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(54) **MEASUREMENT DEVICE**

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(57) **ABSTRACT**

A measurement apparatus (**100**) for measuring biological information by a measured part being contacted to a contact portion includes sensors (**160**, **170**) that acquire biological measurement output from the measured part and a controller (**180**) that calculates a correction coefficient, for calculating the biological information, on the basis of the biological measurement output acquired by the sensors (**160**, **170**) and calculates the biological information on the basis of the calculated correction coefficient and the biological measurement output acquired by the sensors.

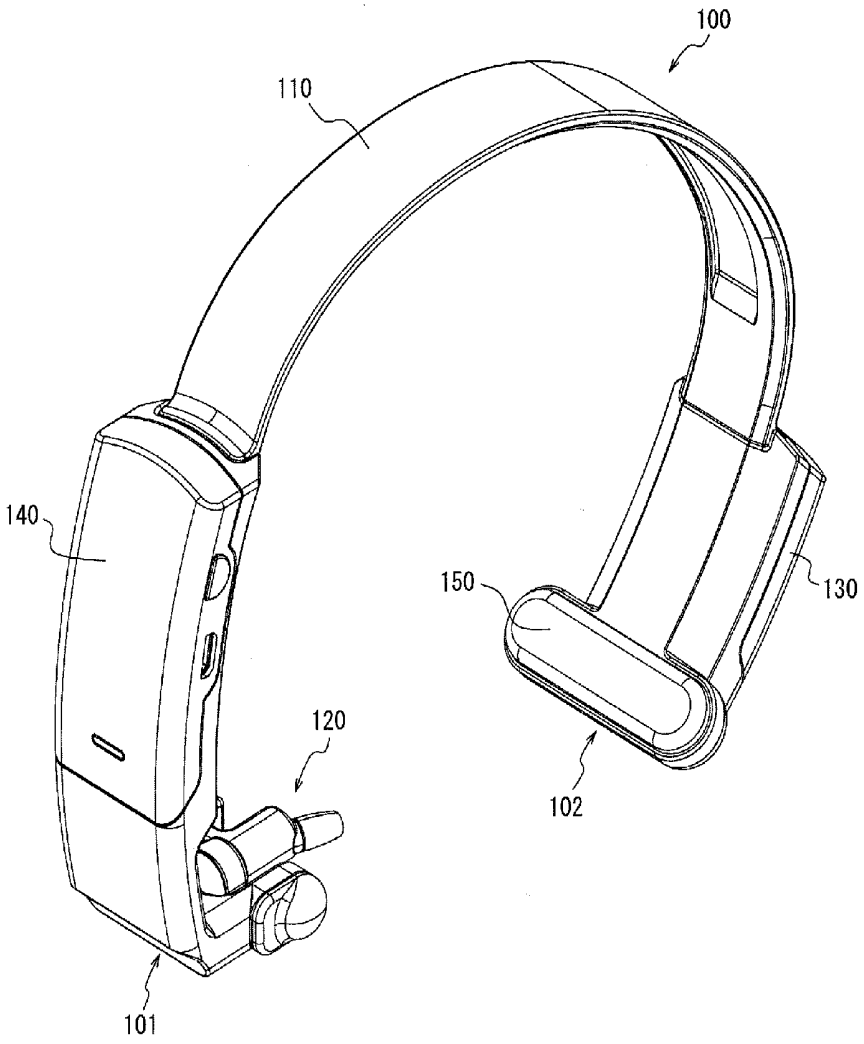


FIG. 1

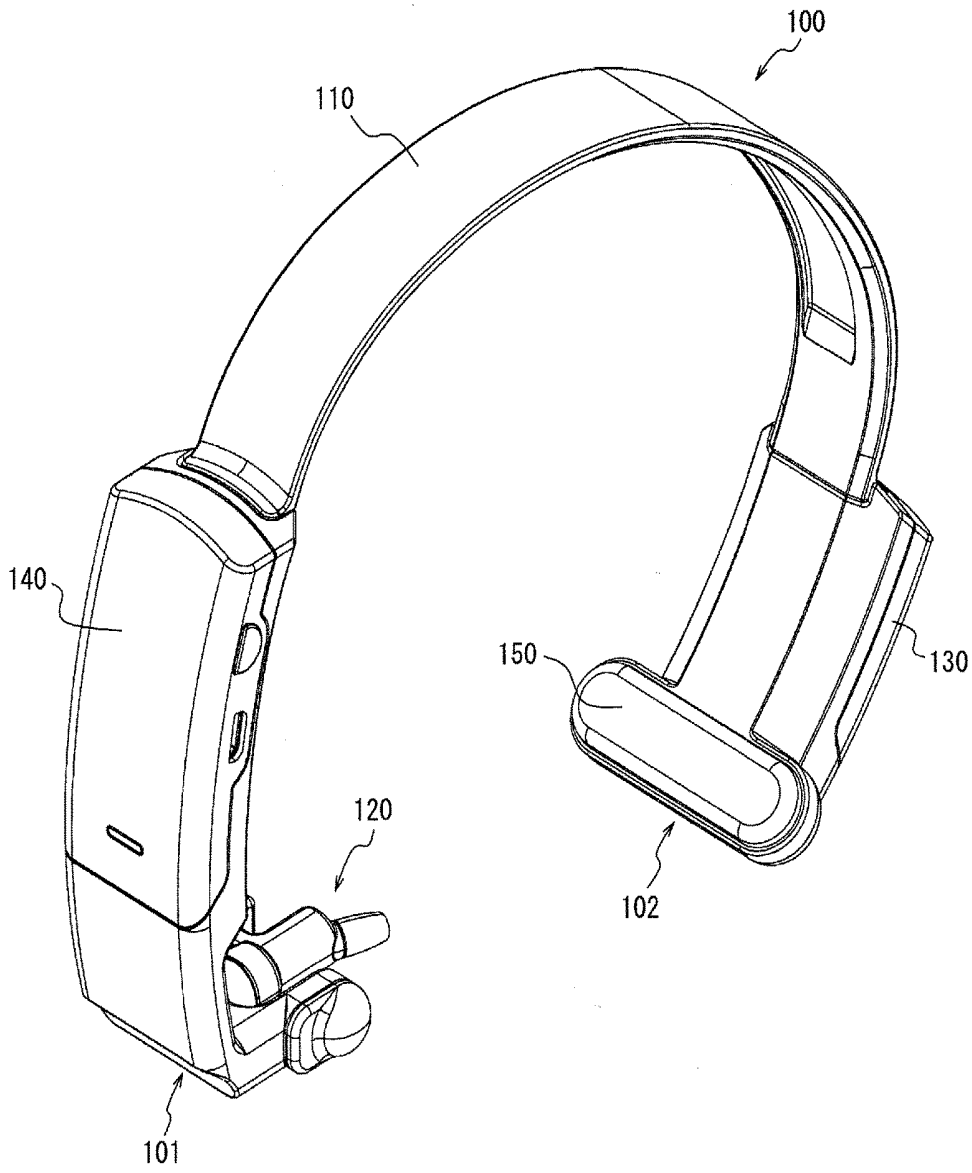


FIG. 2

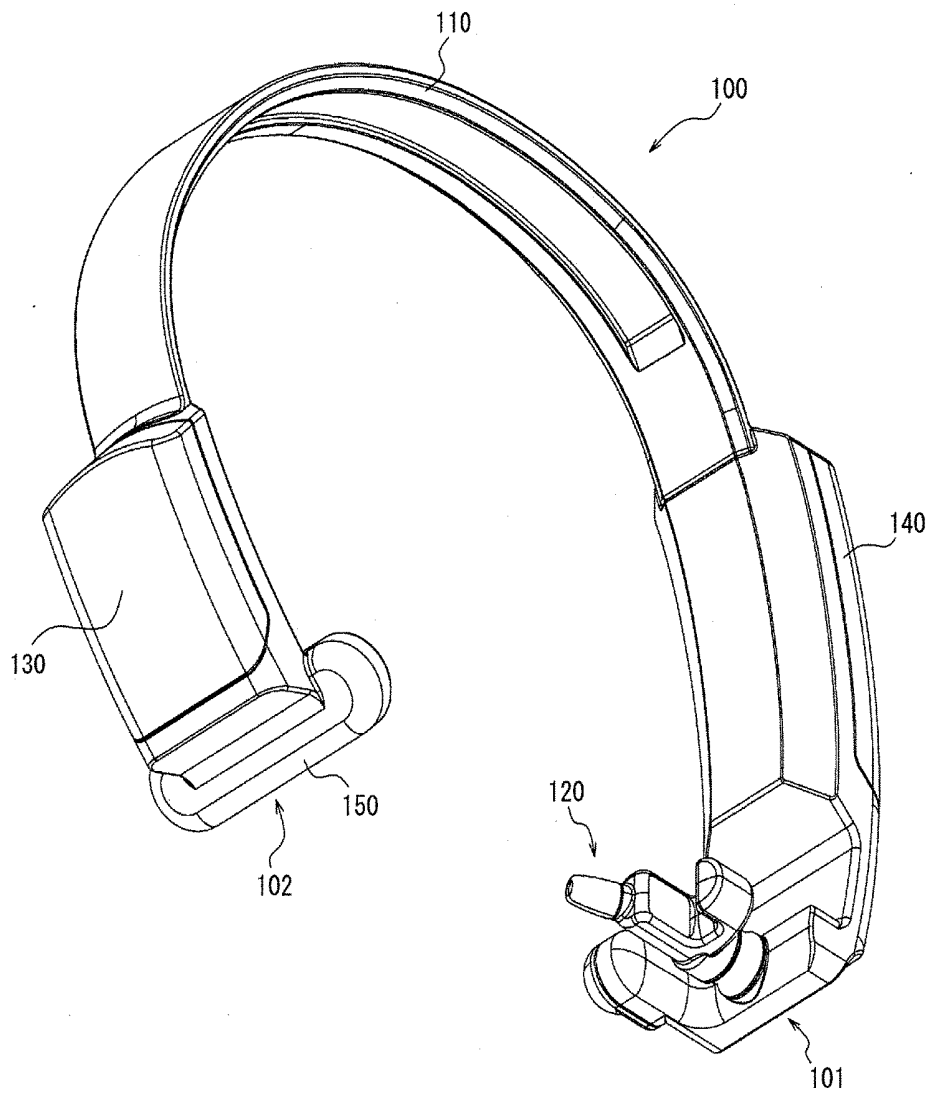


FIG. 3

