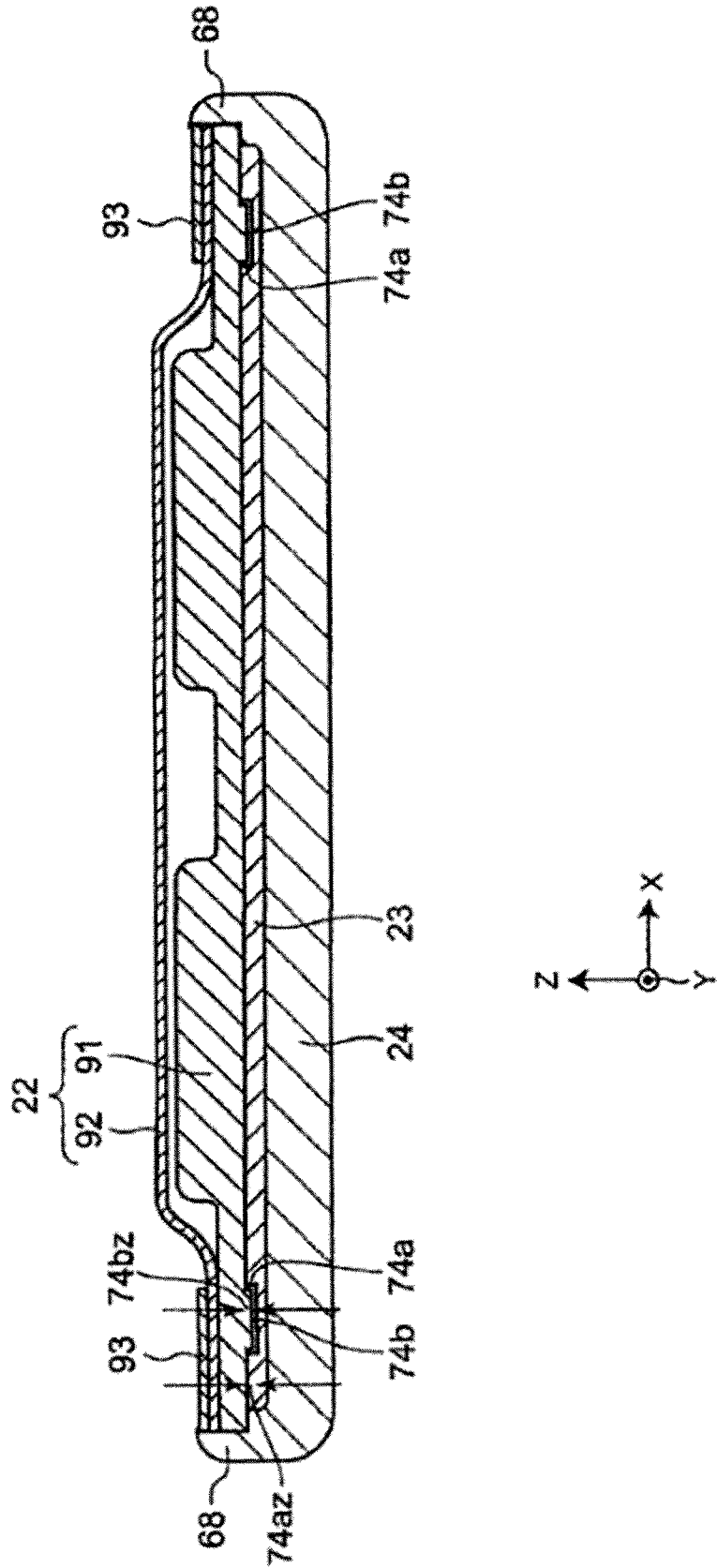


FIG. 14A

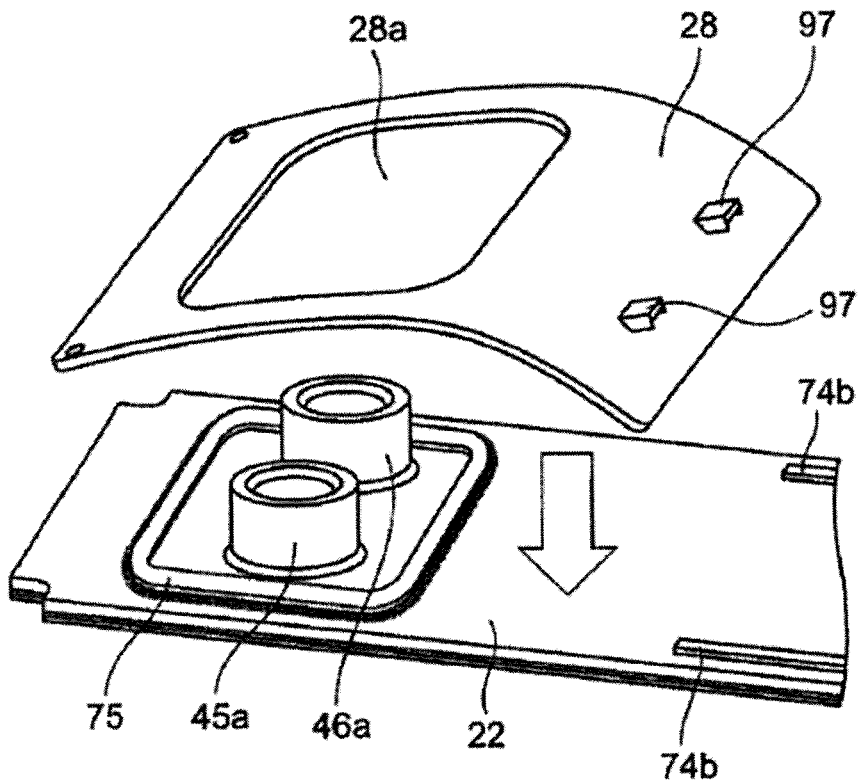


FIG. 14B

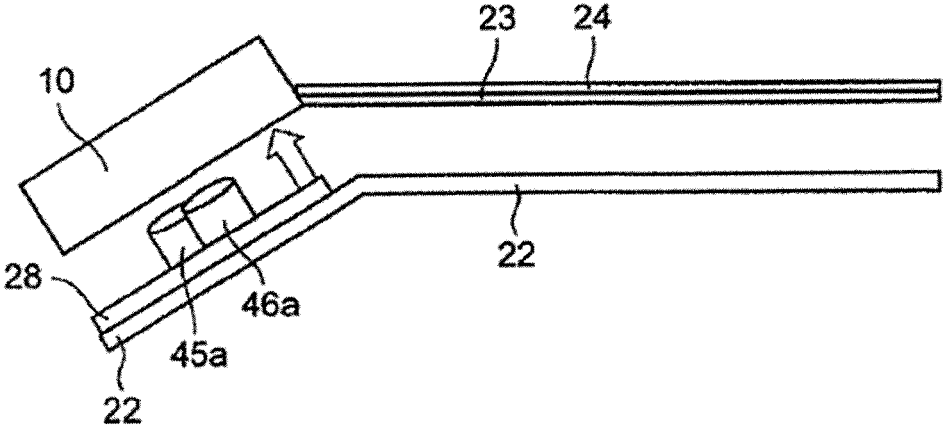


FIG. 14C

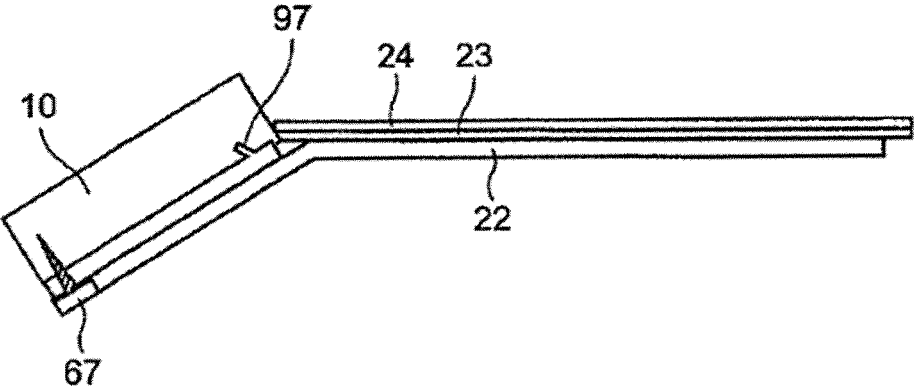


FIG. 14D

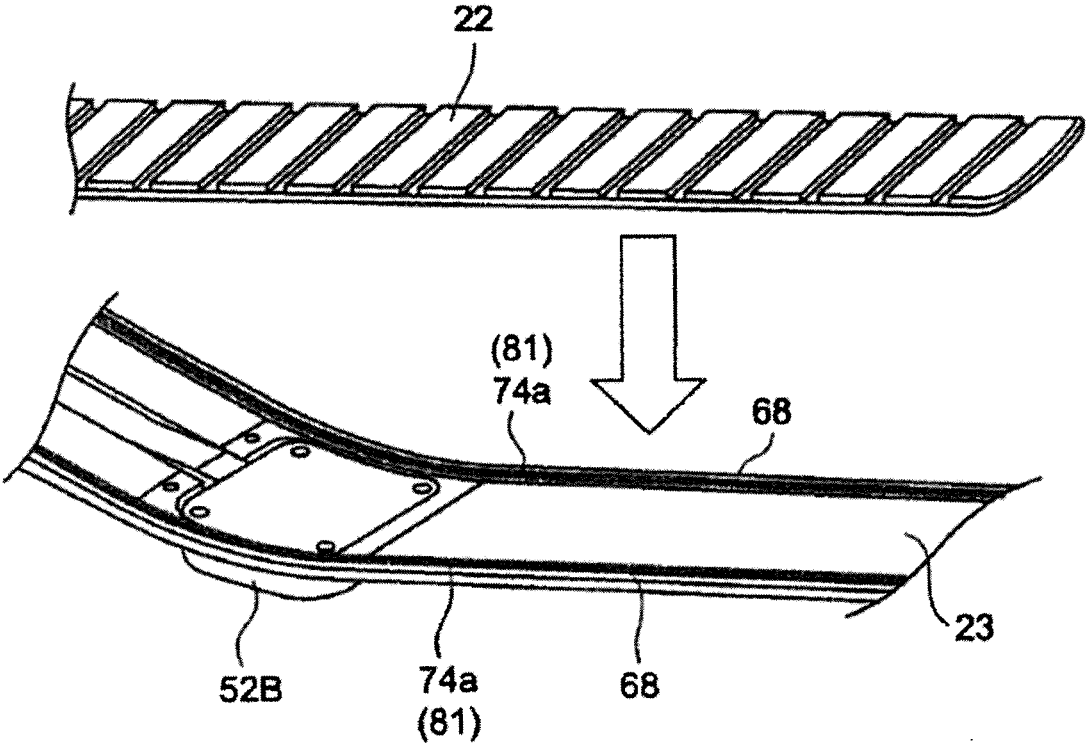


FIG. 14E

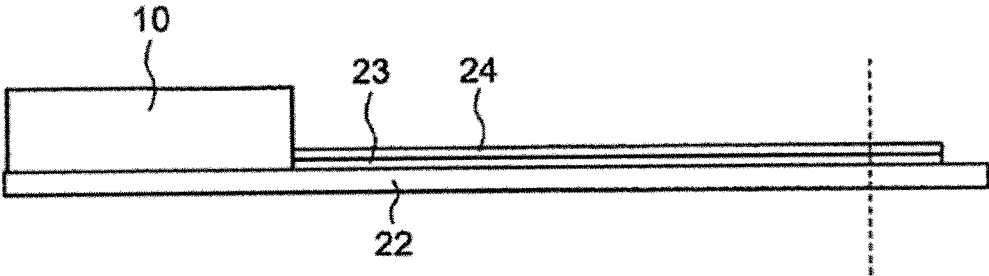


FIG. 14F

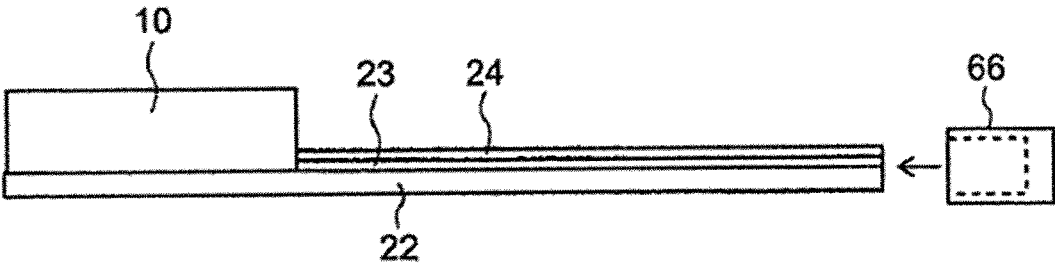
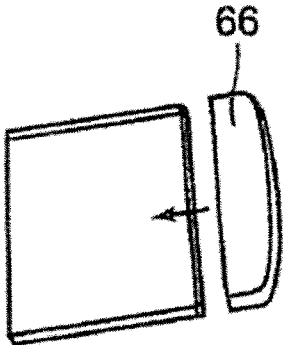
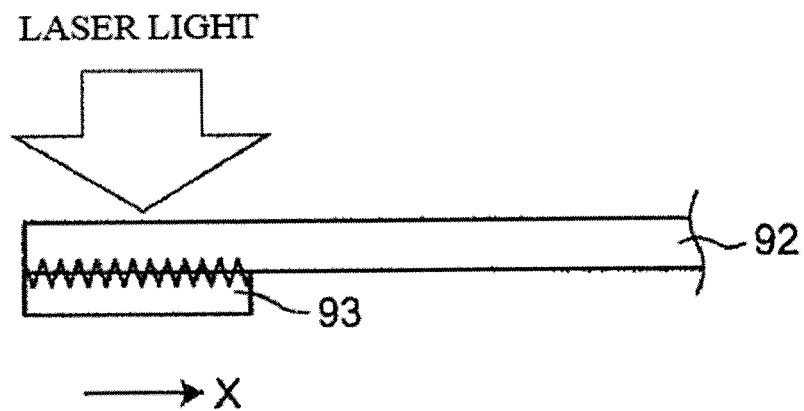


FIG. 14G



**FIG. 15A**



**FIG. 15B**

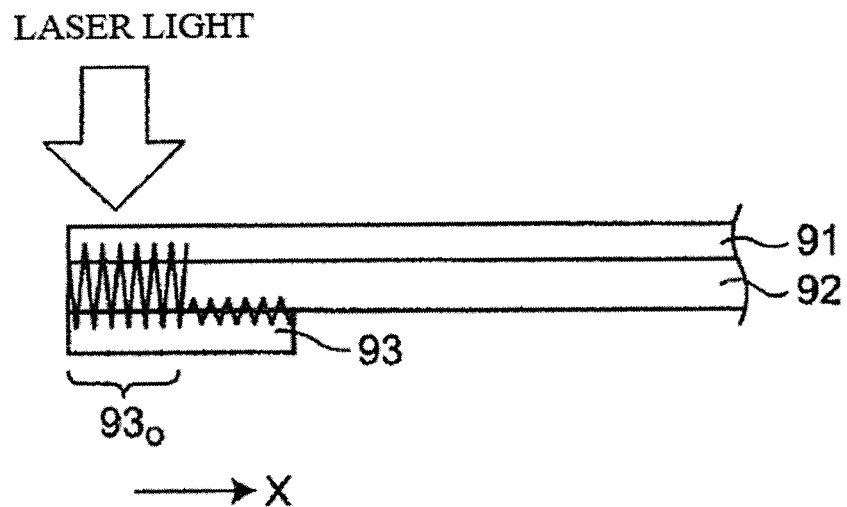




FIG. 16A

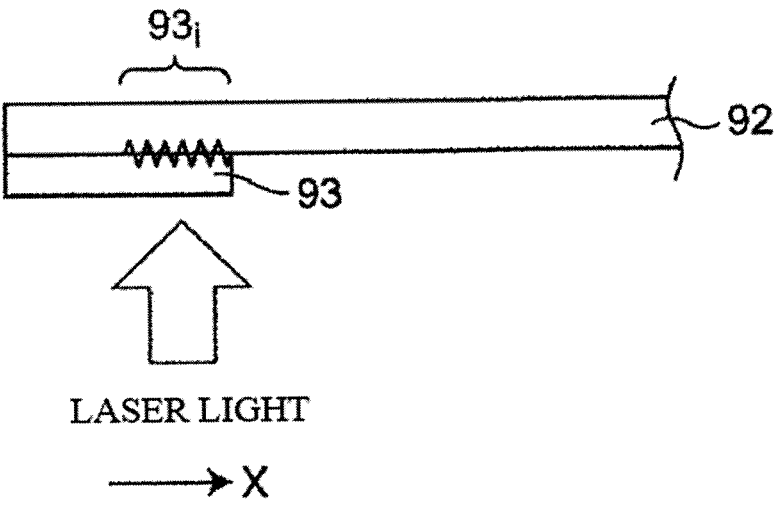
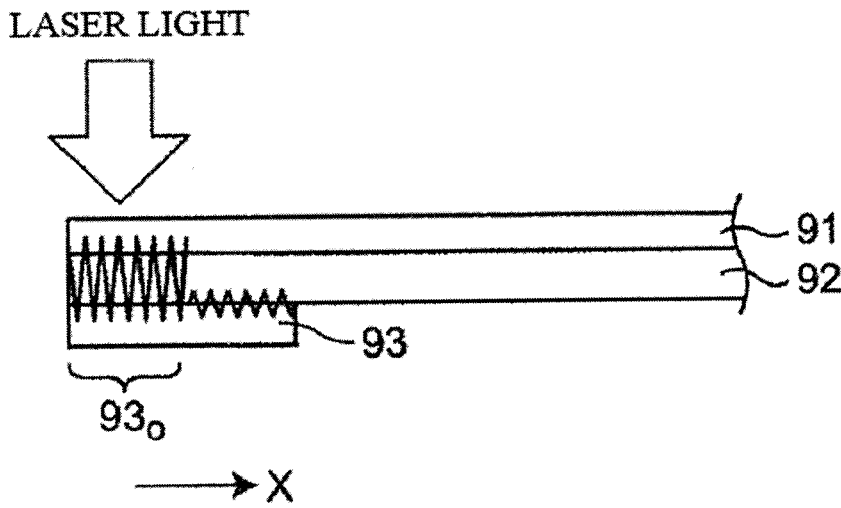


FIG. 16B



**BLOOD PRESSURE MONITOR CUFF,  
METHOD FOR MANUFACTURING THE  
SAME, AND BLOOD PRESSURE MONITOR**

TECHNICAL FIELD

[0001] The present invention relates to a blood pressure monitor cuff, and more specifically relates to a blood pressure monitor cuff that is to be attached to a rod-shaped measurement site such as a wrist, for example. Also, the present invention relates to a method for manufacturing a blood pressure cuff. Furthermore, the present invention relates to a blood pressure monitor that includes the above-described blood pressure monitor cuff.

BACKGROUND ART

[0002] In recent years, requirements of wrist-type blood pressure monitors have been increasing. For example, Patent Documents 2 and 3 disclose watch-type blood pressure measurement devices with an arm-wrapping belt (band) to which a cuff (air bladder) is attached, the arm-wrapping belt being attached to both sides of a main body and being fixed to the arm using an adjustment belt. Also, Patent Document 4 discloses a watch-type blood pressure monitor in which the leading end of a belt (band) made of cloth that extends from one end of a blood pressure monitor main body portion is passed through a band ring provided on the end portion on the opposite side of the main body portion, is folded over, and is fixed with Magic Tape (registered trademark). A cuff is constituted such that an air bladder composed of a nylon upper portion and a nylon lower portion is stored inside of the band (cuff case) of the watch-type blood pressure monitor. Here, the cuff is formed so as to be short enough to cover the blood pressure measurement portion and the pump portion so that the cuff is located near the artery, and the main body portion (includes the blood pressure measurement portion and pump portion) is rotated inward of the wrist during blood pressure measurement.

CITATION LIST

Patent Literature

- [0003] Patent Document 1: JP 2010-51364A
- [0004] Patent Document 2: JP H6-11701A
- [0005] Patent Document 3: JP S63-200144A
- [0006] Patent Document 4: JP H9-285453A

SUMMARY OF INVENTION

Technical Problem

[0007] However, none of the above-described Patent Documents disclose a countermeasure against lateral bulging of the air bladder.

