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(54) **HEMADYNAMOMETER AND MOBILE TERMINAL INCLUDING THE SAME**

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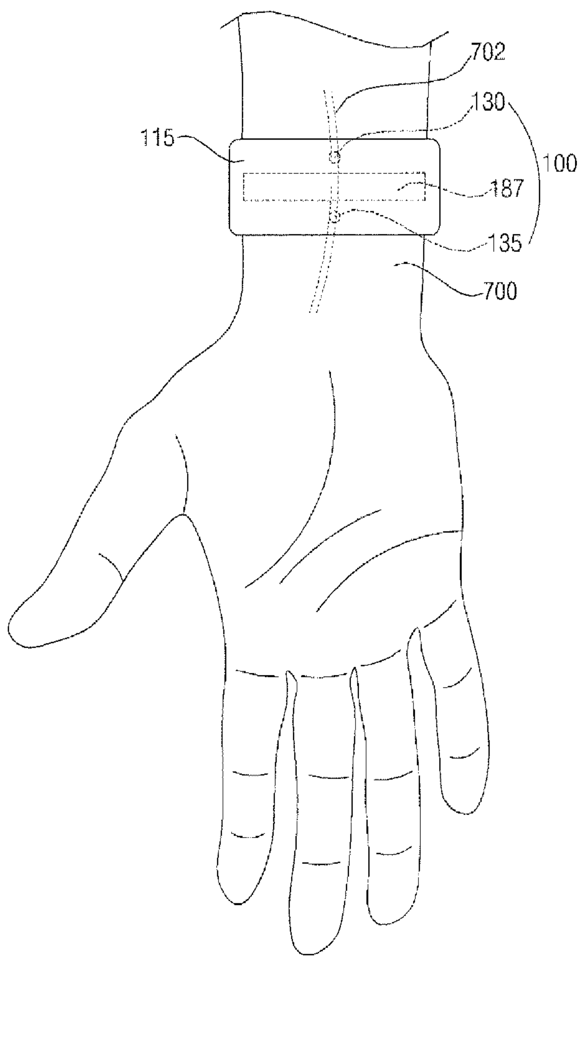
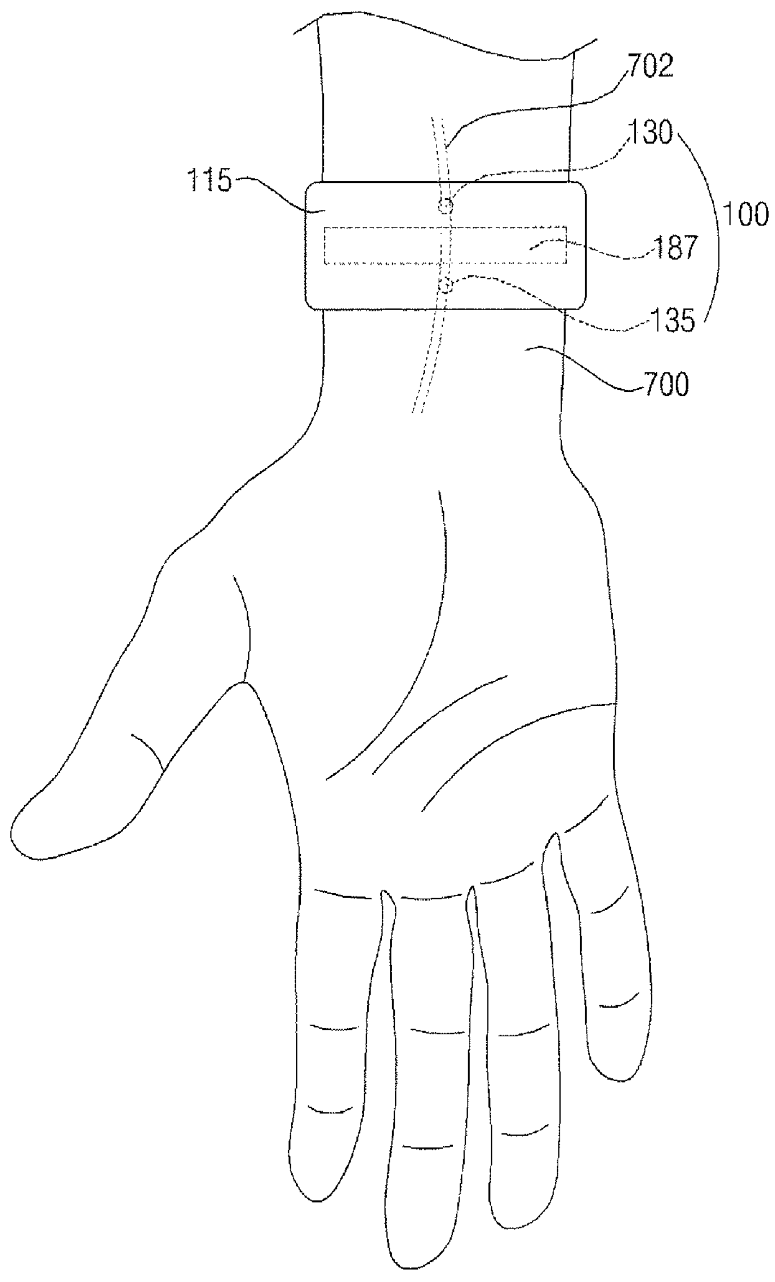
(57) **ABSTRACT**

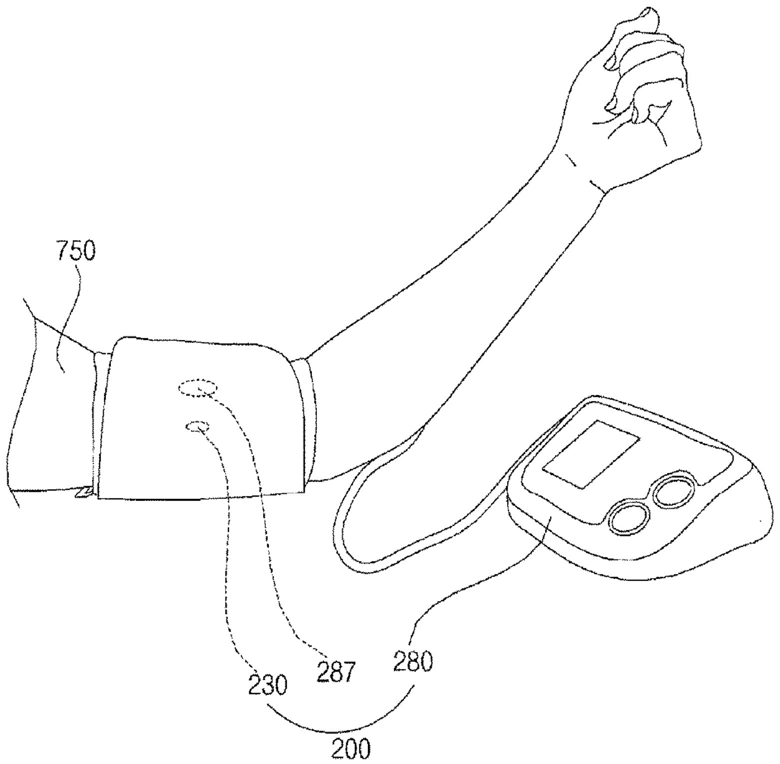
A hemadynamometer and a mobile terminal including the same are disclosed. The hemadynamometer includes first and second pulse wave sensors disposed apart from each other, each converting a pulse wave signal corresponding to a blood pressure into an electric signal, a pressurization unit for applying a pressure to a wrist to change a diameter of a blood vessel, and a controller to measure the blood pressure based on first and second pulse wave signals detected respectively by the first and second pulse wave sensors before a predetermined pressure is applied to the wrist by the pressurization unit, and third and fourth pulse wave signals detected respectively by the first and second pulse wave sensors after the predetermined pressure is applied to the wrist by the pressurization unit. Accordingly, it is possible to simply and accurately measure the blood pressure.