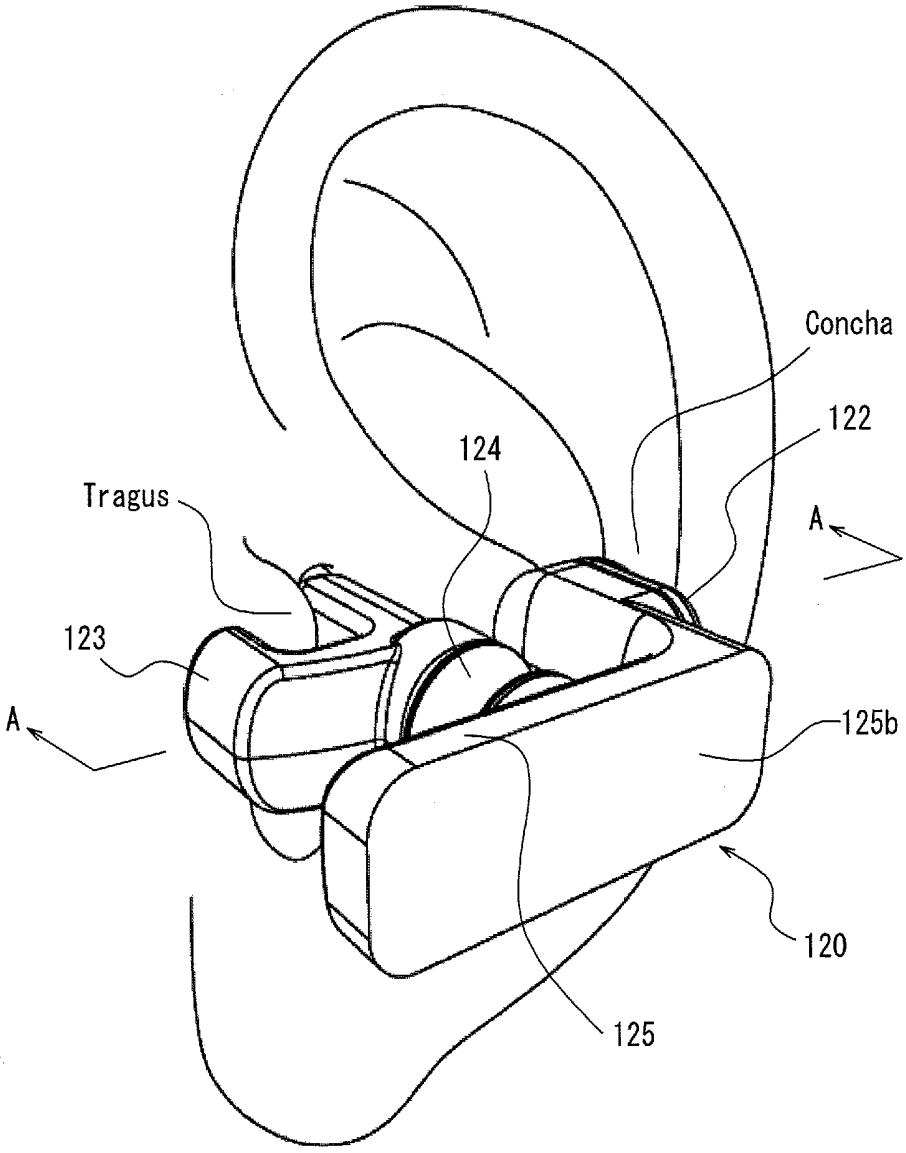


FIG. 4

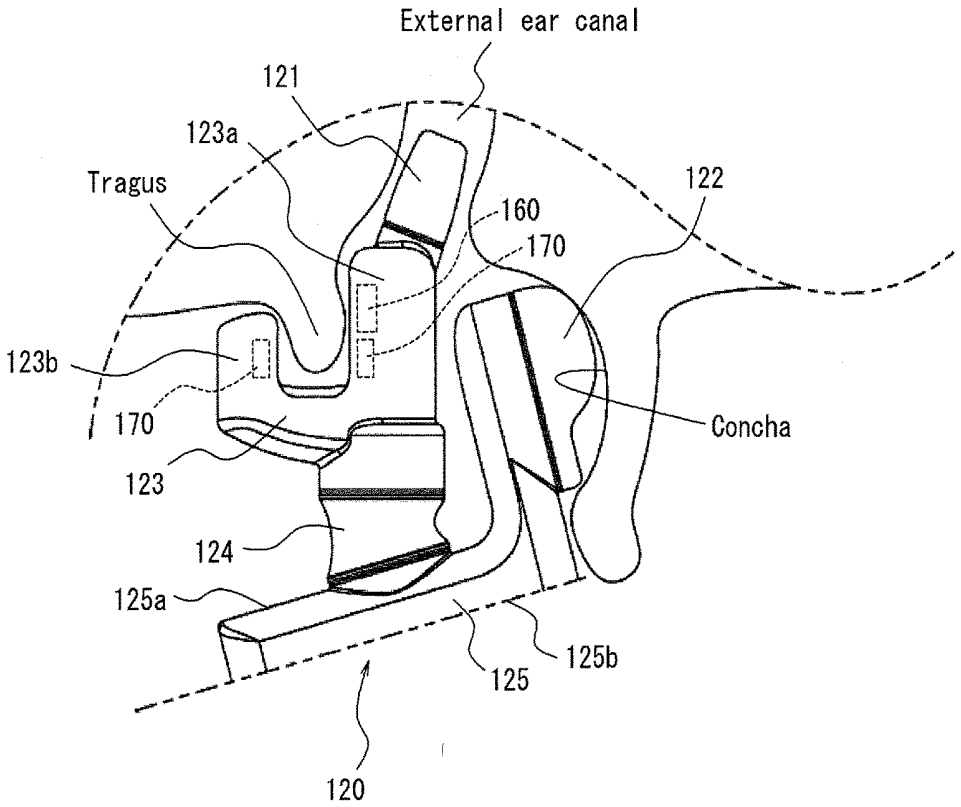

External ear canal
121
123a
Tragus
122
160
170
123b
170
Concha
123
124
125a
125b
125
120

FIG. 5

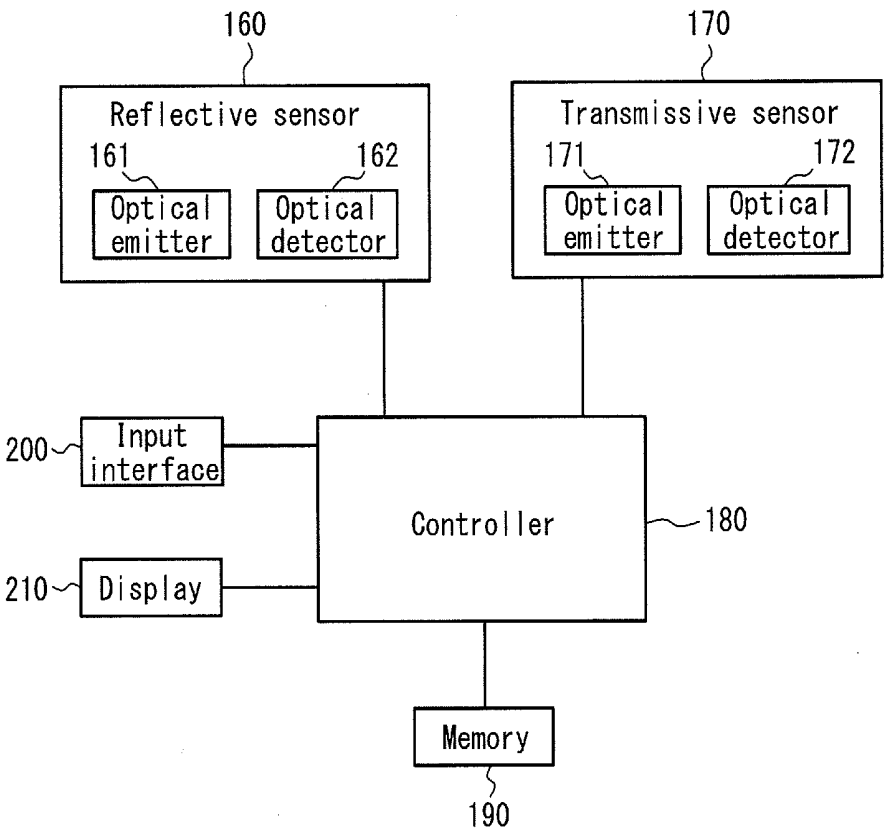

160
Reflective sensor
161
Optical emitter
162
Optical detector
170
Transmissive sensor
171
Optical emitter
172
Optical detector
200
Input interface
210
Display
Controller
180
Memory
190

FIG. 6

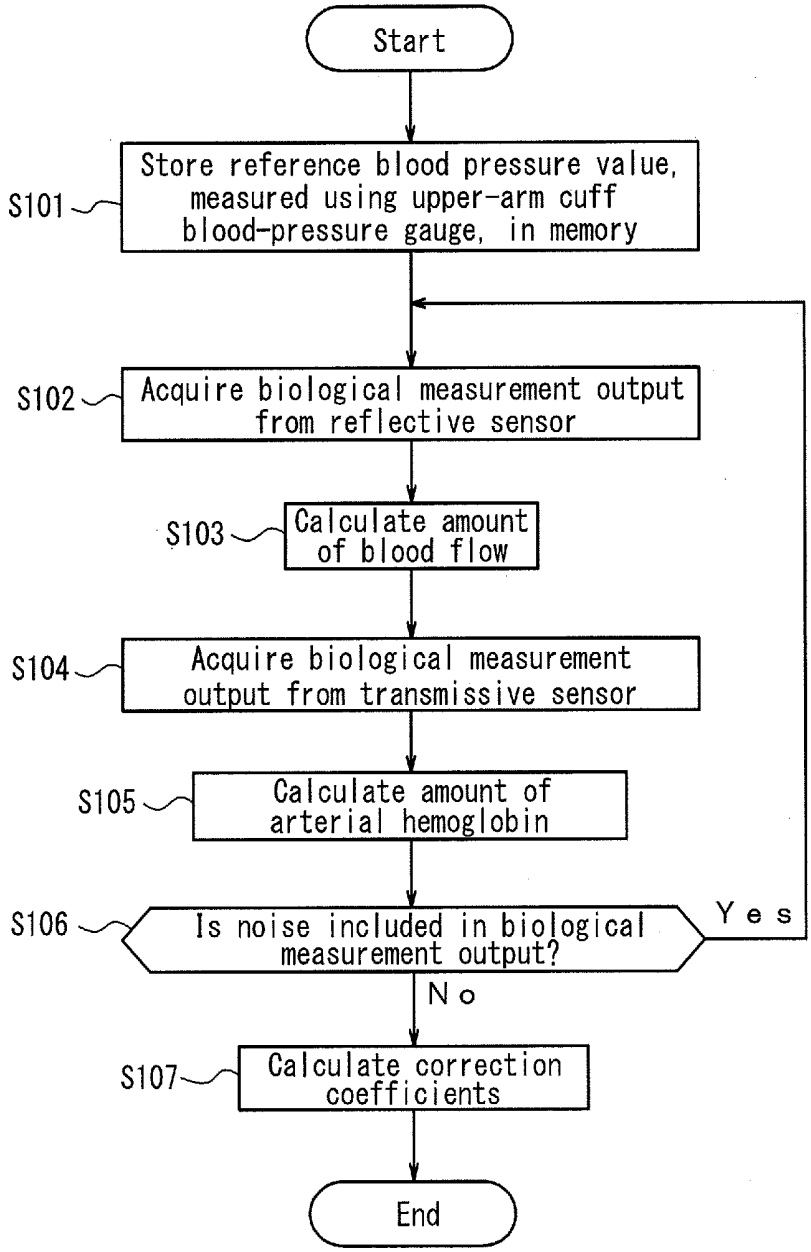

Start
S101
Store reference blood pressure value, measured using upper-arm cuff blood-pressure gauge, in memory
S102
Acquire biological measurement output from reflective sensor
S103
Calculate amount of blood flow
S104
Acquire biological measurement output from transmissive sensor
S105
Calculate amount of arterial hemoglobin
S106
Is noise included in biological measurement output?
Yes
No
S107
Calculate correction coefficients
End