[0008] In view of this, an advantage of one or more embodiments of the present invention is providing a blood pressure monitor cuff that can suppress lateral bulging that occurs when the air bladder swells, a method for manufacturing the same, and a blood pressure monitor including the blood pressure monitor cuff.

Solution to the Problem

[0009] In the present specification, “base end portion”, “leading end portion”, “one end portion”, and “other end

portion” are not limited to the base end, the leading end, the one end, and the other end respectively, and may denote portions within certain ranges.

[0010] Also, “inner surface” denotes a surface on the measurement site side in a state in which the bodily information measurement apparatus has been attached by being wrapped around the measurement site. “Outer surface” denotes a surface on the side opposite to that of the inner surface in a state in which the bodily information measurement apparatus has been attached by being wrapped around the measurement site.

[0011] Also, “bodily information” widely encompasses blood pressure values, a pulse value, an activity amount, a blood oxygen concentration, and the like.

[0012] Thus, a blood pressure monitor cuff according to one or more embodiments of the present invention is

[0013] a band-shaped blood pressure monitor cuff to be wrapped around a measurement site, wherein

[0014] an outer circumferential layer arranged on a side opposite to that of the measurement site and a fluid bladder that is arranged on the measurement site side and swells and contracts by letting a fluid in and out are stacked so as to form the blood pressure monitor cuff,

[0015] the outer circumferential layer and the fluid bladder are formed of an elastomer material,

[0016] two edge portions extending in a lengthwise direction of the outer circumferential layer protrude in a thickness direction toward the measurement site,

[0017] the fluid bladder includes a base layer that opposes the outer circumferential layer, and a top layer that is arranged so as to overlap with the base layer, edge portions of the base layer and the top layer are welded and formed into a bladder shape, and separate additional sheets for preventing lateral bulging are further welded in the thickness direction at the welded edge portions of the top layer and the base layer, and

[0018] the fluid bladder is arranged between the two edge portions of the outer circumferential layer in a width direction, which is perpendicular to the lengthwise direction.

[0019] With the blood pressure monitor cuff according to one or more embodiments of the present invention, the separate sheets for preventing lateral bulging (additional sheets) are further welded in the thickness direction on the edge portions obtained by welding the base layer and the top layer that form the fluid bladder, and therefore lateral bulging that occurs when the fluid bladder swells can be suppressed.