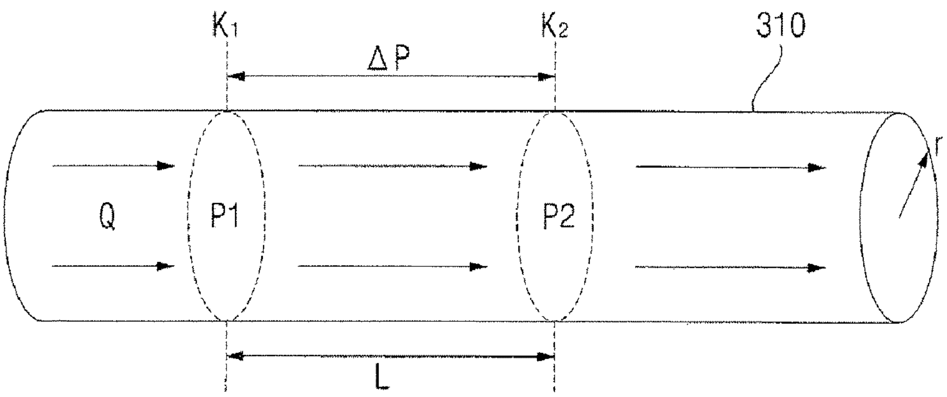
[Fig. 1]



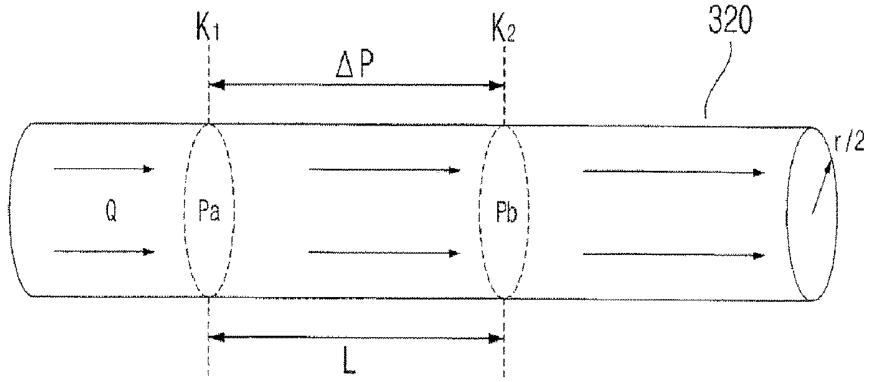
[Fig. 2]



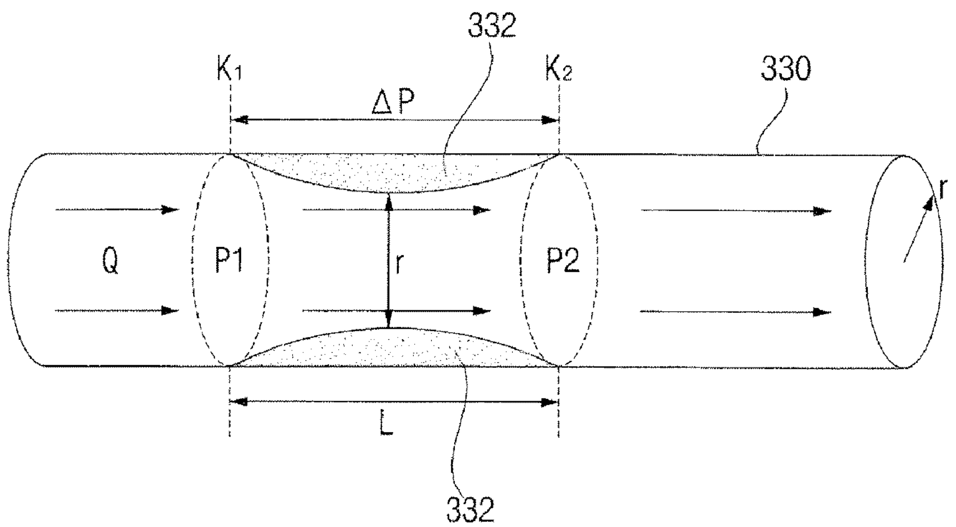
[Fig. 3a]



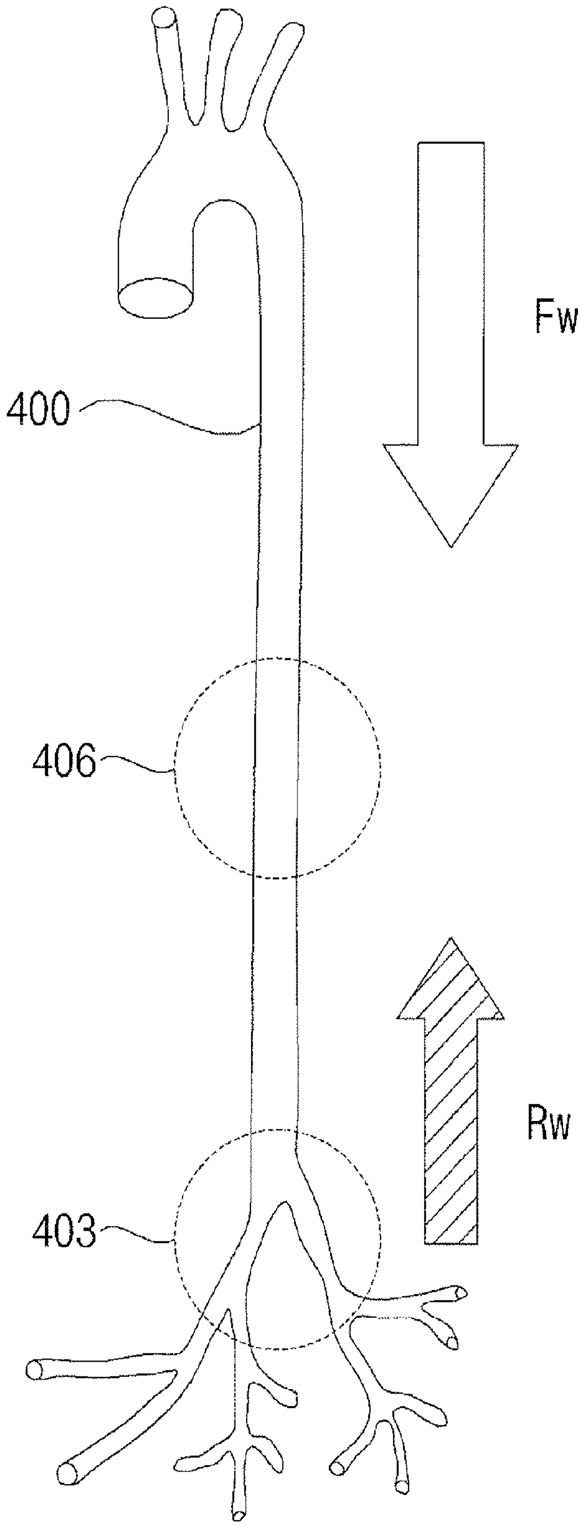
[Fig. 3b]



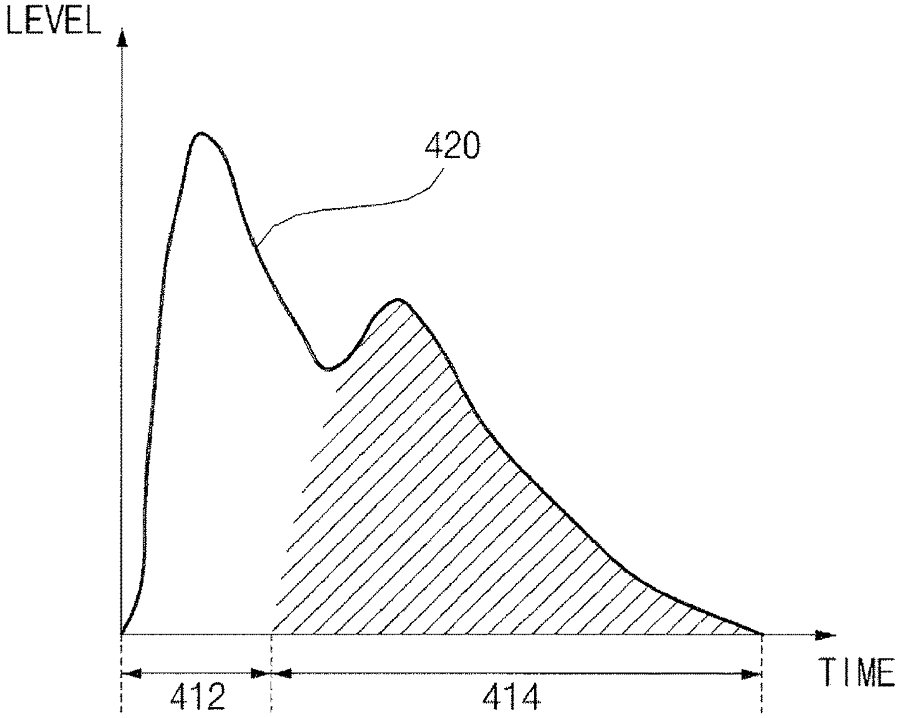
[Fig. 3c]