FIG. 7

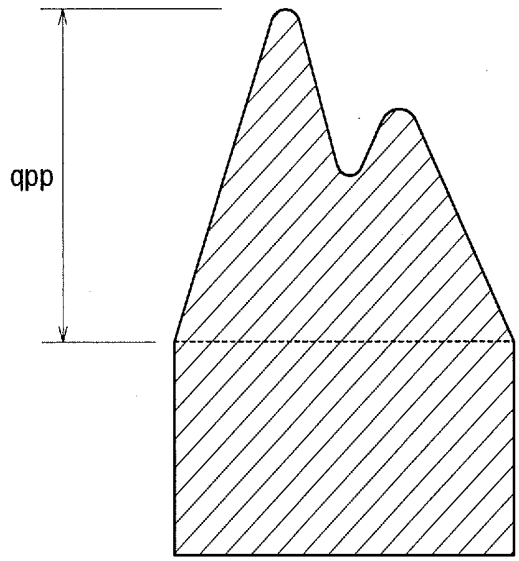


FIG. 8

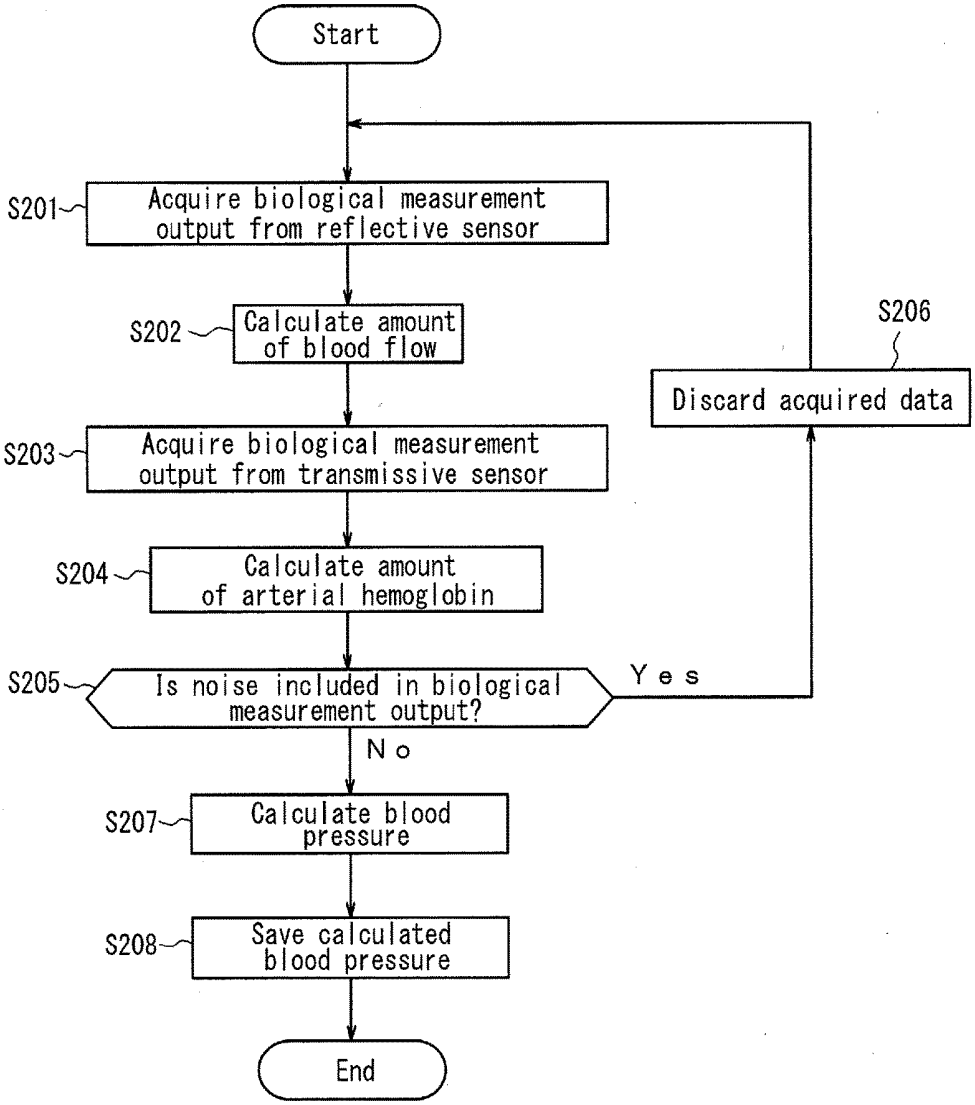

Start
S201
Acquire biological measurement output from reflective sensor
S202
Calculate amount of blood flow
S203
Acquire biological measurement output from transmissive sensor
S204
Calculate amount of arterial hemoglobin
S205
Is noise included in biological measurement output?
Yes
No
S206
Discard acquired data
S207
Calculate blood pressure
S208
Save calculated blood pressure
End

FIG. 9

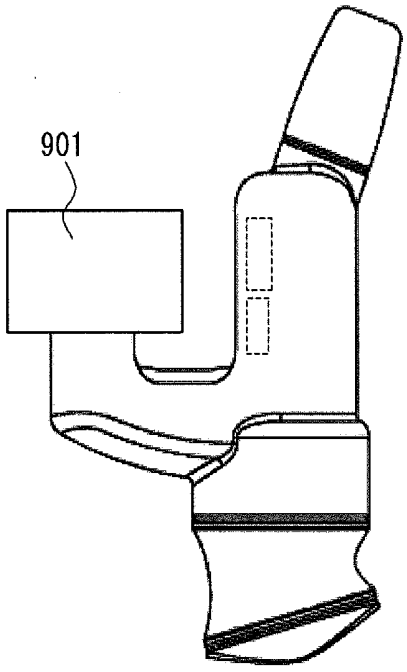


FIG. 10A

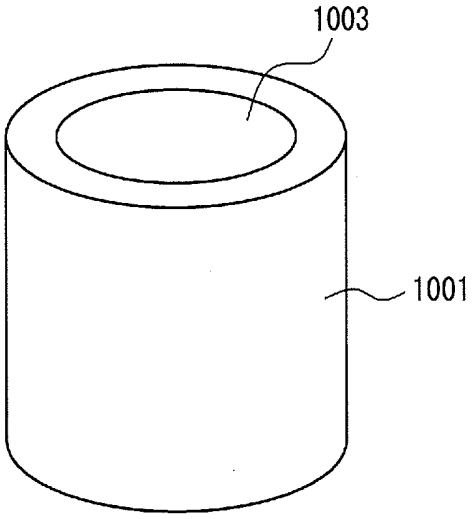



FIG. 10B

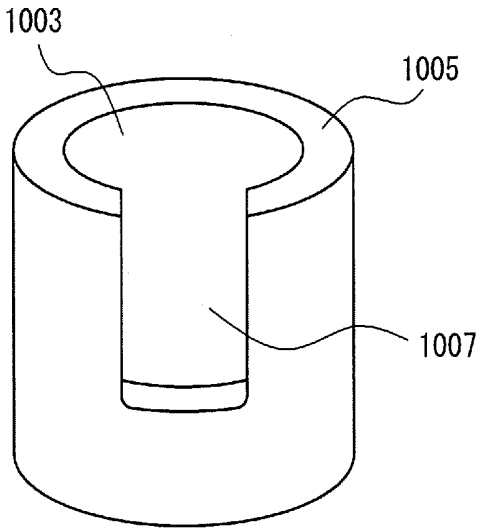


FIG. 11

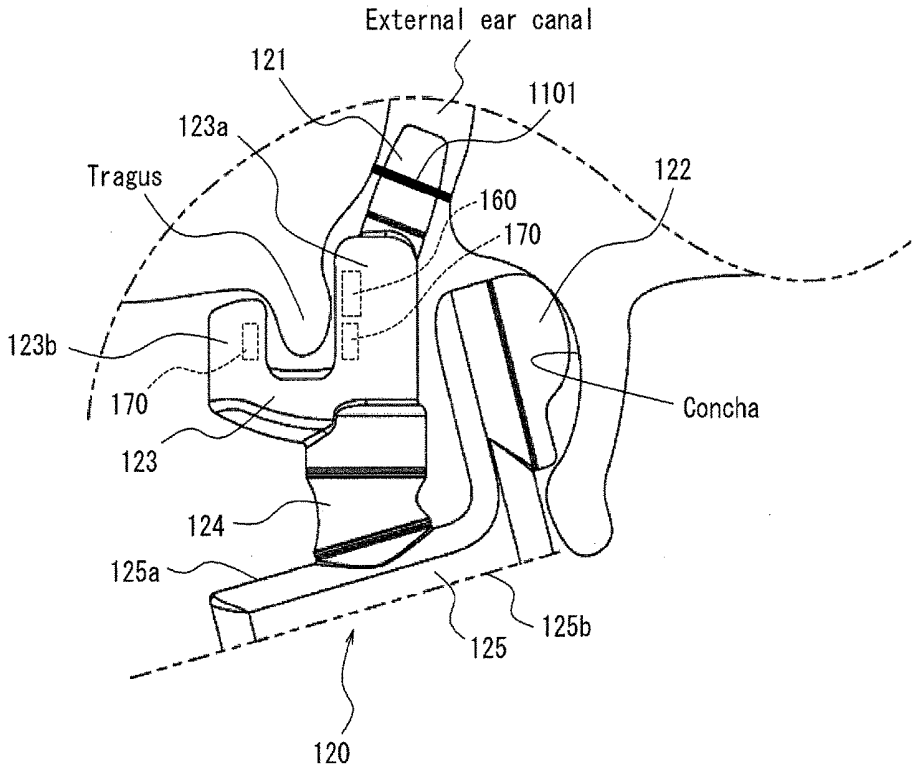

External ear canal
121
1101
123a
Tragus
122
160
170
123b
170
Concha
123
124
125a
125b
125
120