[0020] With the blood pressure monitor cuff of an embodiment, the fluid bladder is pressed between the protrusions of the two edge portions of the circumferential layer in the width direction and is adhered to the outer circumferential layer.

[0021] With the blood pressure monitor cuff of this embodiment, the gaps between the protrusions of the two edge portions of the outer circumferential layer and the fluid bladder are eliminated in the width direction of the belt. For this reason, dust is less likely to accumulate and the appearance improves.

[0022] With the blood pressure monitor cuff of an embodiment,

[0023] a reinforcing layer for suppressing outward swelling of the fluid bladder is provided between the outer circumferential layer and the fluid bladder,

**[0024]** on an inner circumferential surface of the reinforcing layer, grooves with recessed cross-sections extend linearly on the inner sides of the two edge portions in the width direction, and

**[0025]** the base layer is provided with protruding lines that fit into the linear grooves.

**[0026]** With the blood pressure monitor cuff of the embodiment, the adhesion step becomes easier, while protrusion of the adhesive can be suppressed.

**[0027]** With the blood pressure monitor cuff of an embodiment, a depth dimension of the linear grooves and a height dimension of the protruding lines are equal.

**[0028]** With the blood pressure monitor cuff of this embodiment, the adhesion strength in the width direction and the thickness direction of the belt can be increased.

**[0029]** With the blood pressure monitor cuff of an embodiment, the base layer is less flexible than the top layer.

**[0030]** With the bodily information measurement apparatus of the embodiment, the base layer is less likely to separate from the inner circumferential layer of the belt during swelling of the fluid bladder.

**[0031]** A manufacturing method according to one or more embodiments of the present invention is

**[0032]** a manufacturing method for manufacturing the blood pressure monitor cuff, wherein

**[0033]** the top layer and the additional sheets are composed of a light-absorbing material, and the base layer is composed of a light-transmitting material,

**[0034]** the method including:

**[0035]** welding the top layer and the additional sheets by laying the additional sheets on edge portions on the outer surface of the top layer and emitting laser light to the entire region of portions at which the top layer and the additional sheets overlap; and

**[0036]** welding the base layer and the top layer by laying the base layer on a surface on a side opposite to that of the surface of the top layer to which the additional sheets were welded, and emitting laser light from the base layer side to part of portions at which the top layer and the additional sheets overlap.

**[0037]** With the blood pressure monitor cuff manufactured using the manufacturing method, portions of the base layer and the top layer that oppose the additional sheets are welded. With this configuration, it is possible to effectively use the width of the fluid bladder while preventing lateral bulging.

**[0038]** A manufacturing method according to one or more embodiments of the present invention is

**[0039]** a manufacturing method for manufacturing the blood pressure monitor cuff, wherein

**[0040]** the top layer and the additional sheets are composed of a light-absorbing material, and the base layer is composed of a light-transmitting material,

**[0041]** the method including:

**[0042]** welding the top layer and the additional sheets by laying the additional sheets on edge portions on the outer surface of the top layer and emitting laser light to part of portions at which the top layer and the additional sheets overlap; and

**[0043]** welding the base layer and the top layer by laying the base layer on a surface on a side opposite to that of the surface of the top layer to which the additional sheets were welded and emitting laser light from the base layer side to the portions at which the top layer and the additional sheets

have not been welded, in the portions at which the top layer and the additional sheets overlap.

**[0044]** With the blood pressure monitor cuff manufactured using the manufacturing method according to one or more embodiments of the present invention, portions of the base layer and the top layer that oppose the additional sheets are not welded. With this configuration, it is possible to effectively use the width of the fluid bladder while preventing lateral bulging.

**[0045]** With the blood pressure monitor cuff of an embodiment, a reinforcing layer for suppressing outward swelling of the fluid bladder is provided between the outer circumferential layer and the fluid bladder.

**[0046]** With the blood pressure monitor cuff of the embodiment, outward swelling of the fluid bladder can be suppressed, and therefore the efficiency of compressing the measurement site can be improved. Accordingly, the blood pressure measurement accuracy can be further increased.

**[0047]** With the blood pressure monitor cuff of an embodiment, the hardness of the reinforcing layer is greater than the hardness of the outer circumferential layer, which is greater than the hardness of the fluid bladder.

**[0048]** With the blood pressure monitor cuff of an embodiment, the reinforcing layer can suppress outward swelling of the fluid bladder when the fluid bladder swells, and therefore the efficiency of compressing the measurement site can be improved. Accordingly, the blood pressure measurement accuracy can be further increased. Furthermore, since the outer circumference of the reinforcing layer is covered by the outer circumferential layer, which has a smaller hardness than the hardness of the reinforcing layer, the outer circumferential layer of the belt is soft to the touch.

**[0049]** A manufacturing method according to one or more embodiments of the present invention is

**[0050]** a manufacturing method for manufacturing the blood pressure monitor cuff, including:

**[0051]** preparing a reinforcing layer;

**[0052]** manufacturing an intermediate body composed of the reinforcing layer and the outer circumferential layer by laying resin that forms material of the outer circumferential layer through insert molding on the outer surface of the reinforcing layer; and

**[0053]** adhering or welding the fluid bladder prepared in advance along the inner surface of the reinforcing layer of the intermediate body.

**[0054]** A manufacturing method according to one or more embodiments of the present invention is

**[0055]** a manufacturing method for manufacturing a band-shaped blood pressure monitor cuff to be wrapped around a measurement site,

**[0056]** wherein the cuff is formed by stacking an outer circumferential layer arranged on a side opposite to that of the measurement site, and a fluid bladder that is arranged on the measurement site side and swells and contracts by letting a fluid in and out,

**[0057]** the outer circumferential layer and the fluid bladder are formed of an elastomer material,

**[0058]** two edge portions extending in a lengthwise direction of the outer circumferential layer protrude in a thickness direction toward the measurement site,

**[0059]** the fluid bladder includes a reinforcing layer that opposes the outer circumferential layer and prevents outward swelling of the fluid bladder, and a sheet that is arranged so as to overlap with the side of the reinforcing

layer opposite to that of the outer circumferential layer, edge portions of the reinforcing layer and the sheet being welded to form a bladder shape, and

[0060] the fluid bladder is arranged between the two edge portions of the outer circumferential layer in a width direction, which is perpendicular to the lengthwise direction,

[0061] the manufacturing method including:

[0062] preparing a reinforcing layer;

[0063] manufacturing an intermediate body composed of the reinforcing layer and the outer circumferential layer by laying resin that forms material of the outer circumferential layer through insertion molding on the outer surface of the reinforcing layer; and

[0064] adhering or welding a circumferential edge portion of the sheet prepared in advance along the inner surface of the reinforcing layer of the intermediate body so as to form the fluid bladder composed of the reinforcing layer and the sheet.

[0065] According to these manufacturing methods, a blood pressure monitor cuff with a three-layer structure including the outer circumferential layer, the reinforcing layer, and the fluid bladder can be manufactured easily.

[0066] With the blood pressure monitor cuff of an embodiment, a cap member that collectively covers the leading end portion of the outer circumferential layer and the leading end portion of the fluid bladder is further included.

[0067] With the blood pressure monitor cuff of this embodiment, it is possible to conceal positional misalignment caused by a dimensional error or the like in components between the leading end portion of the outer circumferential layer and the leading end portion of the fluid bladder. Accordingly, the appearance improves.

[0068] A blood pressure monitor according to one or more embodiments of the present invention includes:

[0069] the blood pressure monitor cuff; and

[0070] a main body provided with a pressure detection unit and a fluid supply unit that communicate with the fluid bladder,

[0071] wherein the fluid supply unit compresses the measurement site by supplying a fluid to the fluid bladder, and

[0072] the pressure detection unit calculates blood pressure at the measurement site by detecting the pressure in the fluid bladder.

[0073] With the blood pressure monitor according to one or more embodiments of the present invention, the separate sheets are further welded in the thickness direction on the edge portions obtained by welding the base layer and the top layer that form the fluid bladder, and therefore lateral bulging that occurs when the fluid bladder swells can be suppressed.

[0074] A blood pressure monitor cuff according to one or more embodiments of the present invention is

[0075] a band-shaped blood pressure monitor cuff to be wrapped around a measurement site, wherein

[0076] an outer circumferential layer arranged on a side opposite to that of the measurement site and a fluid bladder that is arranged on the measurement site side and swells and contracts by letting a fluid in and out are stacked so as to form the blood pressure monitor cuff,

[0077] the outer circumferential layer and the fluid bladder are formed of an elastomer material,

[0078] two edge portions extending in a lengthwise direction of the outer circumferential layer protrude in a thickness direction toward the measurement site,

[0079] the fluid bladder includes a base layer that opposes the outer circumferential layer, and a top layer that is arranged so as to overlap with the base layer, edge portions of the base layer and the top layer are welded and formed into a bladder shape, and separate additional sheets for preventing lateral bulging are further welded in the thickness direction at the welded edge portions of the top layer and the base layer, and

[0080] the fluid bladder is arranged between the two edge portions of the outer circumferential layer in a width direction, which is perpendicular to the lengthwise direction, and the edge portions of the fluid bladder at which the additional sheets are welded are in contact with the protrusions on the two edge portions of the outer circumferential layer.

[0081] Also, with the blood pressure measurement cuff of an embodiment, the hardness of the outer circumferential layer is greater than the hardness of the fluid bladder.

[0082] As is evident from the description above, with the blood pressure monitor cuff and the blood pressure monitor according to one or more embodiments of the present invention, since the separate sheets are further welded in the thickness direction at the edge portions obtained by welding the base layer and the top layer, which form the fluid bladder, it is possible to suppress lateral bulging that occurs when the fluid bladder swells. Also, with the manufacturing method according to one or more embodiments of the present invention, a blood pressure monitor cuff having a fluid bladder that includes the base layer, the top layer, and the additional sheets, or a blood pressure monitor cuff with a three-layer structure including the outer circumferential layer, the reinforcing layer, and the fluid bladder can be manufactured easily.

#### BRIEF DESCRIPTION OF DRAWINGS

[0083] FIG. 1A is a top view showing an exterior of a bodily information measurement apparatus 1 according to a first embodiment of the present invention.

[0084] FIG. 1B is a lateral cross-sectional view of the bodily information measurement apparatus 1 taken along line B-B in FIG. 1A.

[0085] FIG. 1C is a lateral cross-sectional view of the bodily information measurement apparatus 1 taken along line A-A in FIG. 1A.

[0086] FIG. 2 is a bottom view of the bodily information measurement apparatus 1 shown in FIG. 1.

[0087] FIG. 3 is a perspective view showing a state at a time when the bodily information measurement apparatus 1 shown in FIG. 1 is formed into a loop shape.

[0088] FIG. 4 is a diagram showing a view of the bodily information measurement apparatus 1 in FIG. 3 in a direction orthogonal to the loop of the belt.

[0089] FIG. 5 is an exploded perspective view for illustrating a structure of the bodily information measurement apparatus 1 in FIG. 1A.

[0090] FIG. 6A is a schematic perspective view for illustrating a first state of operations of a buckle 30 in FIG. 5.

[0091] FIG. 6B is a schematic perspective view for illustrating a second state of operations of the buckle 30 in FIG. 5.

[0092] FIG. 7A is a schematic diagram for illustrating a first procedure of performing measurement with the bodily information measurement apparatus 1 in FIG. 1 attached to the wrist.