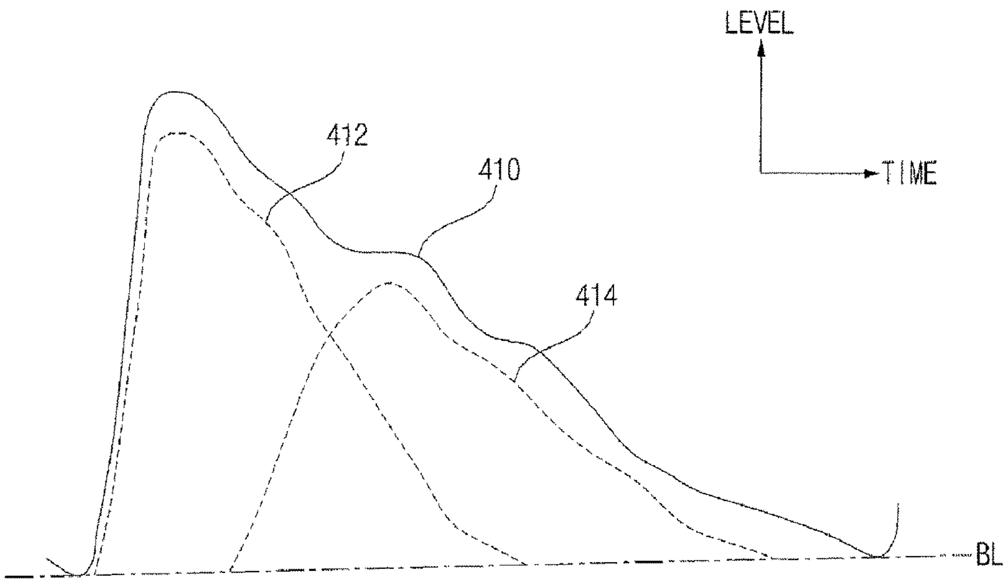
[Fig. 4a]



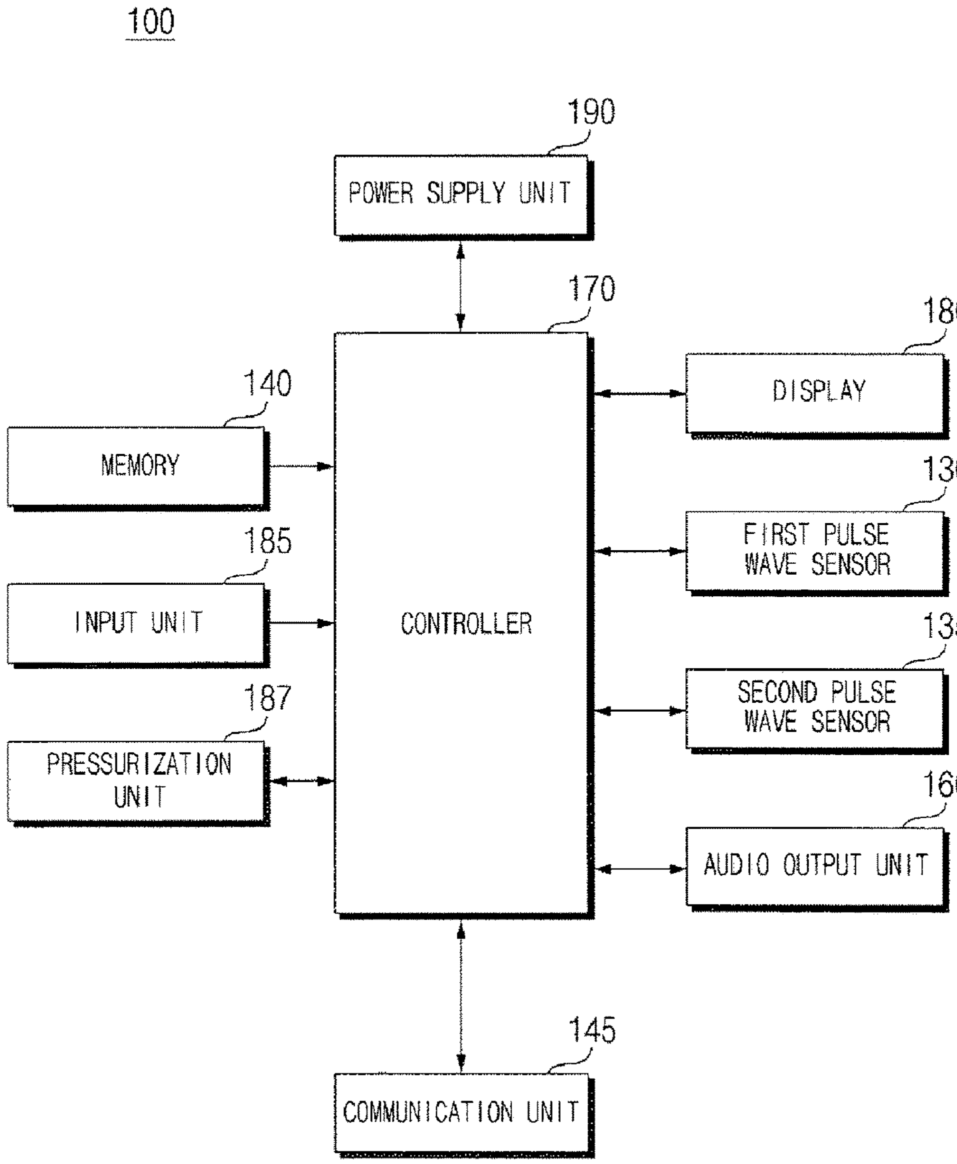
[Fig. 4b]



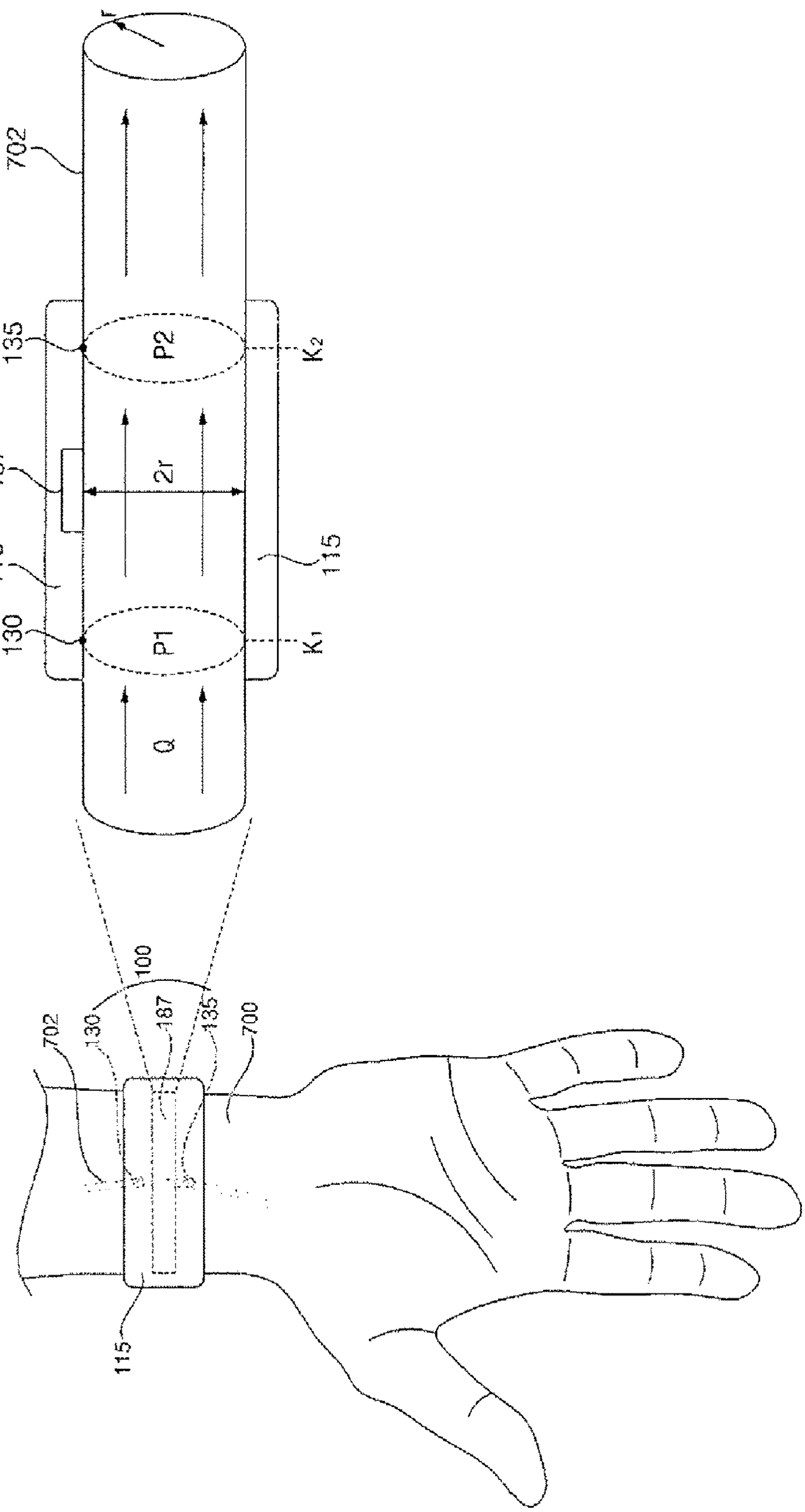
[Fig. 4c]