FIG. 12

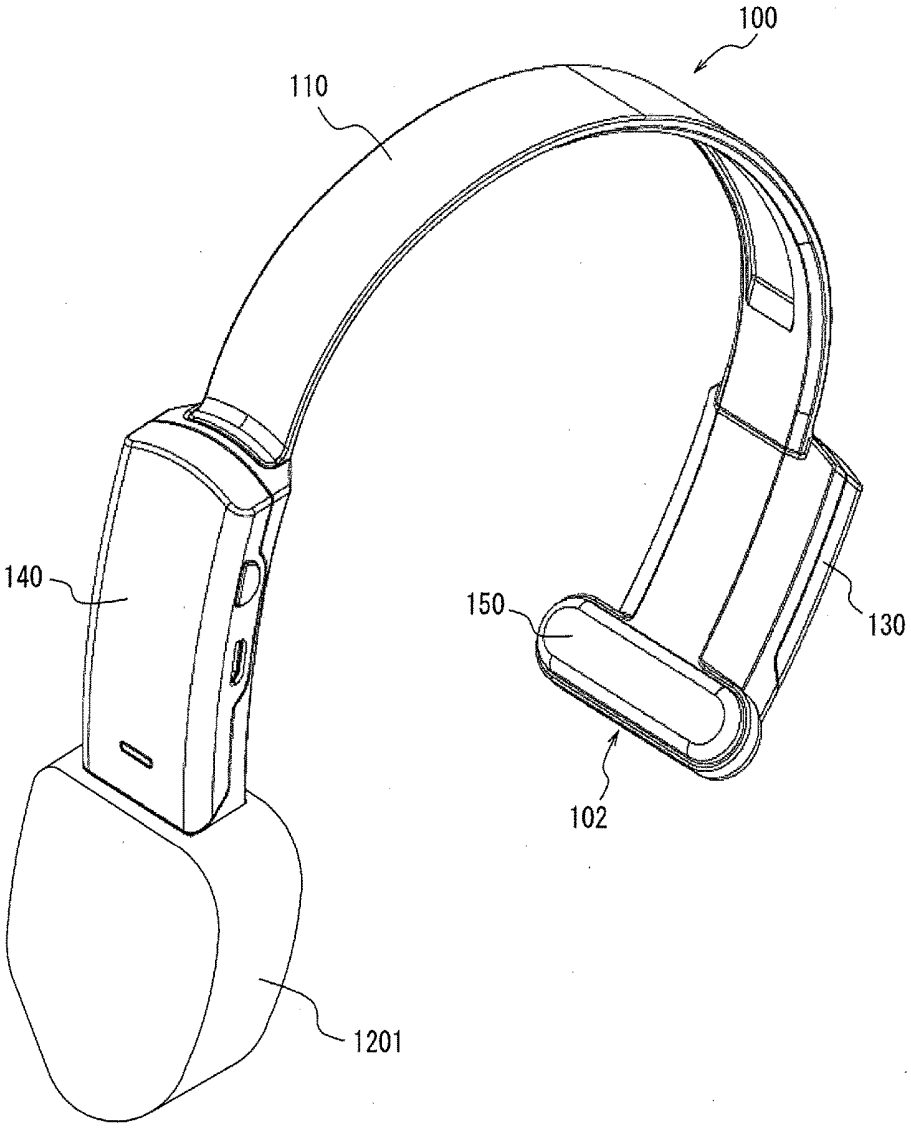


FIG. 13A

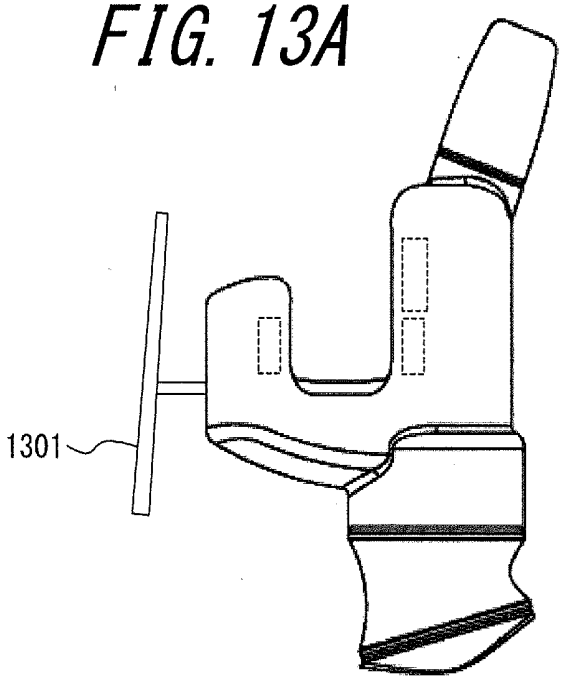
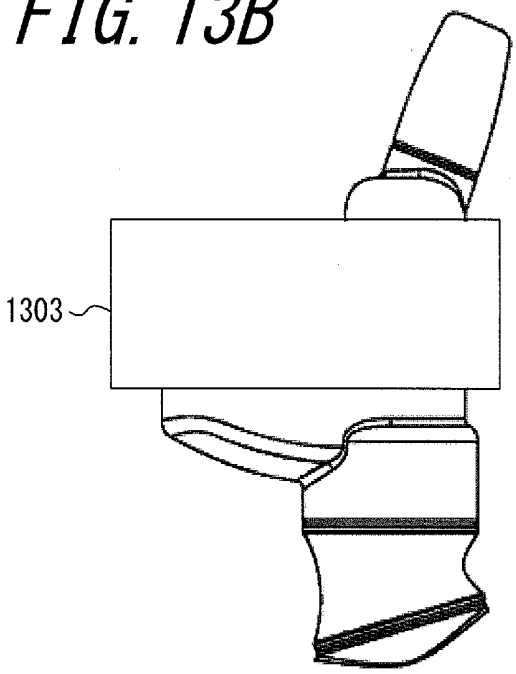



FIG. 13B



# MEASUREMENT DEVICE

## CROSS-REFERENCE TO RELATED APPLICATION

**[0001]** The present application claims priority to and the benefit of Japanese Patent Application No. 2015-203081 filed Oct. 14, 2015, the entire contents of which are incorporated herein by reference.

## TECHNICAL FIELD

**[0002]** The present disclosure relates to a measurement apparatus and a measurement method.

## BACKGROUND

**[0003]** A measurement apparatus that acquires biological measurement output using the tragus of a subject (user) as a measured part and measures biological information, such as blood pressure, on the basis of the biological measurement output is known. For example, patent literature (PTL) 1 and 2 disclose a blood pressure measurement apparatus that acquires biological measurement output from the tragus and measures the subject's blood pressure on the basis of the biological measurement output. As a method for calculating blood pressure on the basis of biological measurement output, PTL 3, for example, discloses a method for calculating blood pressure using Poiseuille's equation.

## CITATION LIST

### Patent literature

**[0004]** PTL 1: JP2008-114037A

**[0005]** PTL 2: JP2006-288644A

**[0006]** PTL 3: JP2004-154231A

## SUMMARY

**[0007]** A measurement apparatus according to the present disclosure is a measurement apparatus for measuring biological information by a measured part being contacted to a contact portion. The measurement apparatus includes a sensor and a controller. The sensor acquires biological measurement output from the measured part. The controller calculates a correction coefficient, for calculating the biological information, on the basis of the biological measurement output acquired by the sensor and calculates the biological information on the basis of the calculated correction coefficient and the biological measurement output acquired by the sensor.

**[0008]** A measurement method according to the present disclosure is for measuring biological information by contacting a measured part to a contact portion and includes an acquiring step, a correction coefficient calculating step, and a biological information calculating step. The acquiring step includes using a sensor to acquire biological measurement output from the measured part. The correction coefficient calculating step includes using a controller to calculate a correction coefficient, for calculating the biological information, on the basis of the biological measurement output acquired in the acquiring step. The biological information calculating step includes using the controller to calculate the biological information on the basis of the correction coefficient calculated in the correction coefficient calculating step and the biological measurement output acquired in the acquiring step.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0009]** In the accompanying drawings:

**[0010]** FIG. **1** is an external perspective view, from one direction, of a measurement apparatus according an embodiment of the present disclosure;

**[0011]** FIG. **2** is an external perspective view, from another direction, of the measurement apparatus in FIG. **1**;

**[0012]** FIG. **3** illustrates the holding state of a measurement mechanism in the left ear when the measurement apparatus in FIG. **1** is worn;

**[0013]** FIG. **4** illustrates the holding state in FIG. **3** viewed from the top of the head;

**[0014]** FIG. **5** is a functional block diagram illustrating the schematic configuration of the measurement apparatus in FIG. **1**;

**[0015]** FIG. **6** is a flowchart illustrating an example of a correction coefficient calculation process in a controller;

**[0016]** FIG. **7** schematically illustrates the pulsatile blood flow wave height within a waveform indicating blood flow;

**[0017]** FIG. **8** is a flowchart illustrating an example of a blood pressure calculation process in the controller;

**[0018]** FIG. **9** is a schematic view of a modification, illustrating a cover mounted on the measurement apparatus in FIG. **1**;

**[0019]** FIGS. **10**A and **10**B are schematic views of the cover in FIG. **9**;

**[0020]** FIG. **11** is a schematic view of a modification to the measurement apparatus in FIG. **1**;

**[0021]** FIG. **12** is a schematic perspective view of a modification to the measurement apparatus in FIG. **1**; and

**[0022]** FIGS. **13**A and **13**B are schematic views of a modification to the measurement apparatus in FIG. **1**.

## DETAILED DESCRIPTION

**[0023]** The calculation method disclosed in PTL 3 calculates the systolic blood pressure Vmax by multiplying the maximum amount of blood flow Qmax by the vascular resistance Rmin when the artery diameter is at a maximum. This method then calculates the diastolic blood pressure Vmin by multiplying the minimum amount of blood flow Qmin by the vascular resistance Rmax when the artery diameter is at a minimum. By contrast, the measurement apparatus and measurement method of the present disclosure can improve measurement accuracy.

**[0024]** An embodiment of the present disclosure is described below in detail with reference to the drawings.

**[0025]** FIG. **1** is an external perspective view, from one direction, of a measurement apparatus according an embodiment of the present disclosure. FIG. **2** is an external perspective view, from another direction, of the measurement apparatus in FIG. **1**. Specifically, FIG. **2** is an external perspective view from a viewpoint in the opposite direction from the viewpoint of the external perspective view in FIG. **1**.

**[0026]** A measurement apparatus **100** includes a holder **110**, a measurement mechanism **120**, and a power supply holder **130**. The holder **110** is an arched member capable of clamping a subject's head from the left and right. The measurement mechanism **120** is located on a first end **101**

side of the holder **110**. The power supply holder **130** is located on a second end **102** side, which is opposite from the first end **101** side where the measurement mechanism **120** is located. The measurement apparatus **100** includes a control mechanism holder **140** on the first end **101** side. The control mechanism holder **140** holds a control mechanism for controlling the functional blocks included in the measurement apparatus **100**. Details of the functional blocks included in the measurement apparatus **100** are provided in the description of FIG. **5**.

**[0027]** The subject wears the measurement apparatus **100** by holding the measurement mechanism **120** in the left ear, placing an abutment **150** provided on the second end **102** side in contact with the upper portion of the right ear, and placing the holder **110** over the top of the head. The abutment **150** may be attached to the holder **110** by a mechanism capable of displacement (expansion and contraction) by sliding along the holder **110**. This structure allows the length from the first end **101** to the second end **102** to be changed in accordance with the size of the subject's head.