[0093] FIG. 7B is a schematic diagram for illustrating a second procedure of performing measurement with the bodily information measurement apparatus 1 in FIG. 1 attached to the wrist.

[0094] FIG. 7C is a schematic diagram for illustrating a third procedure of performing measurement with the bodily information measurement apparatus 1 in FIG. 1 attached to the wrist.

[0095] FIG. 8 is a block diagram schematically showing a configuration of control system inside of the bodily information measurement apparatus 1 in FIG. 1.

[0096] FIG. 9 is a flowchart showing blood pressure measurement processing executed by the bodily information measurement apparatus 1 in FIG. 1.

[0097] FIGS. 10A to 10C are a lateral cross-sectional view illustrating a step of a method for manufacturing a belt 20 in FIG. 1.

[0098] FIGS. 11A to 11C are a lateral cross-sectional view illustrating a step of a method for manufacturing the belt 20 in FIG. 1, according to a modified example of an embodiment of the present invention.

[0099] FIG. 12A is a top view showing an exterior of a bodily information measurement apparatus 1A according to a second embodiment of the present invention.

[0100] FIG. 12B is a bottom view of the bodily information measurement apparatus 1A in FIG. 12A.

[0101] FIG. 12C is a perspective view showing a state at a time of attaching the bodily information measurement apparatus 1 in FIG. 12A by wrapping it around a measurement site.

[0102] FIG. 13A is an exploded perspective view for illustrating a structure of the belt 20 of the bodily information measurement apparatus 1 in FIG. 1A.

[0103] FIG. 13B is a plan view showing an adhesion surface of a fluid bladder 22 in FIG. 13A.

[0104] FIG. 13C is a side view schematically showing a state at a time when a reinforcing plate 28 is adhered to the fluid bladder 22 in FIG. 13A.

[0105] FIG. 13D is a lateral cross-sectional view of the bodily information measurement apparatus 1 taken along line J-J in FIG. 1A.

[0106] FIG. 14A is a schematic diagram showing a first step of assembling the belt 20 in FIG. 1A.

[0107] FIG. 14B is a schematic diagram showing a second step of assembling the belt 20 in FIG. 1A.

[0108] FIG. 14C is a schematic diagram showing a third step of assembling the belt 20 in FIG. 1A.

[0109] FIG. 14D is a schematic diagram showing a fourth step of assembling the belt 20 in FIG. 1A.

[0110] FIG. 14E is a schematic diagram showing a fifth step of assembling the belt 20 in FIG. 1A.

[0111] FIG. 14F is a schematic view showing a sixth step of assembling the belt 20 in FIG. 1A.

[0112] FIG. 14G is a schematic diagram showing a seventh step of assembling the belt 20 in FIG. 1A.

[0113] FIG. 15A is a lateral cross-sectional view illustrating a first step of a method for manufacturing the fluid bladder 22 in FIG. 13D.

[0114] FIG. 15B is a lateral cross-sectional view illustrating a second step of a method for manufacturing the fluid bladder 22 in FIG. 13D.

[0115] FIG. 16A is a lateral cross-sectional view illustrating a modified example of a first step of a method for

manufacturing the fluid bladder 22 in FIG. 13D according to a modified example of the first embodiment.

[0116] FIG. 16B is a lateral cross-sectional view illustrating a modified example of a second step of a method for manufacturing the fluid bladder 22 in FIG. 13D according to a modified example of the first embodiment.

## DESCRIPTION OF EMBODIMENTS

[0117] Hereinafter, embodiments according to the present invention will be described with reference to the drawings. Note that in the following embodiments, similar constituent elements are denoted by the same reference numerals and redundant description thereof is not included.

### First Embodiment

[0118] FIG. 1A is a top view showing an exterior of a bodily information measurement apparatus 1 according to a first embodiment of the present invention, FIG. 1B is a lateral cross-sectional view of the bodily information measurement apparatus 1 taken along line B-B in FIG. 1A, and FIG. 1C is a lateral cross-sectional view of the bodily information measurement apparatus 1 taken along line A-A in FIG. 1C. Also, FIG. 2 is a bottom view of the bodily information measurement apparatus 1 shown in FIG. 1, FIG. 3 is a perspective view showing a state at a time of attaching the bodily information measurement apparatus shown in FIG. 1 by wrapping it around the measurement site, FIG. 4 is a diagram showing a view of the bodily information measurement apparatus 1 shown in FIG. 3 in a direction orthogonal to the loop of the belt 20, and FIG. 5 is an exploded perspective view for illustrating a structure of the bodily information measurement apparatus 1 shown in FIG. 1A.

[0119] As can be understood from FIG. 3, the bodily information measurement apparatus 1 is attached by being wrapped around a rod-shaped measurement site, such as a wrist 90 (see FIGS. 7A to 7C) of a user, for example, and includes a band-shaped belt 20 that is to be wrapped around the measurement site, a main body 10 that is arranged at a base end portion a in the lengthwise direction of the belt 20 and on which an element for measuring blood pressure is mounted, and a buckle 30 for joining the base end portion a and a leading end portion b on the opposite side in the lengthwise direction of the belt 20 such that the belt 20 becomes a loop shape. Here, the belt 20 serves as a blood pressure measurement cuff. Hereinafter, the structure of the belt 20 will be described.

[0120] As can be understood from FIG. 1B, the belt 20 includes a fluid bladder 22 for compressing the measurement site during blood pressure measurement, a reinforcing layer 23 that is provided along the outer surface of the fluid bladder 22 and is for suppressing outward swelling of the fluid bladder 22, and an outer circumferential layer 24 that is provided along the outer surface of the reinforcing layer 23 and covers the reinforcing layer 23. Accordingly, since outward swelling of the fluid bladder 22 can be suppressed, the efficiency of compressing the measurement site can be improved, and the blood pressure measurement accuracy can be further increased. On the other hand, the surface of the fluid bladder 22 (becomes the inner surface when worn) has multiple recesses and protrusions along the lengthwise direction and can easily swell toward the measurement site.

[0121] Also, the fluid bladder 22, the reinforcing layer 23, and the outer circumferential layer 24 that are included in the belt 20 are each formed of an elastomer material. For this reason, the belt 20 is flexible, and therefore can be wrapped around the wrist 90, is not likely to get dirty, and can be wiped with a damp cloth.

[0122] Furthermore, the hardness of the reinforcing layer 23 is greater than the hardness of the outer circumferential layer 24, which is greater than the hardness of the fluid bladder 22. Accordingly, since the reinforcing layer 23 can suppress outward swelling of the fluid bladder 22 when the fluid bladder 22 swells, the efficiency of compressing the measurement site can be improved. Accordingly, the blood pressure measurement accuracy can be further increased. Furthermore, since the outer circumferential layer 23, which has a hardness that is smaller than the hardness of the reinforcing layer 23, covers the outer circumference of the reinforcing layer 23, the outer circumferential layer 24 of the belt 20 is soft to the touch.

[0123] FIG. 13A is an exploded perspective view for illustrating the structure of the belt 20 of the bodily information measurement apparatus 1 shown in FIG. 1A. Here, a bottom surface of the bodily information measurement apparatus 1 is shown. FIG. 13B is a plan view showing an adhesion surface of the fluid bladder 22 shown in FIG. 13A. FIG. 13C is a side view schematically showing a state at a time when a reinforcing plate 28 is adhered to the fluid bladder 22 shown in FIG. 13A. FIG. 13D is a lateral cross-sectional view of the bodily information measurement apparatus 1 taken along line J-J in FIG. 1A. In FIG. 13D, the width direction of the belt 20 is shown as the X direction, the lengthwise direction is shown as the Y direction, and the thickness direction is shown as the Z direction.

[0124] As shown in FIG. 13A, the main body 10 and the fluid bladder 22 are bonded by fitting the reinforcing plate 28 adhered to the fluid bladder 22 side in the main body 10 and fastening with a screw 67 (see FIG. 14C). The reinforcing plate 28 is adhered to the base end portion a side of the fluid bladder 22 using adhesive. Accordingly, by removing the screw 67, the fluid bladder 22 and the reinforcing plate 28 are removed from the main body 10. However, FIG. 13A shows a state when only the fluid bladder 22 has been removed so that the position of the reinforcing plate 28 at the time when the fluid bladder 22 is bonded to the main body 10 using the screw 67 is clearer.

[0125] A ventilation port 45b serving as a first main body-side tube element for supplying a fluid for inflation from a piezoelectric pump 17 (see FIG. 8) mounted in the main body 10 to the interior of the fluid bladder 22, and a ventilation port 46b serving as a second main body-side tube element for transferring the pressure in the fluid bladder 22 to the pressure sensor 16 (see FIG. 8) mounted on the main body 10 using the fluid are provided on a surface of the main body 10 that opposes the fluid bladder 22. The fluid bladder 22 includes a nipple 45a serving as a first bladder-side tube element that fits air-tightly in the ventilation port 45b in a state of opposing the main body 10, and a nipple 46a serving as a second bladder-side tube element that fits air-tightly in the ventilation port 46b. Here, the portion of the fluid bladder 22 that opposes the main body 10 is removably attached to the main body 10 via the reinforcing plate 28 adhered to that portion. With this configuration, the reinforcing plate 28 is bonded to the main body 10 via the screw 67, and therefore the fluid bladder 22 is more strongly

attached to the main body 10. Furthermore, by removing the screw 67, the fluid bladder 22 and the reinforcing plate 28 can be easily removed, and therefore the ventilation port of the pressure sensor 16 and the piezoelectric pump 17 can be exposed. Accordingly, it is possible to perform product testing simply using the ventilation ports 45a and 45b by merely removing the screw 67.

[0126] Also, a through hole 28a having a shape through which all of the ventilation ports 45b and 46b and the nipples 45a and 46a pass is formed in the reinforcing plate 28. With this configuration, it is easier to fit the nipple 45a and the ventilation port 45b together and to fit the nipple 46a and the ventilation port 46b together.

[0127] As shown in FIG. 13B, a protruding ring 75 that protrudes in the thickness direction of the belt 20 is provided at a position along the inner side with respect to the edge portion of the through hole 28a of the reinforcing plate 28 that is to be attached, on the surface of the fluid bladder 22 that opposes the main body 10. With this configuration, the adhesive that is applied between the reinforcing plate 28 and the fluid bladder 22 does not protrude inward with respect to the protruding ring 75.

[0128] The portion of the fluid bladder 22 to which the reinforcing plate 28 is not adhered is adhered to the reinforcing layer 23 of the belt 20 with adhesive. As shown in FIGS. 13A and 13D, on the inner circumferential surface of the belt 20, the two edge portions 68 in the width direction (X direction) of the belt 20 protrude in the thickness direction (Z direction) and extend linearly in the lengthwise direction (Y direction). The gap between the two edge portions 68 is narrower than the width of the fluid bladder 22, and the fluid bladder 22 is pressed in the width direction (X direction) of the belt 20 between the protrusions of the two edge portions 68 so as to be adhered to the belt 20. Accordingly, the fluid bladder 22 is arranged between the two edge portions 68 of the outer circumferential layer 23 and the edge portions of the fluid bladder 22 (to which the later-described sheets 93 for preventing lateral bulging, which serve as additional sheets, are welded) are in contact with the protrusions of the two edge portions 68 of the outer circumferential layer 23. With this configuration, gaps between the protrusions of the two edge portions 68 and the fluid bladder 22 are eliminated in the width direction of the belt 20. For this reason, dust is less likely to accumulate and the appearance improves.