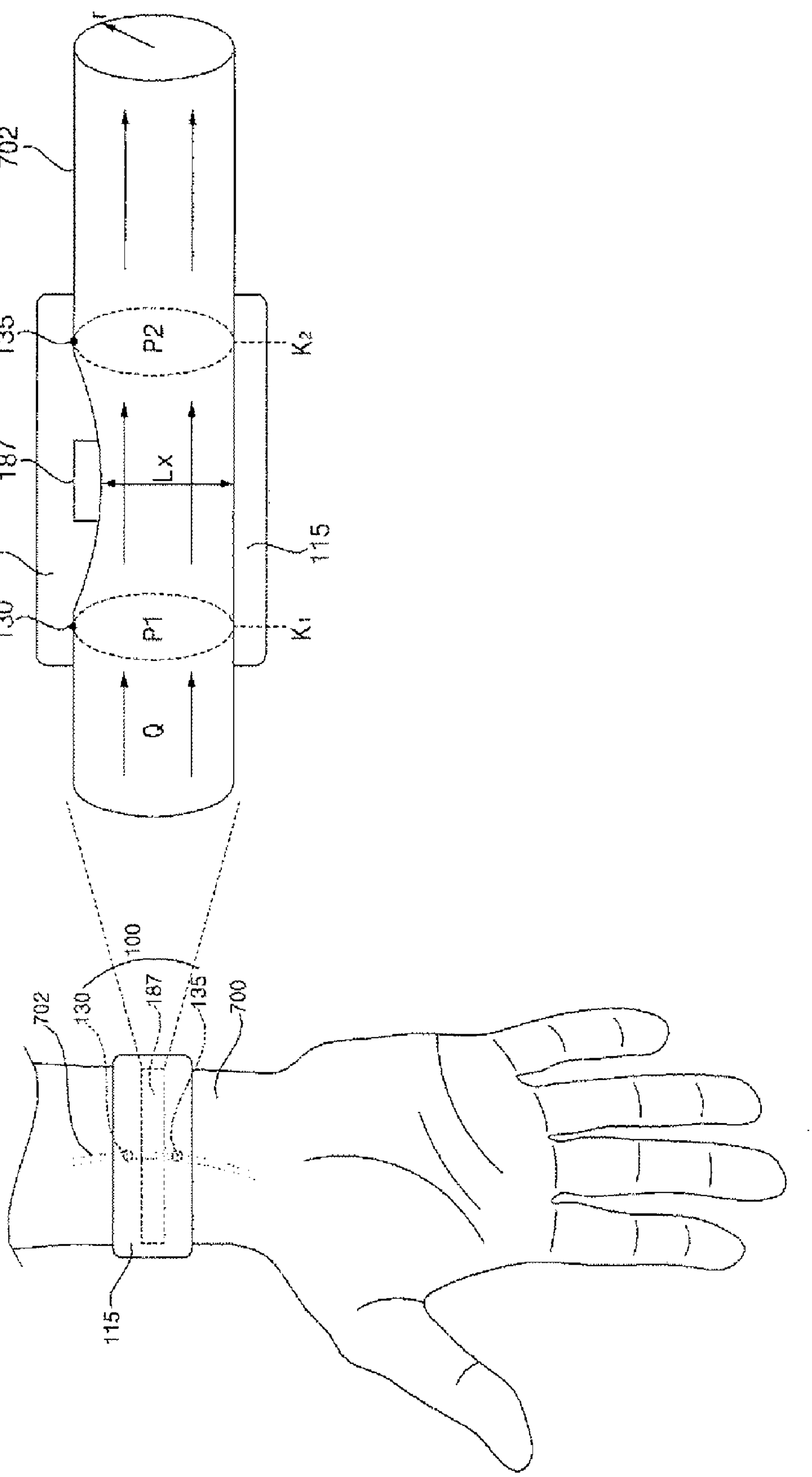
[Fig. 5]


100
190
POWER SUPPLY UNIT
170
CONTROLLER
180
DISPLAY
140
MEMORY
130
FIRST PULSE WAVE SENSOR
185
INPUT UNIT
135
SECOND PULSE WAVE SENSOR
187
PRESSURIZATION UNIT
160
AUDIO OUTPUT UNIT
145
COMMUNICATION UNIT

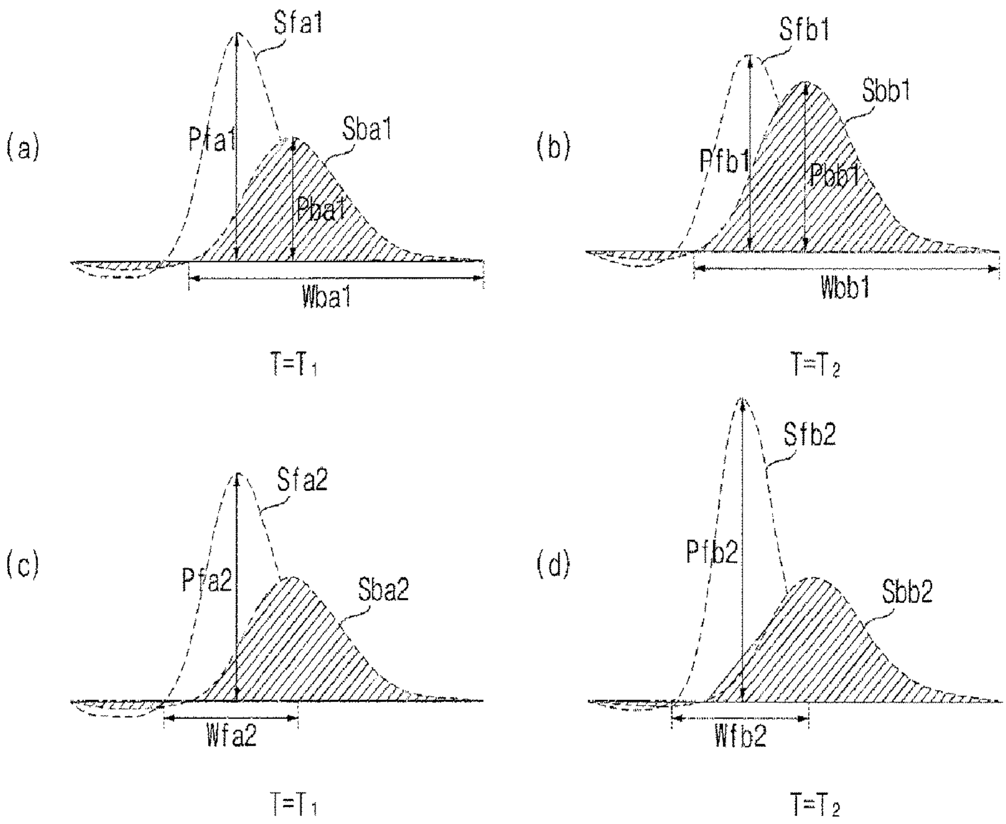
[Fig. 6a]


702
135
187
115
130
P2
P1
2r
Q
K2
K1
115
100
702
130
187
135
700
115

[Fig. 6b]


r
702
135
P2
K2
187
Lx
115
115
130
P1
K1
Q
100
702
130
187
135
700
115

[Fig. 6c]