**[0028]** The subject measures biological information while wearing the measurement apparatus **100**. For example, the measurement apparatus **100** may acquire biological measurement output with the measurement mechanism **120** in contact with the left ear and measure (calculate) biological information on the basis of the biological measurement output. The subject may continually wear the measurement apparatus **100** to continually measure biological information. In an embodiment, the measurement apparatus **100** may calculate the amount of blood flow and amount of arterial hemoglobin on the basis of the acquired biological measurement output and measure the blood pressure as biological information on the basis of the calculated amount of blood flow and amount of arterial hemoglobin. The amount of arterial hemoglobin refers to the amount of hemoglobin flowing in the arteries.

**[0029]** The power supply holder **130** holds a power supply for supplying electric power to the functional blocks of the measurement apparatus **100**. Provision of the power supply holder **130** on the second end **102** opposite the measurement mechanism **120** facilitates an equal left-right weight balance when the subject wears the measurement apparatus **100**. This facilitates stable maintenance of the wearing state.

**[0030]** The measurement mechanism **120** acquires biological measurement output from the measured part while abutted against the measured part. Details of the measurement mechanism **120** are provided with reference to FIG. **3** and FIG. **4**. FIG. **3** illustrates the holding state of the measurement mechanism **120** in the left ear when the subject wears the measurement apparatus **100** of FIG. **1**. FIG. **4** illustrates the holding state in FIG. **3** viewed from the top of the head. FIG. **4** includes a cross-sectional view along the A-A line of the left ear in FIG. **3**. To facilitate understanding of the measurement mechanism **120**, constituent elements of the measurement apparatus **100** other than the measurement mechanism **120** are omitted from FIG. **3** and FIG. **4**. For example, as illustrated in FIG. **1** and FIG. **2**, the control mechanism holder **140** and holder **110** are formed on the upper head side of a frame **125** illustrated in FIG. **3** but are omitted from FIG. **3**. In the present disclosure, a view from the top of the head is also referred to as a top view.

**[0031]** The measurement mechanism **120** includes an insertion portion **121**, a pressing portion **122**, a contact portion **123**, and a connector **124**.

**[0032]** The insertion portion **121** is inserted inside the left external ear canal when the subject wears the measurement apparatus **100**. In other words, the subject wears the measurement apparatus **100** by holding the measurement mechanism **120** to the head so that the insertion portion **121** is inserted inside the left external ear canal.

**[0033]** The pressing portion **122** abuts against the concha and presses the concha towards the back of the head when the subject is wearing the measurement apparatus **100**, i.e. with the insertion portion **121** inserted in the external ear canal. By the concha being pressed towards the back of the head, the distal end of the tragus stands in a direction along the external ear canal in the opposite direction from the external ear canal, i.e. in a direction towards the face. The tragus is thus more easily clamped by the contact portion **123**.

**[0034]** The contact portion **123** is a concave member. The contact portion **123** includes two projections **123***a* and **123***b*. The projection **123***a* is positioned towards the back of the head when the subject wears the measurement apparatus **100**. The projection **123***b* is positioned towards the front of the head when the subject wears the measurement apparatus **100**. When the subject wears the measurement apparatus **100**, the contact portion **123** comes into contact with the tragus so as to clamp the tragus with a concave recess formed between the two projections **123***a* and **123***b*. The insertion portion **121** is fixed to the distal end of the projection **123***a*, i.e. to the side positioned towards the head when the subject wears the measurement apparatus **100**. The proximal end opposite the distal end is connected to the connector **124**. In other words, the pressing portion **122** and the contact portion **123** are connected via the connector **124**.

**[0035]** The contact portion **123** includes a sensor for optically acquiring biological measurement output. In an embodiment, the contact portion **123** includes a reflective sensor **160** and a transmissive sensor **170**. Both an optical emitter and an optical detector of the reflective sensor **160** are located in the projection **123***a*. An optical emitter and an optical detector of the transmissive sensor **170** are located in the projections **123***a* and **123***b* respectively. The positions of the reflective sensor **160** and the transmissive sensor **170** in the contact portion **123** are indicated virtually by dotted lines in FIG. **4**. The reflective sensor **160** and the transmissive sensor **170** are actually mounted inside the contact portion **123**.

**[0036]** The reflective sensor **160** and the transmissive sensor **170** acquire biological measurement output at the tragus (measured part) of the subject. Details of the method for acquiring biological measurement output with the reflective sensor **160** and the transmissive sensor **170** are provided below.

**[0037]** The connector **124** connects the pressing portion **122** and the contact portion **123**. In an embodiment, the contact portion **123** is connected directly to the connector **124** at the proximal end, as illustrated in FIG. **3** and FIG. **4**. In an embodiment, the pressing portion **122** is connected to the connector **124** via the frame **125** on the first end **101** side of the measurement apparatus **100**, as illustrated in FIG. **3** and FIG. **4**. The connector **124** is formed by a movable member capable of changing the relative positional relationship between the pressing portion **122** and the contact

portion **123**. In an embodiment, the connector **124** is formed by an elastic member, such as rubber. The connector **124** may be formed by a material capable of changing the relative positional relationship between the pressing portion **122** and the contact portion **123**. The material of the connector **124** may, for example, be a spring, resin, plastic, cloth, fiber, or the like. The connector **124** may be configured to be capable of changing the relative positional relationship between the pressing portion **122** and the contact portion **123** by a mechanical structure. Examples of a mechanical structure include a mechanism allowing the connector **124** to move using gears or the like.

**[0038]** The contact portion **123** is displaceable relative to the frame **125** via the connector **124**. The relative positional relationship between the pressing portion **122** and the contact portion **123** changes by the contact portion **123** being displaced relative to the frame **125**. The contact portion **123** is displaced relative to the frame **125** by this structure of the connector **124**. Therefore, the contact portion **123** clamps the tragus to facilitate contact with the tragus regardless of the shape of the ear, in particular the positional relationship between the concha and the tragus. In the example illustrated in FIG. **4**, the contact portion **123** is inclined approximately 30° towards the back of the head relative to a perpendicular to a flat portion **125***a* included in the frame **125** where the connector **124** is formed.

**[0039]** As illustrated in FIG. **3**, the frame **125** includes the flat portion **125***a* that faces the outside of the external ear canal when the measurement apparatus **100** is worn on the ear. The connector **124** is formed on the flat portion **125***a* of the frame **125** at a position corresponding substantially to the center of the surface of the opposite side **125***b*. Since the connector **124** does not deform while the measurement apparatus **100** is not being worn on the ear, the connector **124** is formed in a substantially perpendicular direction to the opposite side **125***b* opposite the flat portion **125***a* of the frame **125**. The frame **125** allows the user to easily recognize the position of the connector **124** when wearing the measurement apparatus **100** on the ear. Hence, the user can easily insert the insertion portion **121** formed at the tip of the connector **124** into the external ear canal and mount the contact portion **123** on the tragus.

**[0040]** FIG. **5** is a functional block diagram schematically illustrating the structure of the measurement apparatus **100**. The measurement apparatus **100** includes the reflective sensor **160**, the transmissive sensor **170**, a controller **180**, a memory **190**, an input interface **200**, and a display **210**. The reflective sensor **160** and the transmissive sensor **170** are mounted inside the contact portion **123**, as described above. The controller **180** and the memory **190** are mounted in the control mechanism holder **140**. The input interface **200** and the display **210** are, for example, mounted in the power supply holder **130** or the control mechanism holder **140**.

**[0041]** The controller **180** is a processor for controlling and managing the measurement apparatus **100** overall, starting with the functional blocks of the measurement apparatus **100**. The controller **180** is a processor such as a central processing unit (CPU) that executes a program with prescribed control procedures. Such a program may, for example, be stored in the memory **190** or on an external storage medium or the like connected to the measurement apparatus **100**.

**[0042]** The controller **180** measures the blood pressure, which is biological information, on the basis of the biological measurement output acquired by the reflective sensor **160** and the transmissive sensor **170**. Details of the processing executed by the controller **180** to calculate the blood pressure are provided below.

**[0043]** The reflective sensor **160** irradiates the tragus with a measuring beam, acquires reflected light (scattered light) from tissue inside the tragus, and transmits a photoelectric conversion signal of the acquired scattered light to the controller **180** as biological measurement output. The reflective sensor **160** is provided with an optical emitter **161** and an optical detector **162**.

**[0044]** The optical emitter **161** emits laser light in response to control by the controller **180**. The optical emitter **161** is, for example, configured to irradiate the measured part with laser light, as a measuring beam, that has a wavelength capable of detecting a predetermined component included in blood. The optical emitter **161** is, for example, a single laser diode (LD).

**[0045]** The optical detector **162** detects scattered light of the measurement beam from the measured part as biological information. The optical detector **162** may, for example, be a photodiode (PD). The reflective sensor **160** transmits a photoelectric conversion signal of the scattered light detected by the optical detector **162** to the controller **180** as biological measurement output.

**[0046]** The controller **180** calculates the amount of blood flow at the measured part on the basis of the biological measurement output received from the reflective sensor **160**. A technique for the controller **180** to measure the amount of blood flow using the Doppler shift is now described.

**[0047]** In the body tissue, scattered light that is scattered from moving blood cells undergoes a frequency shift (Doppler shift), due to the Doppler effect, proportional to the speed of travel of the blood cells within the blood. The controller **180** detects the beat signal produced by interference between scattered light from still tissue and the scattered light from moving blood cells. The beat signal represents strength as a function of time. The controller **180** converts the beat signal into a power spectrum that represents power as a function of frequency. In the power spectrum of the beat signal, the Doppler shift frequency is proportional to the speed of blood cells. Also, the power corresponds to the amount of blood cells in the power spectrum of the beat signal. The controller **180** calculates the amount of blood flow by multiplying the power spectrum of the beat signal by the frequency and integrating.

**[0048]** The transmissive sensor **170** irradiates the tragus with a measuring beam, acquires transmitted light transmitted by tissue inside the tragus, and transmits a photoelectric conversion signal of the acquired transmitted light to the controller **180** as biological measurement output. The transmissive sensor **170** is provided with an optical emitter **171** and an optical detector **172**.

**[0049]** The optical emitter **171** emits laser light in response to control by the controller **180**. For example, the optical emitter **171** irradiates the measured part with laser light, as a measuring beam, that has a wavelength capable of detecting a predetermined component included in blood. The optical emitter **171** is, for example, a laser diode (LD).

**[0050]** As biological information, the optical detector **172** detects transmitted light from the measurement beam transmitted through the measured part. The optical detector **172** may, for example, be a photodiode (PD). The transmissive sensor **170** transmits a photoelectric conversion signal of the

transmitted light detected by the optical detector **172** to the controller **180** as biological measurement output.

**[0051]** In an embodiment, the transmissive sensor **170** includes two LDs for irradiating the measured part with laser light of two different wavelengths. For example, the optical emitter **171** includes an LD that irradiates laser light with a wavelength of approximately 660 nm and an LD that irradiates laser light with a wavelength of approximately 940 nm.