[0129] As shown in FIG. 13A, grooves 74a with recessed cross sections extend linearly in the lengthwise direction (Y direction) on the surface of the reinforcing layer 23. The adhesive for adhering the fluid bladder 22 to the reinforcing layer 23 is applied to the grooves 74a. As shown in FIGS. 13B and 13D, protruding lines 74b that fit in the grooves 74a are provided on a base layer 91 of the fluid bladder 22 that opposes the reinforcing layer 23. Due to this configuration, the adhesion step becomes easier, while protrusion of the adhesive can be suppressed.

[0130] As shown in FIG. 13D, the side surfaces and the bottom surfaces of the protruding lines 74b are adhered to the grooves 74a. Due to this configuration, it is possible to increase the strength of adhesion in the width direction (X direction) and the thickness direction (Z direction) of the belt 20. Note that in the present embodiment, the depth dimension 74a7 of the linear grooves 74a is greater than the height dimension 74bZ of the protruding lines 74b, but the present invention is not limited to this. For example, the

depth dimension  $74aZ$  of the linear grooves  $74a$  and the height dimension  $74bZ$  of the protruding lines  $74b$  may be made equal. Due to this configuration, it is possible to further increase the strength of adhesion in the width direction (X direction) and the thickness direction (Z direction) of the belt  $20$ .

[0131] As shown in FIG. 13D, the fluid bladder  $22$  includes a base layer  $91$  that opposes the inner circumferential surface of the belt  $20$  and a top layer  $92$  that is arranged so as to overlap with the base layer  $91$ , the edge portions of the base layer  $91$  and the top layer  $92$  are welded, and thus a bladder shape is formed. Here, the base layer  $91$  is less likely to stretch than the top layer  $92$ . Due to this configuration, the base layer  $91$  is not likely to be separated from the inner circumferential surface of the belt  $20$  when the fluid bladder  $22$  swells. Note that sheets  $93$  for preventing lateral bulging of the fluid bladder  $22$  are further welded in the thickness direction on the edge portions at which the top layer  $92$  and the base layer  $91$  are welded. With this configuration, lateral bulging is suppressed when the fluid bladder  $22$  swells.

[0132] FIGS. 14A to 14F are schematic diagrams showing steps for assembling the belt  $20$  shown in FIG. 1A. First, as shown in FIG. 14A, the reinforcing plate  $28$  is adhered to the fluid bladder  $22$ . Next, as shown in FIG. 14B, the nipples  $45a$  and  $46a$  are inserted into the ventilation ports  $45b$  and  $46b$  of the main body  $10$ , claws  $97$  of the reinforcing plate  $28$  are fit into a fit-together portion (not shown) provided on the main body  $10$  side, and fastening is performed with the screw  $67$  (see FIG. 14C). Next, as shown in FIG. 14D, the reinforcing layer  $23$  and the fluid bladder  $22$  are adhered. At this time, the adhesive  $81$  is allowed to flow into the grooves  $74a$  located several millimeters inward from the two edge portions  $68$  of the belt  $20$ , and thereafter the fluid bladder  $22$  is adhered by being bonded. Next, as shown in FIG. 14E, the leading ends of the fluid bladder  $22$ , the reinforcing layer  $23$ , and the outer circumferential layer  $24$  are cut at the location of the dotted line. Finally, as shown in FIG. 14F, a cap member  $66$  is bonded to the cut end portion with the adhesive, and the leading ends are collectively covered.

[0133] Thereafter, as shown in FIG. 14E, the leading ends of the fluid bladder  $22$ , the reinforcing layer  $23$ , and the outer circumferential layer  $24$  may be further cut at the location of the dotted line, and then, as shown in FIGS. 14F and 14G, the cap member  $66$  may be bonded with adhesive at the cut end portions, and the leading end portions may be collectively covered. The cap member  $66$  is a member that is formed of an elastomer material in which a depression that envelops the leading end portion of the belt  $20$  is provided. By placing the cap member  $66$  on the leading end portion of the belt  $20$ , it is possible to conceal positional misalignment that occurs due to dimensional error and the like of the components, between the leading end portion of the reinforcing layer  $23$  of the belt  $20$ , the leading end portion of the outer circumferential layer  $24$  of the belt  $20$ , and the leading end portion of the fluid bladder  $22$  of the belt  $20$ . Accordingly, the appearance of the product improves.

[0134] Note that by giving the leading end portion of the belt  $20$  a rounded shape so as to curve toward the inner circumferential surface and making it easier to slide by forming the cap member  $66$  with a material having a low friction coefficient, adding a mechanism such as a roller, or the like, it is possible to increase the wearability of the belt  $20$ .

[0135] FIG. 15 shows lateral cross-sectional views illustrating steps of a method for manufacturing the fluid bladder  $22$ . The fluid bladder  $22$  is manufactured using laser transmission welding (LTW). The fluid bladder  $22$  is formed into a bladder shape overall by overlapping two layers (the base layer  $91$  and the top layer  $92$ ). The sheet  $93$  for preventing lateral bulging is furthermore overlaid on the edge portion of the fluid bladder  $22$ . Here, one edge portion in the width direction (X direction) has been described. The other edge portion is welded using a similar method as well.

[0136] First, as shown in FIG. 15A, the top layer  $92$  composed of a light-absorbing material is prepared, and the sheet  $93$  for preventing lateral bulging, which is composed of a light-absorbing material, is laid the edge portion on the outer surface of the top layer  $92$ . Next, for example, laser light is emitted from the top layer  $92$  side over the entire region of the sheet  $93$  in the width direction (X direction). Upon doing so, the light-absorbing material melts and is welded at overlapping portions, and the sheet  $93$  is welded. In FIG. 15A (and later-described FIGS. 15B, 16A, and 16B), the welded region is indicated by a triangular wave mark.

[0137] Next, as shown in FIG. 15B, the base layer  $91$  composed of a light-transmitting material is laid on the inner surface of the top layer  $92$ . Then, the laser light is once again emitted from the base layer  $91$  side to only the outside region  $93o$  of the sheet  $93$  in the width direction (X direction). Upon doing so, the base layer  $91$  and the top layer  $92$  are welded at the emission region (outside region  $93o$ ). Accordingly, the base layer  $91$  and the top layer  $92$  are welded and the fluid bladder  $22$  is formed. Here, the portions of the base layer  $91$  and the top layer  $92$  that oppose the sheets  $93$  for preventing lateral bulging are not welded. With this configuration, it is possible to effectively use the width of the fluid bladder while preventing lateral bulging.

[0138] Here, a modified example of a method for manufacturing the fluid bladder  $22$  will be described. With the method for manufacturing the fluid bladder  $22$ , laser light is emitted twice to the same region (the outside region  $93o$  of the sheet  $93$ ). In this case, since laser emission is performed multiple times on the same region, there is a possibility that the material will deteriorate. In contrast to this, in the present modified example, the problem related to deterioration of the material is prevented from occurring by setting the number of emissions of laser light on the same region to one.

[0139] FIG. 16 shows lateral cross-sectional views illustrating a modified example of a step of a method for manufacturing the fluid bladder  $22$  according to a modified example of the first embodiment. Similarly to the example shown in FIG. 15, the fluid bladder  $22$  is formed into a bladder shape overall by overlapping two layers (the base layer  $91$  and the top layer  $92$ ). The sheet  $93$  for preventing lateral bulging is furthermore overlaid on the edge portion of the fluid bladder  $22$ . Here, one edge portion in the width direction (X direction) has been described. The other edge portion is welded using a similar method as well.

[0140] First, as shown in FIG. 16A, the top layer  $92$  composed of a light-absorbing material is prepared, and the sheet  $93$  for preventing lateral bulging, which is composed of a light-absorbing material, is laid on the edge portion on the outer surface of the top layer  $92$ . Next, laser light is emitted from the sheet  $93$  side to only the inside region  $93i$  of the sheet  $93$  in the width direction (X direction). Upon doing so, the light absorbing material melts and the sheet  $93$  is welded at the inside region  $93i$ .

[0141] Next, as shown in FIG. 16B, the base layer 91 composed of a light-transmitting material is laid on the inner surface of the top layer 92. Then, the laser light is once again emitted from the base layer 91 side to only the outside region 93o of the sheet 93 in the width direction (X direction). Upon doing so, the base layer 91 and the top layer 92 are welded at the emission region (outside region 93o). Accordingly, the base layer 91 and the top layer 92 are welded and the fluid bladder 22 is formed. Here, laser light can be partially transmitted by making the top layer 92 thinner. Here, the portions of the base layer 91 and the top layer 92 that oppose the sheets 93 for preventing lateral bulging are not welded. With this configuration, it is possible to effectively use the width of the fluid bladder while preventing lateral bulging.

[0142] The above-described belt 20 is manufactured as follows.

[0143] FIGS. 10A to 10C are lateral cross-sectional views illustrating steps of a method for manufacturing the belt 20 shown in FIG. 1. As illustrated in FIG. 10A, first, the reinforcing layer 23 is prepared and resin that forms the material of the outer circumferential layer 24 is laid on the outer surface of the reinforcing layer 23 through insert molding. The fluid bladder 22 prepared in advance is adhered or welded as illustrated in FIG. 10B along the inner surface of the reinforcing layer 23 of the intermediate body composed of the reinforcing layer 23 and the outer circumferential layer 24, which were integrated in this manner. In this manner, as illustrated in FIG. 10C, a belt 20 with a three-layer structure, which includes the outer circumferential layer 24, the reinforcing layer 23, and the fluid bladder 22, is formed. Note that in order to facilitate understanding, in the drawings, the resin that forms the material of the outer circumferential layer 24 is denoted by the same reference numeral as the outer circumferential layer 24.

[0144] FIGS. 11A to 11C are lateral cross-sectional views illustrating steps of a method for manufacturing the belt 20 in FIG. 1, according to a modified example of an embodiment of the present invention. As illustrated in FIG. 11A, first, the reinforcing layer 23 is prepared and resin that forms the material of the outer circumferential layer 24 is laid on the outer surface of the reinforcing layer 23 through insert molding. Next, as illustrated in FIG. 11B, an intermediate body composed of the reinforcing layer 23 and the outer circumferential layer 24 is manufactured. Also, one sheet 29 is prepared in addition to this. Finally, the fluid bladder 22 composed of the reinforcing layer 23 and the sheet 29 is formed by adhering or welding the circumferential edge portions 29e of the sheet 29 prepared in advance along the inner surface of the reinforcing layer 23 of the intermediate body manufactured as illustrated in FIG. 11C. In this manner, a belt 20 with a three-layer structure including the outer circumferential layer 24, the reinforcing layer 23, and the fluid bladder 22 can be manufactured easily. Note that in order to facilitate understanding, in the drawings, the resin that forms the material of the outer circumferential layer 24 is denoted by the same reference numeral as the outer circumferential layer 24.

[0145] Note that the above-described reinforcing layer 23 need not be present, and in such a case, the portion of the reinforcing layer is formed as the outer circumferential layer.