(a)
Sfa1
Pfa1
Sba1
Pba1
Wba1
T=T1
(b)
Sfb1
Pfb1
Sbb1
Pbb1
Wbb1
T=T2
(c)
Sfa2
Pfa2
Sba2
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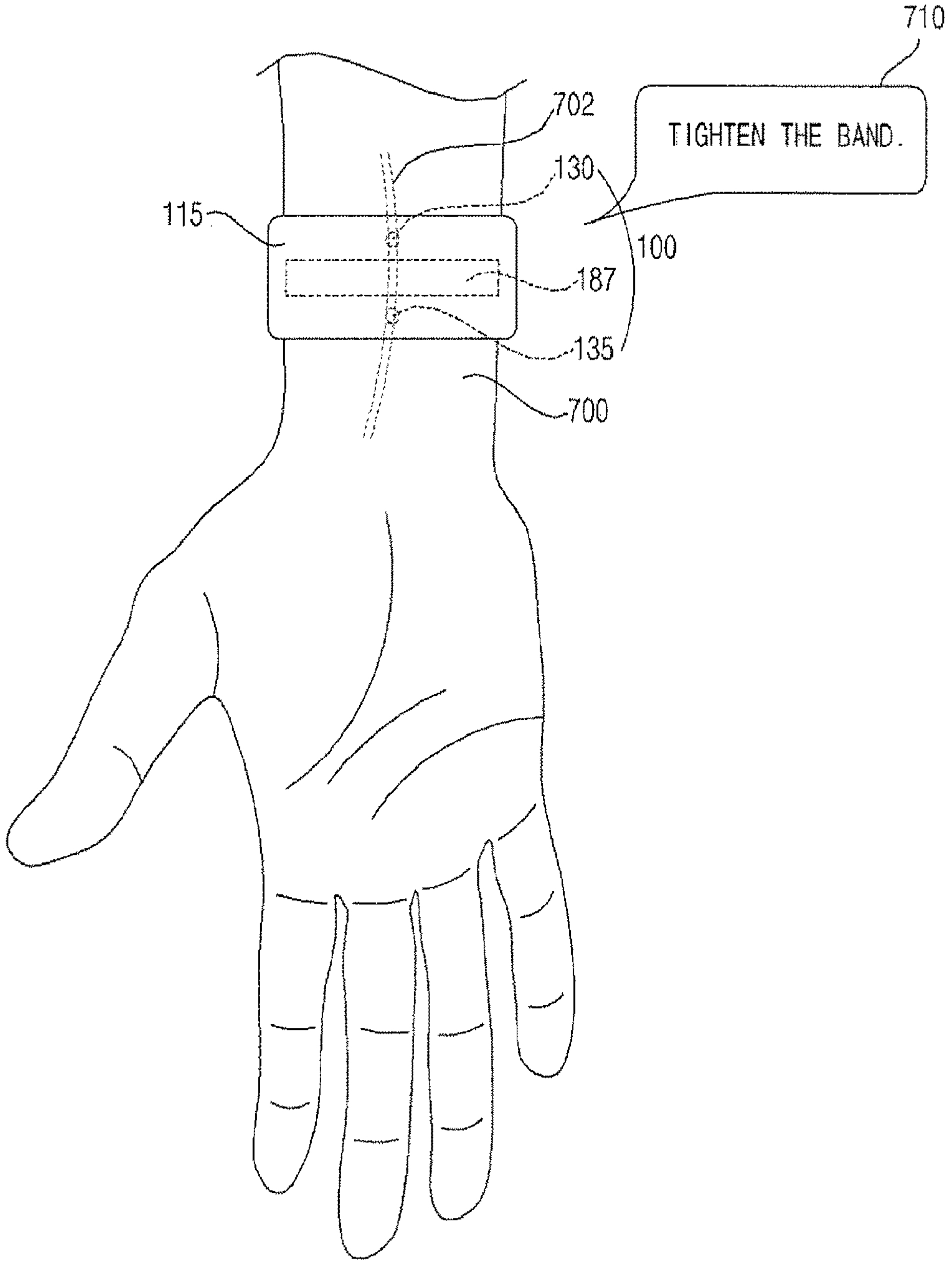
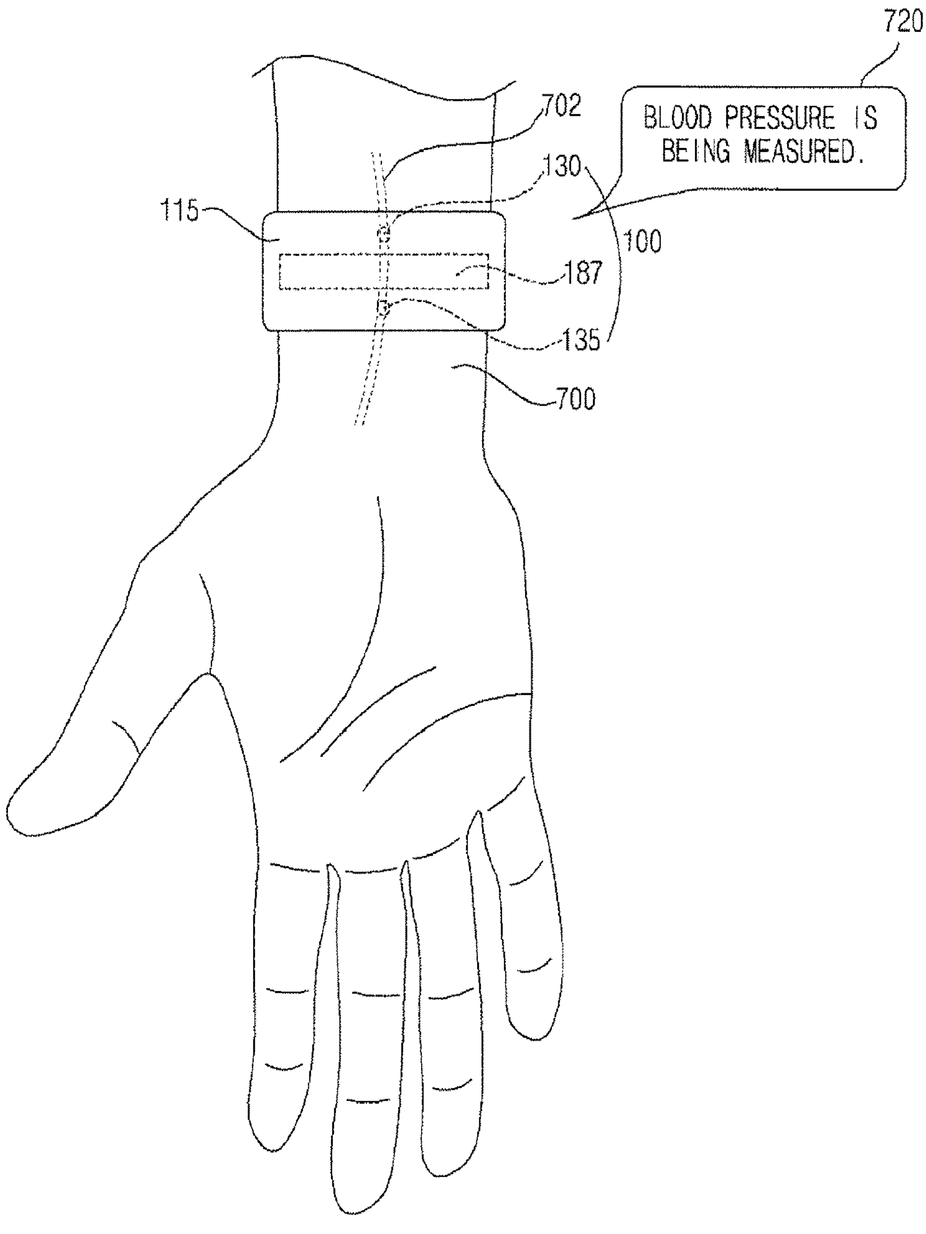
T=T1
(d)
Sfb2
Pfb2
Sbb2
Wfb2
T=T2

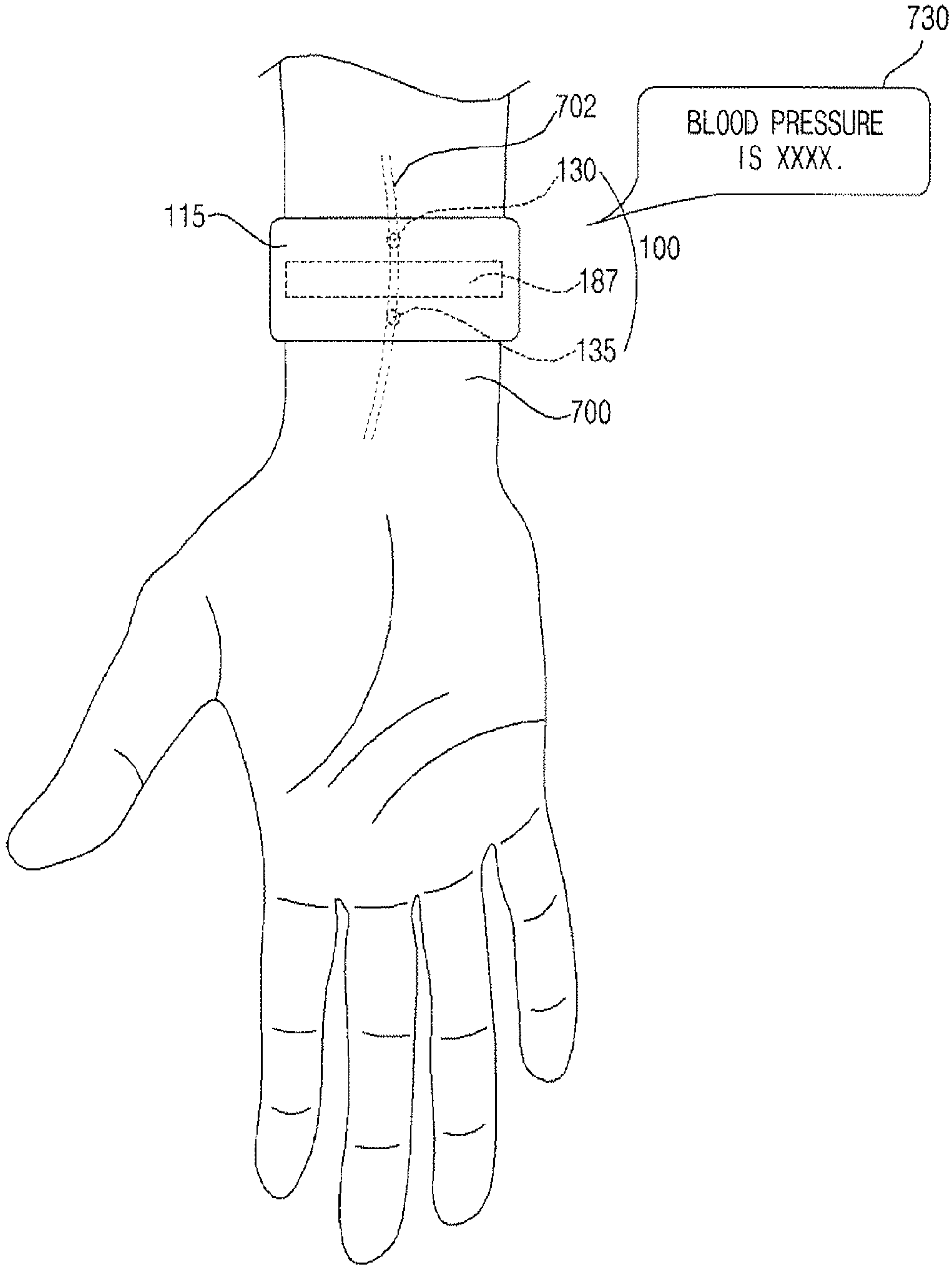
[Fig. 7a]