**[0052]** The absorbance with respect to light in a wavelength range of approximately 940 nm is nearly equal for venous hemoglobin present in tissue and veins and arterial hemoglobin. On the other hand, the absorbance with respect to light in a wavelength range of approximately 660 nm is higher for venous hemoglobin than for arterial hemoglobin. The detected light intensity is acquired for transmitted light that passes through an organism without being absorbed by hemoglobin and is detected by the optical detector **172** when irradiating the measured part with laser light of approximately 940 nm. The detected light intensity is also acquired for transmitted light that passes through an organism without being absorbed by hemoglobin and is detected by the optical detector **172** when irradiating a measured part with laser light of approximately 660 nm. By comparing these two detected light intensities, the amount of arterial hemoglobin can be estimated from the difference in detected light intensity (or the difference in absorbance). The controller **180** calculates the amount of arterial hemoglobin in this way. In other words, the controller **180** assumes that the absorbance is proportional to the amount of arterial hemoglobin. The absorbance does not represent the amount of arterial hemoglobin as an absolute value but rather is used only as a relative indicator.

**[0053]** By including LDs that irradiate laser light of two different wavelengths, the measurement apparatus **100** can calculate the amount of arterial hemoglobin to a high degree of accuracy without using the substantially difficult method of measuring the amount of arterial hemoglobin by irradiating laser light only on an artery.

**[0054]** The memory **190** may be configured by a semiconductor memory, a magnetic memory, or the like. The memory **190** stores a variety of information, programs for causing the measurement apparatus **100** to operate, and the like. The memory **190** may also function as a working memory. The memory **190** stores, for example, the amount of blood flow and amount of arterial hemoglobin that the controller **180** has calculated on the basis of the biological measurement outputs acquired from the reflective sensor **160** and the transmissive sensor **170**. The memory **190** also stores the blood pressure that the controller **180** has measured on the basis of the amount of blood flow and the amount of arterial hemoglobin. Furthermore, the memory **190** stores a reference blood pressure value input by the subject through the input interface **200**. The reference blood pressure value is the diastolic blood pressure and the systolic blood pressure that serve as a reference for the controller **180** to calculate the blood pressure. For example, before measuring blood pressure using the measurement apparatus **100**, the user measures the reference blood pressure value using an upper-arm blood-pressure gauge that measures the blood pressure at the upper arm using a known cuff.

**[0055]** The input interface **200** receives operation input from the subject. The input interface **200** is configured using operation buttons (operation keys), for example. The input interface **200** may be configured as a touch panel, a portion of the display **210** may display operation keys that accept operation input from the subject, and this portion may accept touch operation input by the subject.

**[0056]** The display **210** is a display device such as a liquid crystal display, an organic EL display, an inorganic EL display, or the like. For example, the display **210** displays the result of the measurement apparatus **100** measuring biological information. The display **210** can, for example, display the measurement results with a seven-segment display.

**[0057]** Next, details of the process for the controller **180** to calculate the blood pressure on the basis of the calculated amount of blood flow and amount of arterial hemoglobin is described.

**[0058]** First, the controller **180** calculates a correction coefficient to use during blood pressure calculation. With reference to the flowchart in FIG. **6**, an example of the correction coefficient calculation process performed by the controller **180** is described. At the start of this process, the subject inputs the reference blood pressure value using the input interface **200** and then places the measurement apparatus **100** on the head. The subject may input the reference blood pressure value after placing the measurement apparatus **100** on the head. The process in FIG. **6** is a calibration process, and the flowchart is for calculating a correction coefficient m' and a correction coefficient θ'. The correction coefficient m' and correction coefficient θ' are described below.

**[0059]** The controller **180** stores the reference blood pressure value, which the subject measured using the upper-arm cuff blood-pressure gauge and input through the input interface **200**, in the memory **190** (step **S101**).

**[0060]** Next, the controller **180** acquires the biological measurement output measured by the reflective sensor **160** from the optical detector **162** of the reflective sensor **160** (step **S102**).

**[0061]** The controller **180** calculates the amount of blood flow on the basis of the biological measurement output acquired in step **S102** (step **S103**).

**[0062]** The controller **180** acquires the biological measurement output measured by the transmissive sensor **170** from the optical detector **172** of the transmissive sensor **170** (step **S104**).

**[0063]** The controller **180** calculates the amount of arterial hemoglobin on the basis of the biological measurement output acquired in step **S104** (step **S105**).

**[0064]** The controller **180** need not execute step **S102** through step **S105** in the order indicated in FIG. **6**. The controller **180** may, for example, execute step **S102** and step **S103** simultaneously in parallel with step **S104** and step **S105**.

**[0065]** Next, the controller **180** judges whether noise is included in the biological measurement outputs acquired from the reflective sensor **160** and the transmissive sensor **170** (step **S106**). For example, the controller **180** judges whether noise is included in the biological measurement output on the basis of whether the period of the time change in the amount of blood flow calculated in step **S103** and the period of the time change in the amount of arterial hemoglobin calculated in step **S105** match. When the amount of blood flow and the amount of arterial hemoglobin exhibit a similar period of time change, the controller **180** judges that noise is not included in the biological measurement output.

On the other hand, when the amount of blood flow and the amount of arterial hemoglobin exhibit different periods of time change, the controller **180** judges that noise is included in the biological measurement output.

**[0066]** When it is judged that noise is included in the biological measurement output (step S**106**: Yes), the controller **180** executes step S**102** through step S**105** again.

**[0067]** When it is judged that noise is not included in the biological measurement output (step S**106**: No), the controller **180** calculates the correction coefficients (step S**107**). The correction coefficient calculation process is thus terminated.

**[0068]** Here, the method executed by the controller **180** in step S**107** to calculate the correction coefficients is described in detail. The controller **180** calculates the correction coefficients on the basis of the reference blood pressure value stored in the memory **190** in step S**101**, the calculated amount of blood flow, and the calculated amount of arterial hemoglobin.

**[0069]** [Measurement of Diastolic Blood Pressure DBP]

**[0070]** First, the method for calculating the correction coefficient (constant) m' used in calculating the diastolic blood pressure DBPi at any time i is described. Here, the time i for calculating the correction coefficient is set to i=0. The correction coefficient m' is the proportionality coefficient (constant) of the product of the mean amount of blood flow Q and the ratio (S**0**/Si) of the amounts of arterial hemoglobin when expressing the diastolic blood pressure DBPi at time i, as indicated in Expression (14) below. Here, Si is the amount of arterial hemoglobin at time i. S**0** is the amount of arterial hemoglobin when the correction coefficient was calculated. In other words, for various reasons such as individual differences or individual circumstances of the sensors, the uncorrected product of the mean amount of blood flow Q and the ratio of the amounts of arterial hemoglobin (S**0**/Si) might not accurately indicate the diastolic blood pressure DBPi. Therefore, the diastolic blood pressure DBP is first measured at time i=0 using, for example, the auscultatory method (Korotkoff method) or an upper-arm cuff that uses the oscillometric method. In this way, the correction coefficient m' is determined by using the measurement apparatus **100** of the present embodiment to measure the value indicating the product of the mean amount of blood flow Q measured at i=0 and the ratio (S**0**/Si) of amounts of arterial hemoglobin. This correction coefficient m' might differ with various conditions, such as for each individual or each measurement apparatus **100**. Hence, a process for determining m' at the initial measurement time is necessary. The method for measuring the diastolic blood pressure DBPi at time i=0 may be any other appropriate method other than the aforementioned method using an upper-arm cuff.

**[0071]** The mathematical expressions that the controller **180** uses to calculate the constant m' are Expression (1) to Expression (3) below.

$$P = Q \times R \tag{1}$$

$$P \approx DBP + \frac{SBP - DBP}{3} \tag{2}$$

$$SBP = a \times DBP + b \tag{3}$$

**[0072]** In Expression (1) to Expression (3), P, Q, R, DBP, and SBP respectively represent the mean blood pressure, mean amount of blood flow, vascular resistance, diastolic blood pressure, and systolic blood pressure, and a and b are constants. Expression (4) follows from Expression (1) to Expression (3).

$$P = DBP\left(\frac{2}{3} + \frac{a}{3}\right) + \frac{b}{3} = Q \times R \tag{4}$$

**[0073]** Here, m (constant) is substituted for 2/3+a/3 in Expression (4). Normally, the value of b is approximately 5 mmHg to 15 mmHg in Expression (4). Therefore, b/3 is approximately 2 mmHg to 5 mmHg. The constant b is unique for each individual. If b/3 is approximately 2 mmHg to 5 mmHg, b/3 can be approximated as follows, since b/3 can be considered to be included in m' sought in Expression (14).

$$b/3 \approx 0$$

**[0074]** Therefore, Expression (4) can be transformed into Expression (5).

$$Q \times R = m\mathrm{DBP} \tag{5}$$

**[0075]** Transforming Expression (5) leads to Expression (6).

$$DBP = \frac{QR}{m} \tag{6}$$

**[0076]** Here, the mean amount of blood flow Q can also be expressed as in Expression (7) using the mean blood flow speed V and the arterial radius r.

$$Q \propto V \times \pi r^2 \tag{7}$$

**[0077]** The vascular resistance R can be expressed by Poiseuille's law as in Expression (8) using the blood viscosity μ, the arterial radius r, and the blood vessel length L.

$$R = \frac{8\mu L}{\pi r^4} \tag{8}$$

**[0078]** Transforming Expression (1), Expression (7), and Expression (8) yields Expression (9).

$$\begin{aligned} P = Q \times R &\propto V \times \pi r^2 \times \frac{8\mu L}{\pi r^4} \\ &= V \times \frac{8\mu L \pi}{\pi r^2} \\ &= C \times \frac{V}{S} \end{aligned} \tag{9}$$

**[0079]** In Expression (9), S is the arterial cross-sectional area $\pi r^2$ and is proportional to the amount of arterial hemoglobin. C is a constant representing 8 μLπ. Expression (10) follows from Expression (9).

$$Q \times R \propto \frac{V}{S} \tag{10}$$

**[0080]** Expression (11) follows from Expression (6) and Expression (10).

$$DBP \propto \frac{1}{m} \times \frac{V}{S} \tag{11}$$

**[0081]** As described above, S is the arterial cross-sectional area and is proportional to the amount of arterial hemoglobin. In an embodiment, the measurement apparatus **100** uses the absorbance, acquired as biological measurement output by the transmissive sensor **170**, as an indicator of the amount of arterial hemoglobin. To simplify the explanation below, S indicating the arterial cross-sectional area is also referred to as the amount of arterial hemoglobin. Using the initial amount of arterial hemoglobin S**0** and the amount of arterial hemoglobin Si at any time i, S in Expression (11) can thus be replaced with the rate of change from S**0** to Si to yield Expression (12) below for the diastolic blood pressure DBPi at any time i. The initial amount of arterial hemoglobin S**0** is the amount of arterial hemoglobin calculated by the controller **180** on the basis of the biological measurement output (absorbance) acquired by the transmissive sensor **170** when the controller **180** calculated the correction coefficient. The amount of arterial hemoglobin Si at any time i is the amount of arterial hemoglobin calculated by the controller **180** on the basis of the biological measurement output (absorbance) acquired by the transmissive sensor **170** at time i.