[0146] As can be understood from FIGS. 1A, 1B, and 3, an operation portion that includes a blood pressure measurement switch 52B for inputting an instruction to measure

bodily information is arranged at a site (in this example, the approximate center portion) that is different from a specific portion (in this example, the base end portion a) at which the main body 10 is arranged in the lengthwise direction of the belt 20. Also, as shown in FIG. 5, an FPC cable 54 that electrically connects the main body 10 and the operation portion 52 is interposed between the fluid bladder 22 and the reinforcing layer 23. Thus, since the main body 10 and the operation portion 52 are electrically connected by the FPC cable 54, the belt 20 can be made thin. Note that in the present embodiment, only the operation unit is arranged, but the present invention is not limited to this, and a communication unit and a display unit may be arranged.

[0147] As can be understood from FIG. 2, magnets 33 are provided on the inner surface side of the base end portion a of the belt 20, protruding portions 31 made of metal that stick to the magnets 33 are provided on the second plate frame member 30b, and thus a sticking mechanism is formed. With this sticking mechanism, the inner surface side of the base end portion a of the belt 20 or the one end portion d of the first plate frame member 30a and the other end portion h of the second plate frame member 30b can stick to each other. Accordingly, when the main body 10, the first plate frame member 30a, and the second plate frame member 30b of the buckle 30 are folded in on each other, the inner surface of the main body 10, the first plate frame member 30a, and the second plate frame member 30b of the buckle 30 are guided so as to overlap.

[0148] Note that in addition to or instead of the above-described sticking mechanism, it is desirable to include a lock mechanism that allows the inner surface side of the base end portion a of the belt 20 or the one end portion d of the first plate frame member 30a and the other end portion h of the second plate frame member 30b to engage with each other. Also, the sticking mechanism and/or the lock mechanism preferably include an unlock mechanism for removing the sticking and/or the engagement. In this example, a release button 19 (see FIGS. 1A, 2, and 5) for releasing the sticking is provided as an unlocking mechanism on the main body 10. As shown in FIG. 5, a slide board 19a is integrally formed on the release button 19. When the release button 19 is pressed toward the interior of the main body 10, the slide board 19a enters like a wedge between the one end portion d of the first plate frame member 30a and the other end portion h of the second plate frame member 30b shown in FIG. 6B, and the sticking between the first plate frame member 30a and the second plate frame member 30b is removed.

[0149] As shown in FIGS. 6A and 6B, a first fixing element, which includes engaging portions 32 having protruding shapes, is provided on the inner surface of the other end portion h of the second plate frame member 30b, and as shown in FIGS. 1A, 1B, and 5, a second fixing element, which includes engaged portions 25 having recessed shapes that can engage with the engaging portions 32, is provided on the outer surface of the leading end portion b of the belt 20. Accordingly, as shown in FIGS. 3 and 4, the second plate frame member 30b and the leading end portion b of the belt 20 can be engaged such that the belt 20 is made into a loop shape. Accordingly, the bodily information measurement apparatus 1 can be fixed to the measurement site. Furthermore, since the non-through, recessed second fixing elements (engaged portions 25), which are formed so as to be able to be engaged with the protruding first fixing elements



(engaging portions 32), are provided on the outer surface of the leading end portion b of the belt 20, the fixing elements no longer interfere with the fluid bladder 22. Accordingly, the wrist 90 serving as the measurement site can be reliably compressed by the fluid bladder 22 during blood pressure measurement.

[0150] Also, as can be understood from FIG. 4, in comparison to Patent Documents 2 to 4, the buckle 30 of the bodily information measurement apparatus 1 according to the present embodiment differs in that it aims to serve as a fastening portion for fastening the base end portion a and the leading end portion b on the opposite side in the lengthwise direction of the belt 20 such that the belt 20 forms a loop shape. In other words, in the state in which the base end portion a of the belt 20 and the leading end portion b of the belt 20 overlap, the base end portion a and the leading end portion b are fastened and are attached to the wrist 90 serving as the measurement site by the buckle 30. With this configuration, the base end portion a of the belt 20 and the leading end portion b of the belt 20 overlap when the base end portion a of the belt 20 and the leading end portion b of the belt 20 are fastened. For this reason, the degree of swelling of the fluid bladder 22 on the backhand side of the wrist, or in other words, the swelling of the fluid bladder 22 in the thickness direction, increases, and therefore the pulse can be detected accurately. Accordingly, the blood pressure measurement accuracy improves. Furthermore, the appearance improves without the leading end portion b of the belt 20 protruding in the fastened state.

[0151] Note that in the present embodiment, a protruding shape was used as the first fixing element and a recessed shape was used as the second fixing element, but the present invention is not limited thereto. For example, a recessed shape may be used as the first fixing element and a protruding shape may be used as the second fixing element. In this case as well, an effect similar to that of the present embodiment can be obtained.

[0152] As can be understood from FIGS. 1A, 1B, and 5, the engaged portions 25 are formed in alignment in the lengthwise direction of the belt 20 so as to enable adjustment of the attachment position of the other end portion h of the second plate frame member 30b in the lengthwise direction of the belt 20. Accordingly, the attachment position of the other end portion h (see FIG. 6B) of the second plate frame member 30b can be adjusted in the lengthwise direction of the belt 20. Accordingly, the length of the loop of the belt 20 can be set variably so as to exactly match the circumferential length of the wrist 90 serving as the measurement site.

[0153] Also, the multiple (in this example, 2) engaged portions 25 are formed in alignment in the width direction of the belt 20. Accordingly, even if the belt 20 twists slightly, the engagement between the engaging portions 32 and the engaged portions 25 is not likely to come off.

[0154] Also, at least the outer surface of the leading end portion b of the belt 20 is composed of a flexible material. Accordingly, it is easy to remove the engagement between the engaging portions 32 and the engaged portions 25. Note that it is possible to include a removal mechanism (not shown) according to which the user removes the locking between the engaging portions 32 and the engaged portions 25. In this case, in the state in which the belt 20 is attached to the wrist 90, the user can remove the locking between the

engaging portions 32 and the engaged portions 25 using the removal mechanism. Accordingly, removal of the belt 20 is even easier.

[0155] FIG. 6A is a schematic perspective view for illustrating a first state of operations of the buckle 30 shown in FIG. 5, and FIG. 6B is a schematic perspective view for illustrating a second state of operations of the buckle 30 shown in FIG. 5.

[0156] The buckle 30 includes a first plate frame member 30a that is attached at the one end portion d so as to be able to rotate about the axis c that intersects with the lengthwise direction of the belt 20 on the inner surface side of the base end portion a of the belt 20, and the first plate frame member 30a extends in a curved manner in the form of a plate from the one end portion d to the other end portion e on the opposite side. Also, the second plate frame member 30b is attached so as to be able to rotate about an axis f that is parallel to an axis c and is included on the other end portion e of the second plate frame member 30a, and the second plate frame member 30b extends in a curved manner in the form of a plate from the one end portion g to the other end portion h on the opposite side.

[0157] Furthermore, the other end portion h of the second plate frame member 30b is formed so as to be able to attach to the leading end portion b of the belt 20, and the first plate frame member 30a and the second plate frame member 30b include a first opening portion OP1 and a second opening portion OP2 that penetrate through the plate surfaces of the respective portions. Here, in a state in which the inner surface of the main body 10, the first plate frame member 30a, and the second plate frame member 30b of the buckle 30 are folded over so as to overlap, the first opening portion OP1 of the first plate frame member 30a and the second opening portion OP2 of the second plate frame member 30b are continuous in the thickness direction of the main body 10.

[0158] Accordingly, it is possible to use a configuration in which the fluid bladder 22 is arranged so as to compress the measurement site on the inner side of the main body 10.

[0159] The first opening portion OP1 opens toward the other end portion e side of the first plate frame member 30a, the second opening portion OP2 opens toward the one end portion g side of the second plate frame member 30b, and the first opening portion OP1 and the second opening portion OP2 are in communication. In other words, the first plate frame member 30a and the second plate frame member 30b are formed into an approximate U shape, and are joined together at the sides at which the opening portions are open. Also, as can be understood from FIG. 2, the fluid bladder 22 for compressing the measurement site during blood pressure measurement is provided along the lengthwise direction of the belt 20 in the belt 20, and the fluid bladder 22 is in communication with the interior of the main body 10 through the region corresponding to the first opening portion OP1 and the second opening portion OP2 in the folded state.

[0160] With this configuration, the region of the wrist 90 serving as the measurement site that is spatially continuous from the portion corresponding to the inside of the main body 10 to the leading end portion b of the belt 20 in the circumferential direction can be compressed with the fluid bladder 22. Accordingly, since it is possible to further increase the area with which the air bladder 22 and the measurement site come into contact, the efficiency of com-

pressing the artery can be improved. Accordingly, the blood pressure measurement accuracy can be further increased.

[0161] Also, the fluid bladder 22 extends in the lengthwise direction to the leading end portion b of the belt 20. Also, in the state in which the inner surface of the main body 10, the first plate frame member 30a, and the second plate frame member 30b of the buckle 30 are folded so as to overlap, the portion of the main body 10 with which the fluid bladder 22 is in communication overlaps with the portion of the belt 20 at which the fluid bladder 22 extends.

[0162] Due to this configuration, the above-described region of the belt 20 that overlaps in the lengthwise direction expands by an amount corresponding to the thickness, which is larger than the thickness of the other regions of the main body 10. Accordingly, the distance by which the artery in the wrist 90 is pushed away by the regions other than the overlapping region decreases, and the extra pressure increase amount for pressing down the artery decreases. As a result, the measurement value of the blood pressure measured by inflating the fluid bladder can be brought closer to the true value, and the measurement accuracy can be increased. Note that the effect of being able to reduce the extra pressure increase amount for pressing down the artery is also achieved in the case where the first opening portion OP1 of the first plate frame member 30a and the second opening portion OP2 of the second plate frame member 30b are omitted in the buckle 30.

[0163] FIGS. 7A to 7C are schematic diagrams for illustrating a procedure of attaching the bodily information measurement apparatus 1 shown in FIG. 1 to a wrist and performing measurement. When the bodily information measurement apparatus 1 is actually attached to the wrist 90, as shown in FIG. 7A, the user first aligns the belt 20 with the wrist 90 in the state in which the main body 10, the first plate frame member 30a, and the second plate frame member 30b of the buckle 30 are open toward each other. Then, the leading end portion b of the belt 20 passes through the interior of the second opening portion OP2 (see FIGS. 6A and 6B) of the second plate frame member 30b, and the engaging portions 32 of the second plate frame member 30b are engaged with the engaged portions 25 on the leading end portion b side of the belt 20. Accordingly, the belt 20 is made into a loop, and is set to a state in which the wrist 90 is passed through the loop of the belt 20. Thus, the length of the loop of the belt 20 is set so as to exactly match the circumferential length of the wrist 90.

[0164] Next, as shown in FIG. 7B, the main body 10 is brought close to the wrist 90 side, and the inner surface of the main body 10, the first plate frame member 30a, and the second plate frame member 30b of the buckle 30 are folded so as to overlap. Upon doing so, the protrusions 31 of the second plate frame member 30b stick to the magnet 33, whereby the attachment of the bodily information measurement apparatus 1 to the wrist 90 is complete. Next, as shown in FIG. 7C, measurement of the blood pressure is started when the user presses the blood pressure measurement switch 52B.