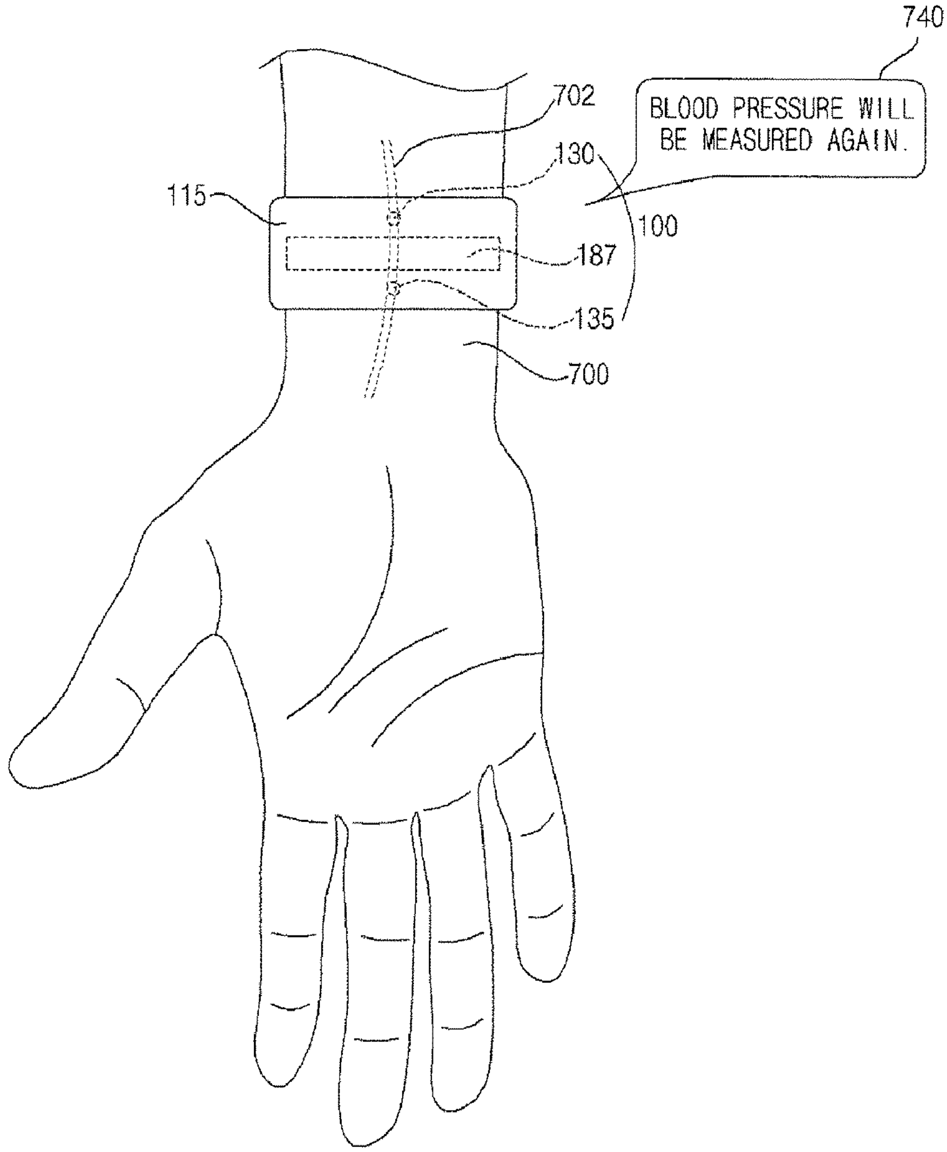
[Fig. 7b]


720
BLOOD PRESSURE IS BEING MEASURED.
702
130
115
100
187
135
700

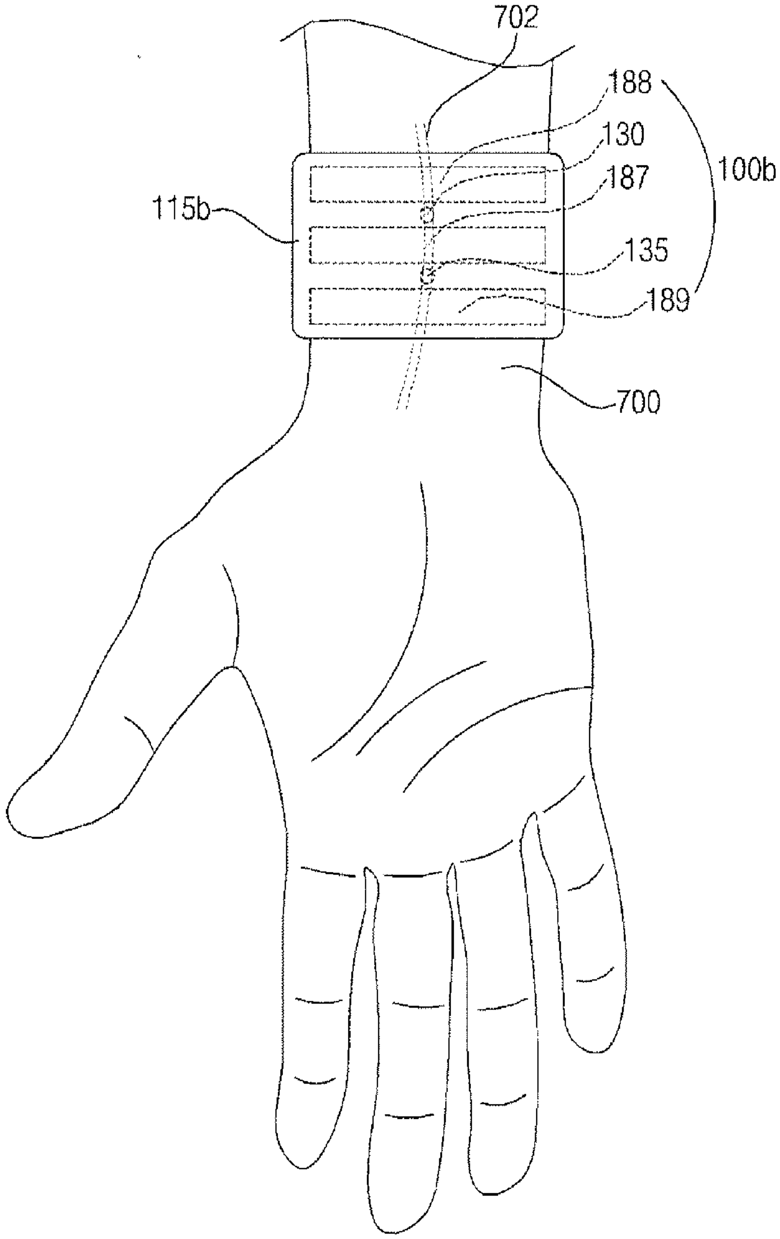
[Fig. 7c]



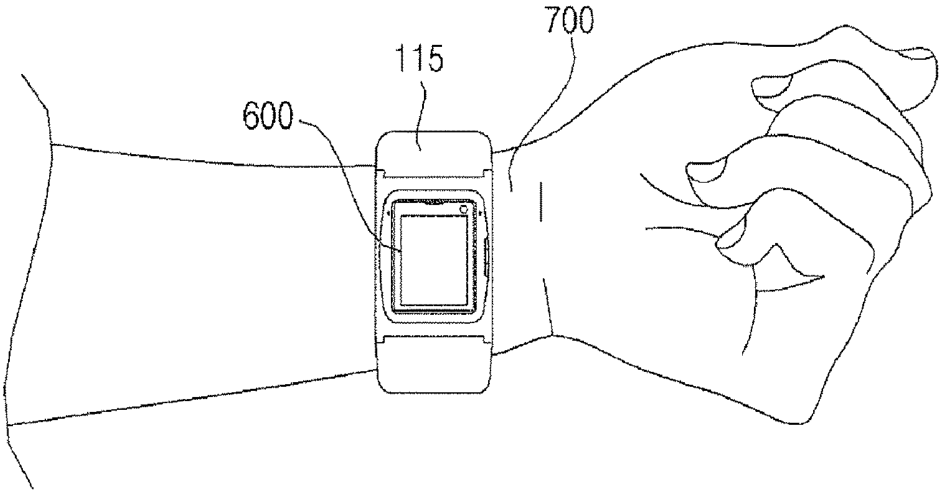
[Fig. 7d]