$$DBPi \propto \frac{V}{m} \times \frac{SO}{Si} \tag{12}$$

**[0082]** Here, the mean blood flow speed V is proportional to the mean amount of blood flow Q by the definition of the blood flow speed V, i.e. V=Q/S. Hence, Expression (12) can be transformed into Expression (13).

$$DBPi \propto \frac{Q}{m} \times \frac{SO}{Si} \tag{13}$$

**[0083]** The constant m' is the constant corresponding to the constant m in Expression (13) when the correction coefficient is calculated, i.e. when Si=S**0**. The constant m' is determined by Expression (13) on the basis of the diastolic blood pressure DBP of the reference blood pressure value stored in the memory **190** and the mean amount of blood flow Q calculated by the controller **180**. Consequently, the diastolic blood pressure DBPi at any time i is expressed by Expression (14) using the calculated constant m'.

$$DBPi = \frac{Q}{m'} \times \frac{SO}{Si} \tag{14}$$

**[0084]** [Measurement of Systolic Blood Pressure SBPi]

**[0085]** Next, the method for calculating the correction coefficient (constant) θ' used in calculating the systolic blood pressure SBPi at any time i is described. The correction coefficient θ' is the proportionality coefficient (constant) with respect to the pulsatile blood flow wave height qpp when representing the systolic blood pressure SBP at time i, as indicated in Expression (24) below. In other words, for various reasons such as individual differences or individual circumstances of the sensors, the uncorrected pulsatile blood flow wave height qpp might not accurately indicate the systolic blood pressure SBPi. Therefore, the correction coefficient θ' is determined by first measuring the systolic blood pressure SBP using a cuff, and at the time of this measurement, measuring the diastolic blood pressure DBP of the reference blood pressure value, the constant m', and the pulsatile blood flow wave height qpp using the measurement apparatus **100** of the present embodiment. In other words, this correction coefficient θ' might differ with various conditions, such as for each individual or each measurement apparatus **100**. Hence, a process for determining θ' at the initial measurement time is necessary.

**[0086]** Expression (15) to Expression (18) are mathematical expressions that the controller **180** uses to calculate the constant θ'.

$$Q = SV \times HR \tag{15}$$

$$qpp = \frac{Q}{HR} - Roff \tag{16}$$

$$PP = SBP - DBP = E(SV - Roff) \tag{17}$$

$$MBP = DBP + \frac{1}{3}(SBP - DBP) = QR \tag{18}$$

**[0087]** In Expression (15) to Expression (18), qpp, PP, and MBP are respectively the pulsatile blood flow wave height, pulse pressure, and mean pulse pressure. The pulse pressure is the difference between the systolic blood pressure (maximum blood pressure) and the diastolic blood pressure (minimum blood pressure). The mean blood pressure refers to the average of the blood pressure in the arteries and is calculated from the systolic blood pressure (maximum blood pressure) and the diastolic blood pressure (minimum blood pressure). The pulsatile blood flow wave height qpp is the maximum difference in the amount of blood flow in one beat, as illustrated schematically in the example in FIG. **7**. The pulsatile blood flow wave height qpp is derived from the amount of blood flow calculated by the controller **180** on the basis of the biological measurement output acquired from the reflective sensor **160**. SV is the stroke volume in one beat. HR is the heart rate, and Roff is the amount of blood flow flowing out from the artery during systole of the blood vessel (run off in systole). E is the elastic modulus of the pulse.

**[0088]** Expression (19) follows from Expression (15) and Expression (16).

$$qpp = SV - Roff \tag{19}$$

**[0089]** Expression (20) follows from Expression (17) and Expression (19).

$$DBP = SBP - E \times qpp \tag{20}$$

**[0090]** Expression (18) can be transformed into Expression (21).

$$2/3\ DBP+1/3\ SBP=QR \tag{21}$$

**[0091]** Substituting Expression (20) into Expression (21) and simplifying leads to Expression (22).

$$SBP = QR + 2E \times \frac{qpp}{3} \tag{22}$$

**[0092]** Using Expression (6) and Expression (22) and setting θ=2E/3 leads to Expression (23).

$$SBP \propto m \times DBP + \theta \times qpp \tag{23}$$

**[0093]** The correction coefficient θ' is the coefficient corresponding to θ calculated by substituting the diastolic blood pressure DBP and systolic blood pressure SBP of the reference blood pressure value, the above-calculated m', and the pulsatile blood flow wave height qpp into Expression (23). The pulsatile blood flow wave height qpp is calculated from the amount of blood flow calculated by the controller **180** on the basis of the biological measurement output acquired from the reflective sensor **160**. The systolic blood pressure SBPi at any time i is expressed by Expression (24), using the constant θ' calculated in this way. In Expression (24), qppi is the pulsatile blood flow wave height at time i.

$$SBPi = m' \times DBPi + \theta' \times qppi \tag{24}$$

**[0094]** The controller **180** uses the calculated correction coefficients m' and θ' to calculate the diastolic blood pressure DBPi and the systolic blood pressure SBPi of a subject at any time i on the basis of Expression (14) and Expression (24).

**[0095]** [Example of Process for Calculating Blood Pressure]

**[0096]** Next, with reference to the flowchart in FIG. **8**, an example of the process for the controller **180** to calculate the subject's blood pressure is described. The controller **180** can perform the process to calculate blood pressure on the basis of any biological measurement output of the heart rate. For example, the controller **180** performs the process to calculate blood pressure according to the process in FIG. **8** on the basis of the biological measurement output for five beats. The controller **180** determines the five beats of the pulse on the basis of the calculated period of the amount of blood flow, for example.

**[0097]** First, as in steps S**102** and S**103** in FIG. **6**, the controller **180** acquires the biological measurement output for five beats from the reflective sensor **160** (step S**201**) and calculates the amount of blood flow on the basis of the biological measurement output (step S**202**).

**[0098]** As in steps S**104** and S**105** in FIG. **6**, the controller **180** also acquires the biological measurement output for five beats from the transmissive sensor **170** (step S**203**) and calculates the amount of arterial hemoglobin on the basis of the biological measurement output (step S**204**).

**[0099]** As in step S**106** in FIG. **6**, the controller **180** judges whether noise is included in the biological measurement outputs acquired from the reflective sensor **160** and the transmissive sensor **170** (step S**205**).

**[0100]** When it is judged that noise is included in the biological measurement output (step S**205**: Yes), the controller **180** discards (deletes) the acquired biological measurement output data (step S**206**). The controller **180** then executes step S**201** through step S**204** again.

**[0101]** When it is judged that noise is not included in the biological measurement output (step S**205**: No), the controller **180** calculates the subject's blood pressure on the basis of Expression (14) and Expression (24) using the calculated correction coefficients m' and θ' (step S**207**).

**[0102]** The controller **180** saves the calculated blood pressure of the subject by storing the blood pressure in the memory **190** (step S**208**).

**[0103]** The controller **180** accumulates data related to the subject's blood pressure by repeating the process in FIG. **8**. The subject, a doctor, and the like can learn of changes in the subject's blood pressure from the accumulated data.

**[0104]** As described above, the measurement apparatus **100** according to an embodiment calculates correction coefficients on the basis of the subject's reference blood pressure value, which is input by the subject, and the calculated amount of blood flow and amount of arterial hemoglobin. The measurement apparatus **100** then calculates biological information on the basis of the calculated correction coefficients and biological measurement output acquired from the sensor. Therefore, the measurement apparatus **100** calculates the biological information with higher reliability and measurement accuracy than a known measurement apparatus.

**[0105]** The measurement apparatus **100** judges whether noise is included in the acquired biological measurement outputs on the basis of biological measurement outputs acquired by the reflective sensor **160** and the transmissive sensor **170**. When it is judged that noise is included in the biological measurement outputs, the measurement apparatus **100** does not use the biological measurement outputs, but rather reacquires the biological measurement outputs. Hence, the reliability and measurement accuracy of the measured biological information improve.

**[0106]** The measurement apparatus **100** irradiates laser light of two different wavelengths on the measured part using the transmissive sensor **170**. Therefore, the measurement apparatus **100** can compare the detected light intensities of the transmitted light detected by the optical detector **172** to estimate the amount of arterial hemoglobin from the difference therebetween. By estimating the amount of arterial hemoglobin in this way, the measurement apparatus **100** can estimate the amount of arterial hemoglobin more accurately than a known measurement apparatus.

**[0107]** The measurement apparatus **100** is configured so that when the subject is wearing the measurement apparatus **100**, the concha is pressed towards the back of the head by the pressing portion **122**, so that the tragus faces away from the head. The measurement apparatus **100** can therefore clamp the tragus more easily with the contact portion **123** regardless of the shape of the subject's ear. In this way, the measurement apparatus **100** is more useful.

**[0108]** The contact portion **123** and pressing portion **122** of the measurement apparatus **100** are connected via the connector **124** formed by a movable member. The relative positional relationship between the pressing portion **122** and the contact portion **123** changes by the contact portion **123** being displaced relative to the frame **125** via the connector **124**. Therefore, the contact portion **123** more easily comes in contact with the tragus, regardless of the shape of the subject's ear.

**[0109]** The measurement apparatus **100** includes the holder **110**, which is an arched member capable of clamping the subject's head from the left and right. Therefore, when the subject is wearing the measurement apparatus **100**, the measurement apparatus **100** holds the subject's head by applying pressure from the left and right. The contact portion **123** is thus fixed to the tragus more easily.

**[0110]** In the measurement apparatus **100**, the power supply holder **130** is provided at the second end **102** side, on the opposite side from the measurement mechanism **120**. This facilitates an equal left-right weight balance when the subject wears the measurement apparatus **100**, thereby facilitating stable maintenance of the wearing state.

**[0111]** The present disclosure is not limited to the above embodiments, and a variety of modifications and changes are possible. For example, the functions and the like included in the components, steps, and the like may be reordered in any logically consistent way. Furthermore, components, steps, and the like may be combined into one or divided.

**[0112]** For example, as illustrated in FIG. **9**, the measurement apparatus **100** may include a cover **901** over the projection **123***b* of the contact portion **123**. FIG. **9** is a schematic view of a modification, illustrating the cover **901** mounted on the measurement apparatus **100** in FIG. **1**. The cover **901** may be made of a material capable of transmitting light beams emitted from the transmissive sensor **170** so as not to block acquisition of the biological measurement output by the transmissive sensor **170**. The cover **901** may be detachable from the projection **123***b*.