[0165] FIG. 8 is a block diagram schematically showing an internal configuration of the bodily information measurement apparatus 1 shown in FIG. 1. In addition to the above-described display device 50 and the operation unit 52, the main body 10 is provided with a CPU (Central Processing Unit) 100, a memory 51, a power source unit 53, a pressure sensor 16 serving as a piezoresistant pressure

detection unit, a piezoelectric pump 17 serving as a fluid supply unit, which is a piezoelectric pump that supplies air serving as a fluid to the fluid bladder 22, a valve 18 for adjusting the pressure (back pressure) on the discharge side of the piezoelectric pump 17, an oscillation circuit 160 that converts the output from the pressure sensor 16 into a frequency, a pump driving circuit 170 that drives the piezoelectric pump 17, and a valve driving circuit 180 that drives the valve 18. The pressure sensor 16, the piezoelectric pump 17, and the valve 18 are connected to the fluid bladder 22 contained in the belt 20 via an air tube 39 provided inside of the main body and a nipple 38 (see FIG. 5) that fits in and is in communication with the air tube 39. Accordingly, the air serving as the fluid flows through the gap between the pressure sensor 16, piezoelectric pump 17, and valve 18, and the fluid bladder 22.

[0166] The display device 50 includes a display, an indicator, and the like, and displays predetermined information in accordance with the control signal from the CPU 100.

[0167] With the operation unit 52, the power switch 52A receives an instruction to turn on or off the power source unit 53. The blood pressure measurement switch 52B receives an instruction to start blood pressure measurement and an instruction to display the data of the measurement results of the blood pressure values stored in the memory 51 on the display device 50. The switches 52A and 52B input operation signals corresponding to instructions given by the user to the CPU 100.

[0168] The memory 51 stores programs for controlling the bodily information measurement apparatus 1, setting data for setting various functions of the bodily information measurement apparatus 1, and data of measurement results of blood pressure values. Also, the memory 51 is used as a work memory or the like for when a program is executed.

[0169] The power source unit 53 supplies power to the units, namely, the CPU 100, the pressure sensor 16, the piezoelectric pump 17, the valve 18, the display device 50, the memory 51, the oscillation circuit 160, the pump driving circuit 170, and the valve driving circuit 180.

[0170] The oscillation circuit 160 oscillates based on an electric signal value based on changes in electrical resistance caused by a piezoresistant effect from the pressure sensor 16 and outputs a frequency signal having a frequency corresponding to the electrical signal value of the pressure sensor 16 to the CPU 100.

[0171] The CPU 100 functions as a back pressure control unit in accordance with a program for controlling the bodily information measurement apparatus 1 stored in the memory 51 so as to perform control for driving the piezoelectric pump 17 via the pump driving circuit 170 according to the operation signals from the operation unit 52, and driving the valve 18 via the valve driving circuit 180. The valve 18 opens and closes so as to control the back pressure by discharging or sealing the air in the air bladder 22. Also, the CPU 100 calculates the blood pressure values based on the signal from the pressure sensor 16 and controls the display device 50 and the memory 51.

[0172] The piezoelectric pump 17 supplies air as a fluid to the fluid bladder 22 in order to increase the pressure (back pressure) in the fluid bladder 22 contained in the belt 20. The valve 18 opens and closes so as to control the back pressure by discharging or sealing the air in the air bladder 22. The pump driving circuit 170 drives the piezoelectric pump 17 based on the control signal provided by the CPU 100. The

valve driving circuit **180** opens and closes the valve **18** based on the control signal provided by the CPU **100**.

[0173] The pressure sensor **16** and the oscillation circuit **160** operate as a pressure detection unit that detects back pressure. The pressure sensor **16** is, for example, a piezoresistant pressure sensor, and is connected via the air tube **39** to the piezoelectric pump **17**, the valve **18**, and the fluid bladder **22** contained in the belt **20**. In this example, the oscillation circuit **160** oscillates based on an electric signal value based on changes in electrical resistance caused by a piezoresistant effect from the pressure sensor **16** and outputs the frequency signal having the frequency corresponding to the electrical signal value of the pressure sensor **16** to the CPU **100**.

[0174] Operations of the bodily information measurement apparatus **1** configured as described above will be described below.

[0175] FIG. **9** is a flowchart showing blood pressure measurement processing executed by the bodily information measurement apparatus **1** shown in FIG. **1**. In the case of measuring the blood pressure in accordance with a common oscillometric method, the following operations are generally performed. In other words, the cuff is wrapped around the measurement site (wrist, etc.) of the user in advance, and during measurement, the pump and valve are controlled, the back pressure is increased to be greater than the systolic blood pressure, and thereafter the back pressure is gradually reduced. In the process of reducing the pressure, the back pressure is detected by the pressure sensor, and the variation in the artery volume that occurs in the artery at the measurement site is taken as a pulse wave signal. The systolic blood pressure and the diastolic blood pressure are calculated based on changes in the amplitude of the pulse wave signal accompanying changes in the back pressure at this time (mainly rising edges and falling edges).

[0176] With the bodily information measurement apparatus **1**, the blood pressure values of the user are measured by the CPU **100** using an oscillometric method according to the flow shown in FIG. **9**.

[0177] Specifically, when the measurement switch **52B** is pressed while the power source switch **52A** is on, the bodily information measurement apparatus **1** starts blood pressure measurement as shown in FIG. **9**. At the start of blood pressure measurement, the CPU **100** initializes the memory region for processing and outputs a control signal to the valve driving circuit **180**. Based on the control signal, the valve driving circuit **180** opens the valve **18** to discharge the air in the fluid bladder **22** of the belt **20**. Next, control for adjusting the pressure sensor **16** to 0 mmHg is performed.

[0178] In FIG. **9**, when the blood pressure measurement is started, first, the CPU **100** closes the valve **18** via the valve driving circuit **180**, and thereafter, drives the pump **32** via the pump driving circuit **170** to perform pressure increase processing for sending air to the fluid bladder **22**. Accordingly, the fluid bladder **22** is inflated and the back pressure gradually increases (step ST101).

[0179] When the cuff pressure is increased and reaches a predetermined cuff pressure (YES in step ST102), the CPU **100** stops the pump **32** via the pump driving circuit **170** and thereafter performs control for gradually opening the valve **18** via the valve control circuit **180**. Accordingly, the fluid bladder **22** contracts and the back pressure gradually decreases (step ST103).

[0180] Here, the predetermined pressure is a pressure that is sufficiently higher than the systolic blood pressure of the user (e.g., systolic blood pressure+30 mmHg), and is stored in the memory **51** in advance or is determined by the CPU **100** estimating the systolic blood pressure using a predetermined calculation method while the back pressure is increasing (e.g., see JP 2001-70263A).

[0181] Also, regarding the pressure decrease speed, a target pressure decrease speed is set while the pressure in the cuff is increased, and the CPU **100** controls the opening degree of the valve **18** so as to reach the target pressure decrease speed (see JP 2001-70263A).

[0182] In the process of reducing the pressure, the pressure sensor **16** detects a back pressure signal (indicated by reference sign Pc) that indicates the pressure of the belt **20**, via the belt **20**. Based on the back pressure signal Pc, the CPU **100** calculates the blood pressure values (systolic blood pressure and diastolic blood pressure) by applying a later-described algorithm through the oscillometric method (step ST104). Note that the calculation of the blood pressure values is not limited to being performed during the pressure reduction process and may be performed during the pressure increase process.

[0183] When the blood pressure values are calculated and determined (YES in step ST105), the CPU **100** displays the calculated blood pressure values on the display device **50** (step ST106) and performs control for storing the blood pressure values in the memory **51** (step ST107).

[0184] Next, the CPU **100** opens the valve **18** via the valve driving circuit **180** and performs control for discharging the air in the fluid bladder **22** of the belt **20** (step ST108).

[0185] Thereafter, when the power source switch **52A** is pressed, the blood pressure measurement ends.

[0186] In the case of removing the bodily information measurement apparatus **1** from the wrist **90**, the user opens the first plate frame member **30a** and the second plate frame member **30b** of the buckle **30** and removes the wrist **90** from the belt **20** in a state in which the loop of the belt **20** has been made larger.

[0187] During the second and subsequent instances of attaching, the wrist **90** need only be passed through the loop of the belt **20** in a state in which the first plate frame member **30a** and the second plate frame member **30b** of the buckle **30** are open, and the buckle **30** need only be closed. Accordingly, the user can easily attach the bodily information measurement apparatus **1** to the wrist **90**.

#### Second Embodiment

[0188] FIG. **12A** is a top view showing the exterior of a bodily information measurement apparatus **1A** according to a second embodiment of the present invention. FIG. **12B** is a bottom view of the bodily information measurement apparatus **1A** shown in FIG. **12A**, and FIG. **12C** is a perspective view showing a state at a time of attaching the bodily information measurement apparatus **1A** shown in FIG. **12A** by wrapping it around a measurement site.

[0189] As shown in FIG. **12A**, in comparison to the bodily information measurement apparatus **1** according to the first embodiment, the bodily information measurement apparatus **1A** according to the present embodiment differs in that a belt **20A** is included instead of the belt **20** and a buckle **30A** is included instead of the buckle **30**.

[0190] Also, as can be understood from FIGS. **12A** and **12B**, in comparison to the belt **20** according to the first

embodiment, the belt 20A according to the present embodiment differs in that wide portions 20a are provided in the width direction, which is perpendicular to the lengthwise direction of the belt 20A. The wide portions 20a are formed on both sides of the second fixing elements (engaged portions 25) in the width direction. In other words, the engaged portions 25 are formed in a wide region of the belt 20A and are formed such that the leading end portion of the belt 20A is wide in the width direction, which is perpendicular to the lengthwise direction of the belt 20A, such that the engaged portions 25 are caught by the leading end portions of later-described hook portions 34.

[0191] Also, as can be understood from FIGS. 12B and 12C, in comparison to the buckle 30 according to the first embodiment, the buckle 30A according to the present embodiment differs in that the second plate frame member 30Ab is included instead of the second plate frame member 30b. Here, the first fixing elements including the engaging portions 32A, which have protruding shapes, are provided on the inner surface of the other end portion h of the second plate frame member 30Ab. Along with this, as shown in FIGS. 12A and 12C, second fixing elements including the engaged portions 25, which have recessed shapes that can be engaged with the engaging portions 32A, are provided on the outer surface of the leading end portion b of the belt 20A. Accordingly, as shown in FIG. 12C, the second plate frame member 30Ab and the leading end portion b of the belt 20A can be engaged so as to make the belt 20A into a loop shape. Accordingly, the bodily information measurement apparatus 1A can be fixed to the measurement site. Furthermore, since the non-through, recessed second fixing elements (engaged portions 25), which are formed so as to be able to be engaged with the protruding first fixing elements (engaging portions 32A), are provided on the outer surface of the leading end portion b of the belt 20A, the fixing elements no longer interfere with the fluid bladder 22. Accordingly, the wrist 90 serving as the measurement site can be reliably compressed by the fluid bladder 22 during blood pressure measurement.

[0192] As shown in FIGS. 12A, 12B, and 12C, hook-shaped hook portions 34 that are formed so as to protrude are formed on the other end portion h of the second plate frame member 30Ab. The hook portions 34 are locked by catching on the wide portion 20a of the belt 20A. Accordingly, the second plate frame member 30Ab can be reliably fixed to the belt 20A.

[0193] As can be understood from FIG. 12B, the engaged portions 33A, which have recessed shapes, are included on the inner surface side of the base end portion a of the belt 20A, and the engaging portions 31A that engage with the engaged portions 33A are included on the second plate frame member 30Ab, and thereby the lock mechanism is configured. With the lock mechanism, it is possible to lock the inner surface side of the base end portion a or the one end portion d of the first plate frame member 30a of the belt 20A together with the other end portion h of the second plate frame member 30Ab. Accordingly, when the main body 10, the first plate frame member 30a, and the second plate frame member 30Ab of the buckle 30A are folded in on each other, the inner surface of the main body 10, the first plate frame member 30a, and the second plate frame member 30Ab of the buckle 30A are fixed so as to overlap.