740
BLOOD PRESSURE WILL BE MEASURED AGAIN.
702
130
115
100
187
135
700

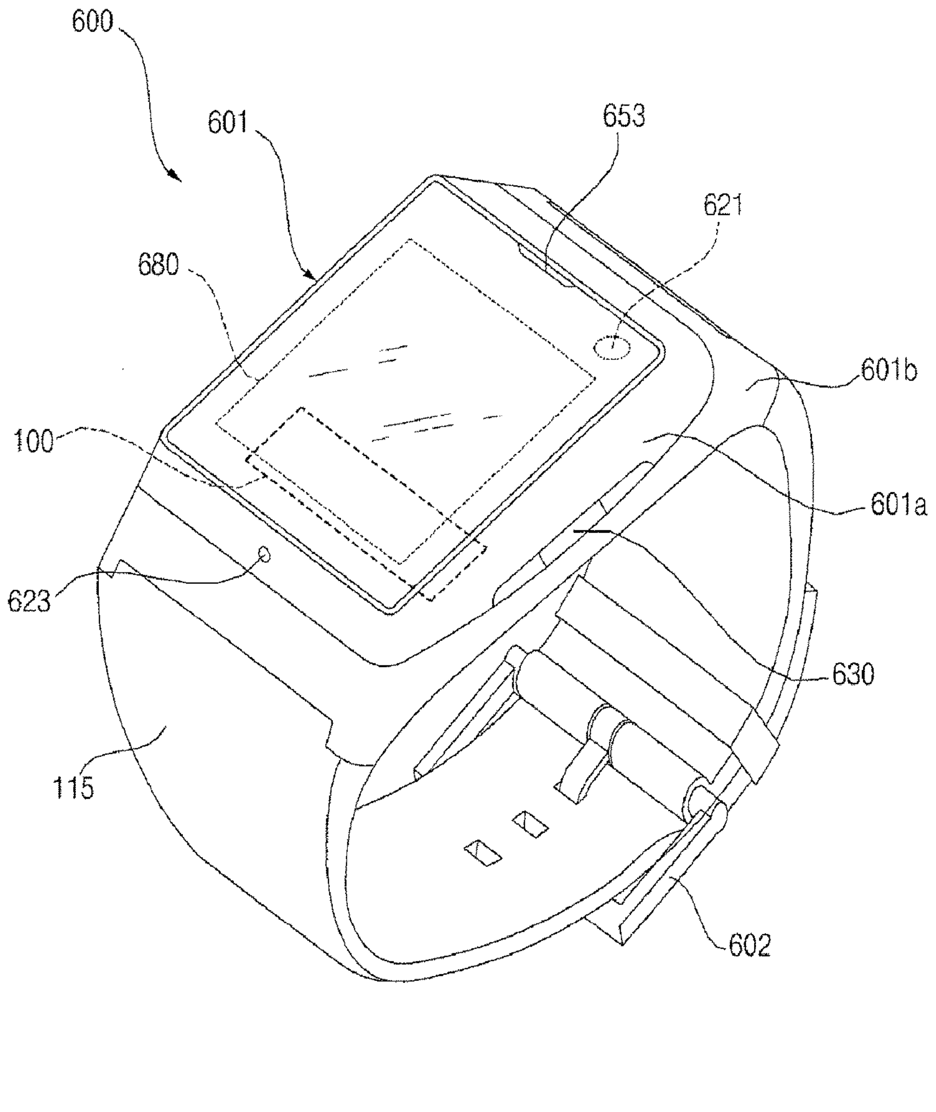
[Fig. 8]



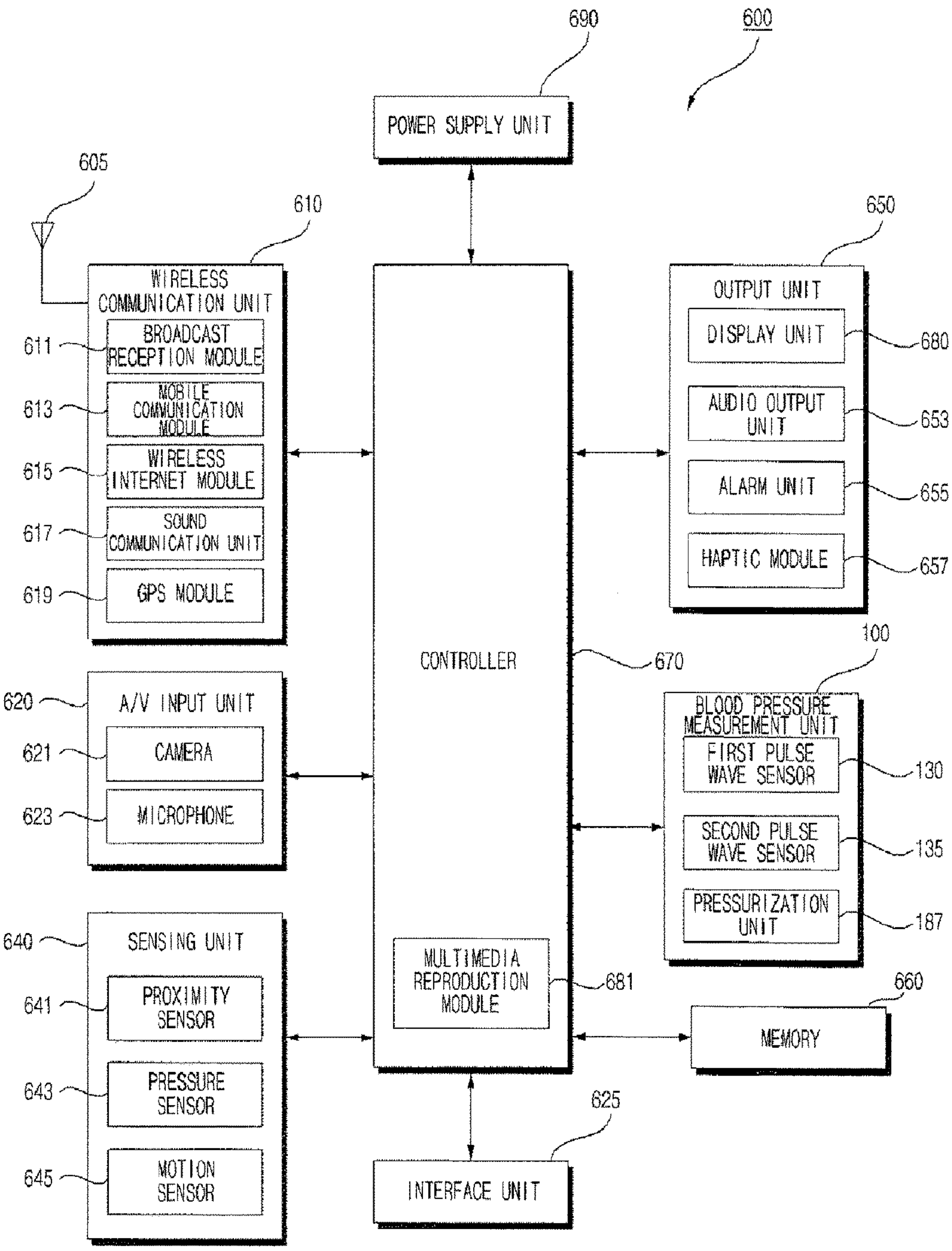
[Fig. 9a]



[Fig. 9b]



[Fig. 10]


690
600
POWER SUPPLY UNIT
605
610
WIRELESS COMMUNICATION UNIT
611
BROADCAST RECEPTION MODULE
613
MOBILE COMMUNICATION MODULE
615
WIRELESS INTERNET MODULE
617
SOUND COMMUNICATION UNIT
619
GPS MODULE
650
OUTPUT UNIT
DISPLAY UNIT
680
AUDIO OUTPUT UNIT
653
ALARM UNIT
655
HAPTIC MODULE
657
CONTROLLER
670
100
BLOOD PRESSURE MEASUREMENT UNIT
FIRST PULSE WAVE SENSOR
130
SECOND PULSE WAVE SENSOR
135
PRESSURIZATION UNIT
187
620
A/V INPUT UNIT
621
CAMERA
623
MICROPHONE
640
SENSING UNIT
641
PROXIMITY SENSOR
643
PRESSURE SENSOR
645
MOTION SENSOR
MULTIMEDIA REPRODUCTION MODULE
681
660
MEMORY
625
INTERFACE UNIT

HEMADYNAMOMETER AND MOBILE TERMINAL INCLUDING THE SAME

TECHNICAL FIELD

[0001] The present invention relates to a hemadynamometer and a mobile terminal including the same, and more particularly to a hemadynamometer capable of simply and accurately measuring a blood pressure, and a mobile terminal including the same.