**[0113]** The cover **901** illustrated in FIG. **9** is further described with reference to FIGS. **10**A and **10**B. FIG. **10**A is a schematic view of the cover **901** in FIG. **9**. As illustrated in FIG. **10**A, the cover **1001** includes a hole **1003** into which the projection **123***b* is inserted and may, for example, be formed from a material such as resin or plastic. The thickness of the projection **123***b* in the measurement apparatus **100** changes by the cover **1001** being attached to or removed from the projection **123***b*. By changing the thickness of the projection **123***b* in this way, the subject can adjust the contact strength of the contact portion **123** relative to the tragus in accordance with the shape and thickness of the tragus. In particular, providing a plurality of types of covers **1001** allows the subject to select the cover **1001** for the contact portion **123** to come into contact with the tragus with the most appropriate contact strength for the shape and thickness of the subject's own tragus. The appropriate contact strength refers to, for example, the contact strength at which the measurement accuracy of biological information increases, the contact strength at which the subject feels less discomfort when wearing the measurement apparatus **100**, the contact strength at which the positional relationship between the tragus and the contact portion **123** tends not to change, or the like.

**[0114]** As illustrated in FIG. **10**B, the cover **1005** may expose the transmissive sensor **170** to the outside while the cover **1005** is mounted on the contact portion **123** to avoid blocking acquisition of the biological measurement output by the transmissive sensor **170**. In other words, the cover **1005** may include an opening **1007** on the tragus side for exposing the transmissive sensor **170**.

**[0115]** As illustrated in FIG. **11**, the insertion portion **121** may include a lid **1101** covering the external ear canal when the insertion portion **121** is inserted in the external ear canal. FIG. **11** is a schematic view of a modification to the measurement apparatus **100** in FIG. **1**. Inclusion of the lid **1101** allows the lid of the insertion portion **121** to come into contact with the surface of the external ear canal so that the insertion portion **121** is inserted into the external ear canal in a more stable state. The lid **1101** may be made from a material through which sound passes easily, such as sponge, rubber, cloth, plastic, or resin, so as not to block sound that the subject hears from the surroundings.

**[0116]** The measurement apparatus **100** may include a light-blocking portion to block external light incident on the sensor when the contact portion **123** is in contact with the tragus. FIG. **12** is a schematic perspective view of a modification to the measurement apparatus **100** in FIG. **1**. For example, as illustrated in FIG. **12**, a light-blocking portion **1201** may be an ear cover, formed from material such as cloth, plastic, or resin, that covers the entire auricle along with the insertion portion **121** and the reflective sensor **160** and transmissive sensor **170** of the contact portion **123**.

**[0117]** FIGS. **13**A and **13**B are schematic views of a modification to the measurement apparatus **100** in FIG. **1**, illustrating a different type of light-blocking portion than the light-blocking portion **1201** illustrated in FIG. **12**. As illustrated in FIG. **13**A, a light-blocking portion **1301** may, for example, be formed on the side of the contact portion **123** facing the front of the head (towards the face) to block light entering the reflective sensor **160** and the transmissive sensor **170** from the direction of the front of the head (the face). As illustrated in FIG. **13**B, a light-blocking portion **1303** may, for example, be formed on the side of the contact portion **123** facing the top of the head to block light entering the reflective sensor **160** and the transmissive sensor **170** from the direction of the top of the head above the contact portion **123**. The light-blocking portions **1301** and **1303** may, for example, be screens formed from plastic, resin, or the like.

**[0118]** By including the light-blocking portion **1201**, **1301**, or **1303**, the measurement apparatus **100** can block external light from entering the sensor, thereby facilitating the removal of noise that can be produced by external light when biological measurement output is acquired. The light-blocking portion may be configured as any combination of the light-blocking portions **1201**, **1301**, and **1303** in FIG. **12** and FIGS. **13**A and **13**B.

**[0119]** The measurement apparatus **100** may be configured so that the weight thereof is adjusted for the downward forces in the direction of gravity on the first end **101** and the second end **102** to be substantially equal when the first end **101** and the second end **102** are facing downward in the direction of gravity. This configuration makes the downward forces in the direction of gravity on the first end **101** and the second end **102** nearly equal when the measurement apparatus **100** is worn on a human head, improving the wearing performance of the measurement apparatus **100** on the head.

**[0120]** The measurement apparatus **100** of the above embodiment includes the arched holder **110** that clamps the subject's head from the left and right, the measurement mechanism **120** provided on the first end **101** side, and the power supply holder **130** provided on the second end **102** side opposite the first end **101** side. The present disclosure is not limited to this embodiment, however. For example, the measurement apparatus may be worn on the head by configuring the measurement mechanism **120** to include a wearing portion worn on the auricle of only one of the left

and right ears. That is, a structure without a holder such as the holder **110**, illustrated in FIG. **1**, in the measurement apparatus **100** of the above embodiment may be adopted. By omitting a holder such as the holder **110** illustrated in FIG. **1**, this structure can reduce the weight of the apparatus overall and is more convenient, since it does not disturb the user's hair.

**[0121]** In the measurement apparatus **100** of the above embodiment, the measurement mechanism **120**, power supply holder **130**, or control mechanism holder **140** may have a waterproof structure or a dustproof structure. In this case, the measurement apparatus **100** can be used even on rainy days, for example, increasing the opportunities for using the measurement apparatus **100** and increasing convenience.

**[0122]** The measurement apparatus **100** of the above embodiment may have a communication function that is wired, wireless, or a combination thereof. The wired communication function may be USB, LAN, or the like. The wireless communication function may be long term evolution (LTE), a wireless local area network (LAN), infrared communication, or the like. By incorporating such a communication function, the measurement apparatus **100** can, for example, be operated or controlled by an external operation terminal and can transmit various measured information to an external apparatus.

**[0123]** The measurement apparatus **100** of the above embodiment measures the amount of blood flow and the amount of arterial hemoglobin as biological information but may be configured to measure other types of biological information. Depending on the biological information that the measurement apparatus **100** acquires, the measurement apparatus **100** may be provided with an appropriate combination of various sensors, such as a body temperature sensor, a pulse wave sensor, a vibration sensor, a sound sensor, a humidity sensor, an altitude sensor, a direction sensor, a position sensor, or a brightness sensor.

**[0124]** The measurement apparatus **100** of the above embodiment incorporates the power supply holder **130**. As the power source of the measurement apparatus **100**, however, a power source may be separately provided in a separate housing from the measurement apparatus **100**, and electric power may be supplied from the power source to the components of the measurement apparatus **100** in a wired or wireless manner.

**[0125]** In the above embodiment, the controller **180** provided in the measurement apparatus **100** has been described as generating the biological information on the basis of biological measurement output acquired by a sensor, but the biological information is not limited to being generated by the controller **180** provided in the measurement apparatus **100**. For example, a server that is connected to the measurement apparatus **100** by a network that is wired, wireless, or a combination of both may be provided with a functional component corresponding to the controller **180**, and the biological information may be generated by the server that includes this functional component. In this case, the measurement apparatus **100** transmits the biological measurement output acquired by the sensor to the server via a separately provided communication interface. The server calculates the biological information on the basis of the biological information output and stores the calculated biological information in the memory. When the server calculates and stores biological information in this way, the measurement apparatus **100** can, for example, be reduced in size as compared to when all of the functional components in FIG. **1** are implemented on one measurement apparatus **100**.

REFERENCE SIGNS LIST

**[0126]** **100** Measurement apparatus
**[0127]** **101** First end
**[0128]** **102** Second end
**[0129]** **110** Holder
**[0130]** **120** Measurement mechanism
**[0131]** **121** Insertion portion
**[0132]** **122** Pressing portion
**[0133]** **123** Contact portion
**[0134]** **123***a*, **123***b* Projection
**[0135]** **124** Connector
**[0136]** **125** Frame
**[0137]** **125***a* Flat portion
**[0138]** **125***b* Opposite side
**[0139]** **130** Power supply holder
**[0140]** **140** Control mechanism holder
**[0141]** **150** Abutment
**[0142]** **160** Reflective sensor
**[0143]** **161**, **171** Optical emitter
**[0144]** **162**, **172** Optical detector
**[0145]** **170** Transmissive sensor
**[0146]** **180** Controller
**[0147]** **190** Memory
**[0148]** **200** Input interface
**[0149]** **210** Display
**[0150]** **901**, **1001**, **1005** Cover
**[0151]** **1101** Lid
**[0152]** **1201**, **1301**, **1303** Light-blocking portion

**1**. A measurement apparatus for measuring biological information by a measured part being contacted to a contact portion, the measurement apparatus comprising:

a sensor configured to acquire biological measurement output from the measured part; and

a controller configured to calculate a correction coefficient, for calculating the biological information, on the basis of the biological measurement output acquired by the sensor and to calculate the biological information on the basis of the correction coefficient calculated and the biological measurement output acquired by the sensor.

**2**. The measurement apparatus of claim **1**, wherein

the sensor includes two types of sensors capable of acquiring two types of biological measurement output that differ from each other, and

the controller is configured to judge measurement accuracy of the two types of biological measurement output acquired by the two types of sensors by comparing the two types of biological measurement output and to execute processing for calculating the biological information when judging that the two types of biological measurement output have a predetermined measurement accuracy.

**3**. The measurement apparatus of claim **2**, wherein

the biological information is blood pressure,

the two types of sensors are a reflective sensor and a transmissive sensor,

the transmissive sensor comprises an optical emitter capable of irradiating laser light of two different wavelengths on the measured part and an optical detector

configured to detect transmitted light from the laser light of two different wavelengths transmitted through the measured part, and

the controller is configured to calculate an amount of blood flow on the basis of output of the reflective sensor and to determine an amount of arterial hemoglobin on the basis of output of the transmissive sensor.

**4**. The measurement apparatus of claim **3**, wherein the controller is configured to calculate correction coefficients m' and θ' in Expression (1) and Expression (2) on the basis of the biological measurement output acquired by the reflective sensor and the transmissive sensor and to calculate diastolic blood pressure and systolic blood pressure as biological information using Expression (1) and Expression (2) on the basis of the calculated correction coefficients m' and θ' and the biological measurement output acquired by the sensors;

$$DBPi = \frac{Q}{m'} \times \frac{SO}{Si} \quad (1)$$

$$SBPi = m' \times DBPi + \theta' \times qppi \quad (2)$$

where DBPi represents diastolic blood pressure at any time i, SBPi represents systolic blood pressure at any time i, Q represents mean amount of blood flow, **S0** represents the amount of arterial hemoglobin when the controller calculates the correction coefficients, Si represents the amount of arterial hemoglobin at time i, and qppi represents pulsatile blood flow wave height at time i.

**5**. A measurement method for measuring biological information by contacting a measured part to a contact portion, the measurement method comprising:

an acquiring step using a sensor to acquire biological measurement output from the measured part;

a correction coefficient calculating step using a controller to calculate a correction coefficient, for calculating the biological information, on the basis of the biological measurement output acquired in the acquiring step; and

a biological information calculating step using the controller to calculate the biological information on the basis of the correction coefficient calculated in the correction coefficient calculating step and the biological measurement output acquired in the acquiring step.

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摘要(译)

用于通过与接触部分接触的测量部分测量生物信息的测量设备（ 100 ）包括从测量部分获取生物测量输出的传感器（ 170 ）和控制器（ 180 ），根据传感器获取的生物测量输出（ 160,170 ）计算校正系数，用于计算生物信息。基于所计算的校正系数和由传感器获取的生物测量输出来计算生物信息。