[0194] As can be understood from FIGS. 12A and 12C, multiple engaged portions 25 are formed in alignment in the lengthwise direction of the belt 20A so as to enable the

attachment position of the other end portion h of the second plate frame member 30Ab to be adjusted in the lengthwise direction of the belt 20A. Accordingly, the attachment position of the other end portion h (see FIG. 12C) of the second plate frame member 20Ab can be adjusted in the lengthwise direction of the belt 20A. Accordingly, the length of the loop of the belt 20A can be set variably so as to exactly match the circumferential length of the wrist 90 serving as the measurement site.

[0195] In the above-described embodiment, a wrist was used as the measurement site, but the present embodiment is not limited to this. For example, the measurement site may be an arm or a leg. Also, the bodily information measurement apparatuses 1 to 11 according to one or more embodiments of the present invention need not merely measure blood pressure values, and may also measure other bodily information, such as a pulse count.

[0196] The above-described embodiments are merely exemplary, and various modifications are possible without departing from the scope of the invention. The above-described multiple embodiments can be achieved independently, but the embodiments can also be combined. Also, the various characteristics in the different embodiments can be achieved independently, and the characteristics in the different embodiments can also be combined.

#### REFERENCE SIGNS LIST

|        |  |
|--------|--|
| [0197] | 1, 1A Bodily information measurement apparatus |
| [0198] | 10 Main body                                   |
| [0199] | 16 Pressure sensor                             |
| [0200] | 17 Piezoelectric pump                          |
| [0201] | 18 Valve                                       |
| [0202] | 20, 20A Belt                                   |
| [0203] | 22 Fluid bladder                               |
| [0204] | 23 Reinforcing layer                           |
| [0205] | 24 Outer circumferential layer                 |
| [0206] | 25 Engaged portion                             |
| [0207] | 29 Sheet                                       |
| [0208] | 30, 30A Buckle                                 |
| [0209] | 30a First plate frame member                   |
| [0210] | 30b, 30Ab Second plate frame member            |
| [0211] | 31 Protruding portion                          |
| [0212] | 31A, 32, 32A Engaging portion                  |
| [0213] | 33 Magnet                                      |
| [0214] | 34 Hook portion                                |
| [0215] | 38 Nipple                                      |
| [0216] | 39 Air tube                                    |
| [0217] | 50 Display device                              |
| [0218] | 51 Memory                                      |
| [0219] | 52 Operation portion                           |
| [0220] | 52A Power source switch                        |
| [0221] | 52B Blood pressure measurement switch          |
| [0222] | 53 Power source unit                           |
| [0223] | 66 Cap member                                  |
| [0224] | 160 Oscillation circuit                        |
| [0225] | 170 Pump driving circuit                       |
| [0226] | 180 Valve driving circuit                      |
| [0227] | 100 CPU  |

1. A band-shaped blood pressure monitor cuff to be wrapped around a measurement site, wherein  
 an outer circumferential layer arranged on a side opposite to that of the measurement site and a fluid bladder that is arranged on the measurement site side and swells and

contracts by letting a fluid in and out are stacked so as to form the blood pressure monitor cuff,  
 the outer circumferential layer and the fluid bladder are formed of an elastomer material,  
 two edge portions in a lengthwise direction of the outer circumferential layer protrude in a thickness direction toward the measurement site,  
 the fluid bladder includes a base layer that opposes the outer circumferential layer, and a top layer that is arranged so as to overlap with the base layer, the edge portions of the base layer and the top layer are welded and formed into a bladder shape, and separate additional sheets for preventing lateral bulging are further welded in the thickness direction at the welded edge portions of the top layer and the base layer, and  
 the fluid bladder is arranged between the two edge portions of the outer circumferential layer in a width direction, which is perpendicular to the lengthwise direction.

2. The blood pressure monitor cuff according to claim 1, wherein the fluid bladder is pressed between the protrusions of the two edge portions of the circumferential layer in the width direction and is adhered to the outer circumferential layer.

3. The blood pressure monitor cuff according to claim 2, wherein a reinforcing layer for suppressing outward swelling of the fluid bladder is provided between the outer circumferential layer and the fluid bladder, wherein on an inner circumferential surface of the reinforcing layer, grooves with recessed cross-sections extend linearly on the inner sides of the two edge portions in the width direction, and wherein the base layer is provided with protruding lines that fit into the linear grooves.

4. The blood pressure monitor cuff according to claim 3, wherein a depth dimension of the linear grooves and a height dimension of the protruding lines are equal.

5. The blood pressure monitor cuff according to claim 2, wherein the base layer is less flexible than the top layer.

6. A manufacturing method for manufacturing the blood pressure monitor cuff according to claim 1, wherein the top layer and the additional sheets are composed of a light-absorbing material, and the base layer is composed of a light-transmitting material,  
 the method comprising:  
 welding the top layer and the additional sheets by laying the additional sheets on edge portions on the outer surface of the top layer and emitting laser light to the entire region of portions at which the top layer and the additional sheets overlap; and  
 welding the base layer and the top layer by laying the base layer on a surface on a side opposite to that of the surface of the top layer to which the additional sheets were welded, and emitting laser light from the base layer side to part of portions at which the top layer and the additional sheets overlap.

7. A manufacturing method for manufacturing the blood pressure monitor cuff according to claim 1, wherein the top layer and the additional sheets are composed of a light-absorbing material, and the base layer is composed of a light-transmitting material,  
 the method comprising:  
 welding the top layer and the additional sheets by laying the additional sheets on edge portions on the outer

surface of the top layer and emitting laser light to part of portions at which the top layer and the additional sheets overlap; and  
 welding the base layer and the top layer by laying the base layer on a surface on a side opposite to that of the surface of the top layer to which the additional sheets were welded and emitting laser light from the base layer side to the portions at which the top layer and the additional sheets have not been welded, in the portions at which the top layer and the additional sheets overlap.

8. The blood pressure monitor cuff according to claim 1, wherein a reinforcing layer for suppressing outward swelling of the fluid bladder is provided between the outer circumferential layer and the fluid bladder.

9. The blood pressure monitor cuff according to claim 3, wherein the hardness of the reinforcing layer is greater than the hardness of the outer circumferential layer, which is greater than the hardness of the fluid bladder.

10. A manufacturing method for manufacturing the blood pressure monitor cuff according to claim 8, comprising:  
 preparing a reinforcing layer;  
 manufacturing an intermediate body composed of the reinforcing layer and the outer circumferential layer by laying resin that forms material of the outer circumferential layer through insert molding on the outer surface of the reinforcing layer; and  
 adhering or welding the fluid bladder prepared in advance along the inner surface of the reinforcing layer of the intermediate body.

11. A manufacturing method for manufacturing a band-shaped blood pressure monitor cuff to be wrapped around a measurement site,  
 wherein the cuff is formed by stacking an outer circumferential layer arranged on a side opposite to that of the measurement site, and a fluid bladder that is arranged on the measurement site side and swells and contracts by letting a fluid in and out,  
 wherein the outer circumferential layer and the fluid bladder are formed of an elastomer material,  
 wherein two edge portions extending in a lengthwise direction of the outer circumferential layer protrude in a thickness direction toward the measurement site,  
 wherein the fluid bladder includes a reinforcing layer that opposes the outer circumferential layer and prevents outward swelling of the fluid bladder, and a sheet that is arranged so as to overlap with the side of the reinforcing layer opposite to that of the outer circumferential layer, edge portions of the reinforcing layer and the sheet being welded to form a bladder shape, and  
 wherein the fluid bladder is arranged between the two edge portions of the outer circumferential layer in a width direction, which is perpendicular to the lengthwise direction,  
 the manufacturing method comprising:  
 preparing a reinforcing layer;  
 manufacturing an intermediate body composed of the reinforcing layer and the outer circumferential layer by laying resin that forms material of the outer circumferential layer through insertion molding on the outer surface of the reinforcing layer; and  
 adhering or welding a circumferential edge portion of the sheet prepared in advance along the inner surface of the reinforcing layer of the intermediate body so

as to form the fluid bladder composed of the reinforcing layer and the sheet.

**12.** The blood pressure monitor cuff according to claim 1, further comprising a cap member that collectively covers the leading end portion of the outer circumferential layer and the leading end portion of the fluid bladder.

**13.** A blood pressure monitor comprising:

the blood pressure monitor cuff according to claim 1; and a main body provided with a pressure detection unit and a fluid supply unit that communicate with the fluid bladder,

wherein the fluid supply unit compresses the measurement site by supplying a fluid to the fluid bladder, and wherein the pressure detection unit calculates blood pressure at the measurement site by detecting the pressure in the fluid bladder.

**14.** A band-shaped blood pressure monitor cuff to be wrapped around a measurement site,

wherein an outer circumferential layer arranged on a side opposite to that of the measurement site and a fluid bladder that is arranged on the measurement site side and swells and contracts by letting a fluid in and out are stacked so as to form the blood pressure monitor cuff, wherein the outer circumferential layer and the fluid bladder are formed of an elastomer material,

wherein two edge portions extending in a lengthwise direction of the outer circumferential layer protrude in a thickness direction toward the measurement site,

wherein the fluid bladder includes a base layer that opposes the outer circumferential layer, and a top layer that is arranged so as to overlap with the base layer, the edge portions of the base layer and the top layer are welded and formed into a bladder shape, and separate additional sheets for preventing lateral bulging are further welded in the thickness direction at the welded edge portions of the top layer and the base layer, and the fluid bladder is arranged between the two edge portions of the outer circumferential layer in a width direction, which is perpendicular to the lengthwise

direction, and the edge portions of the fluid bladder at which the additional sheets are welded are in contact with the protrusions on the two edge portions of the outer circumferential layer.

**15.** The blood pressure monitor cuff according to claim 14, wherein the hardness of the outer circumferential layer is greater than the hardness of the fluid bladder.

**16.** The blood pressure monitor cuff according to claim 1, wherein the base layer is less flexible than the top layer.

**17.** The blood pressure monitor cuff according to claim 2, wherein a reinforcing layer for suppressing outward swelling of the fluid bladder is provided between the outer circumferential layer and the fluid bladder.

**18.** The blood pressure monitor cuff according to claim 2, further comprising a cap member that collectively covers the leading end portion of the outer circumferential layer and the leading end portion of the fluid bladder.

**19.** A blood pressure monitor comprising:

the blood pressure monitor cuff according to claim 2; and a main body provided with a pressure detection unit and a fluid supply unit that communicate with the fluid bladder,

wherein the fluid supply unit compresses the measurement site by supplying a fluid to the fluid bladder, and wherein the pressure detection unit calculates blood pressure at the measurement site by detecting the pressure in the fluid bladder.

**20.** The blood pressure monitor cuff according to claim 1, wherein a reinforcing layer for suppressing outward swelling of the fluid bladder is provided between the outer circumferential layer and the fluid bladder,

wherein on an inner circumferential surface of the reinforcing layer, grooves with recessed cross-sections extend linearly on the inner sides of the two edge portions in the width direction, and

wherein the base layer is provided with protruding lines that fit into the linear grooves.

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