BACKGROUND ART

[0002] In modern society, the percentage of patients suffering from vascular diseases is increasing due to an increase in the percentage of the elderly and dietary habits.

[0003] In this regard, research into various schemes for measurement of a blood pressure is being conducted. The blood pressure measurement schemes may include an invasive scheme and a non-invasive scheme. Since the invasive scheme entails user inconvenience, the non-invasive scheme, which is based on a pressure, has recently commanded attention.

[0004] However, the pressure-based non-invasive scheme has an issue in that it is difficult to accurately measure a blood pressure and an associated device is inconvenient to carry.

DISCLOSURE OF INVENTION

Technical Problem

[0005] Therefore, the present invention has been made in view of the above problems, and it is an object of the present invention to provide a hemadynamometer capable of simply and accurately measuring a blood pressure, and a mobile terminal including the same.

Solution to Problem

[0006] In accordance with an aspect of the present invention, the above and other objects can be accomplished by the provision of a hemadynamometer including a first pulse wave sensor and a second pulse wave sensor disposed apart from each other, each of the first pulse wave sensor and the second pulse wave sensor converting a pulse wave signal corresponding to a blood pressure into an electric signal, a pressurization unit disposed between the first pulse wave sensor and the second pulse wave sensor to apply a pressure to a wrist to change a diameter of a blood vessel, and a controller to measure the blood pressure based on first and second pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor before a predetermined pressure is applied to the wrist by the pressurization unit, and third and fourth pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor after the predetermined pressure is applied to the wrist by the pressurization unit.

[0007] In accordance with another aspect of the present invention, there is provided a mobile terminal including a communication unit, a display to display information received from the communication unit, a blood pressure measurement unit including a first pulse wave sensor and a second pulse wave sensor disposed apart from each other, each of the first pulse wave sensor and the second pulse wave sensor converting a pulse wave signal corresponding to a blood pressure into an electric signal, and a pressurization unit disposed between the first pulse wave sensor and the second pulse wave sensor to apply a pressure to a wrist to change a diameter of a blood vessel, and a controller to measure the blood pressure based on first and second pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor before a predetermined pressure is applied to the wrist by the pressurization unit, and third and fourth pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor after the predetermined pressure is applied to the wrist by the pressurization unit.

BRIEF DESCRIPTION OF DRAWINGS

[0008] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0009] FIG. **1** is a view illustrating an example of a hemadynamometer according to an embodiment of the present invention;

[0010] FIG. **2** is a view referred to for comparison with the hemadynamometer of FIG. **1**;

[0011] FIGS. **3**A to **3**C are views referred to for describing various blood vessels and blood flow velocities in the blood vessels;

[0012] FIGS. **4**A to **4**C are views referred to for describing a principle of superposition of pulse waves;

[0013] FIG. **5** is a block diagram schematically showing an internal configuration of the hemadynamometer of FIG. **1**;

[0014] FIG. **6**A is a view illustrating a shape of a blood vessel before a predetermined pressure is applied to the hemadynamometer of FIG. **1**;

[0015] FIG. **6**B is a view illustrating a shape of the blood vessel after the predetermined pressure is applied to the hemadynamometer of FIG. **1**;

[0016] FIG. **6**C is a waveform diagram of pulse wave signals detected by first and second pulse wave sensors in the shapes of FIGS. **6**A and **6**B;

[0017] FIGS. **7**A to **7**D are views illustrating various audio outputs of the hemadynamometer of FIG. **1**;

[0018] FIG. **8** is a view illustrating an example of a hemadynamometer according to another embodiment of the present invention;

[0019] FIG. **9**A is a view illustrating that a mobile terminal equipped with the hemadynamometer of FIG. **1** is worn on a wrist;

[0020] FIG. **9**B is a perspective view of the wearable mobile terminal of FIG. **9**A; and

[0021] FIG. **10** is a block diagram showing an internal configuration of the wearable mobile terminal of FIG. **9**A or **9**B.

BEST MODE FOR CARRYING OUT THE INVENTION

[0022] Exemplary embodiments of the present invention will be described with reference to the attached drawings.

[0023] The terms "module" and "unit" used in description of components are used herein to aid in understanding of the components and thus should not be misconstrued as having specific meanings or roles. Accordingly, the terms "module" and "unit" may be used interchangeably.

[0024] A hemadynamometer and a mobile terminal equipped with the hemadynamometer described in this specification are a hemadynamometer simply attachable to a case and available for medication counseling, and a mobile terminal equipped with the hemadynamometer. Hereinafter, the hemadynamometer and the mobile terminal equipped with the hemadynamometer will be described in detail.

[0025] FIG. **1** illustrates an example of a hemadynamometer according to an embodiment of the present invention.

[0026] Referring to FIG. **1**, the hemadynamometer according to the present embodiment, denoted by reference numeral **100**, includes a first pulse wave sensor **130** and a second pulse wave sensor **135** disposed apart from each other. Each of the first pulse wave sensor **130** and the second pulse wave sensor **135** converts a pulse wave signal corresponding to a blood pressure into an electric signal. The hemadynamometer **100** further includes a pressurization unit **187** disposed between the first pulse wave sensor **130** and the second pulse wave sensor **135** for applying a pressure to a wrist **700** to change a diameter of a blood vessel.

[0027] The hemadynamometer **100** measures the blood pressure based on first and second pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** before a predetermined pressure is applied to the wrist **700** by the pressurization unit **187**, and third and fourth pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** after the predetermined pressure is applied to the wrist **700** by the pressurization unit **187**.

[0028] The first pulse wave sensor **130**, the second pulse wave sensor **135** and the pressurization unit **187** in the hemadynamometer **100** are attached to a band **115** wearable on the wrist **700**.

[0029] To measure a blood pressure at a radial artery **702**, the hemadynamometer **100** may be worn such that the first pulse wave sensor **130**, the second pulse wave sensor **135** and the pressurization unit **187** are disposed near the radial artery **702**. Each of the first pulse wave sensor **130** and the second pulse wave sensor **135** in the hemadynamometer **100** may convert a pulse wave signal detected on the radial artery **702** in the wrist **700** into an electric signal, which may then be transmitted to a controller (denoted by reference numeral **170** in FIG. **5**) included in the hemadynamometer **100**.

[0030] The hemadynamometer **100** may separate first to fourth forward wave signals and first to fourth backward wave signals respectively from the first to fourth pulse wave signals, and measure a blood pressure based on at least one of a difference in pulse width or a difference in peak value between the first and third backward wave signals and a difference in pulse width or a difference in peak value between the second and fourth forward wave signals.

[0031] The hemadynamometer **100** may measure the blood pressure in proportion to the difference in pulse width or the difference in peak value.

[0032] The hemadynamometer **100** may output a message for adjustment of positions of the first pulse wave sensor **130**, the second pulse wave sensor **135** and the pressurization unit **187**, or a remeasurement notification message when the difference in pulse width is less than or equal to a first predetermined value, the difference in peak value is less than or equal to a second predetermined value, or the first to fourth pulse wave signals have levels less than or equal to a third predetermined value.

[0033] The hemadynamometer **100** may measure the blood pressure based on the first and second pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** in a state in which a first pressure is transmitted to the wrist **700** by the pressurization unit **187**, and the third and fourth pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** in a state in which a second pressure is transmitted to the wrist **700** by the pressurization unit **187**.

[0034] FIG. **2** is referred to for comparison with the hemadynamometer **100** of FIG. **1**.

[0035] A hemadynamometer **200** of FIG. **2** is a general hemadynamometer provided in a hospital or the like, and includes a pulse wave sensor **230** and a pressurization unit **287** attached to an arm of a user.

[0036] The pulse wave sensor **230** and the pressurization unit **287** are used in the following manner. That is, the pressurization unit **287** is operated to apply a maximum pressure, and then the pulse wave sensor **230** is operated to measure pulse waves at the same position while the pressure is gradually lowered.

[0037] A blood pressure is measured using a variation in pulse wave at a particular position with a variation in pressure.

[0038] The use of the hemadynamometer **200** does not consider a variation in ambient temperature or body temperature and requires time to change a pressure, resulting in user inconvenience. In particular, the hemadynamometer **200** is difficult to carry.

[0039] In order to solve the above-described issues, the present invention proposes the hemadynamometer **100** as in FIG. **1**.

[0040] The hemadynamometer **100** according to the present embodiment may easily and accurately measure a blood pressure by including the first pulse wave sensor **130** and the second pulse wave sensor **135** which are disposed apart from each other, and each convert a pulse wave signal corresponding to the blood pressure into an electric signal, and the pressurization unit **187** which is disposed between the first pulse wave sensor **130** and the second pulse wave sensor **135** to apply a pressure to the wrist **700** to change a diameter of a blood vessel.

[0041] In particular, it is possible to estimate a diameter of a blood vessel by detecting pulse waves at two or more positions in the blood vessel while changing the diameter of the blood vessel using the pressurization unit **187**, and it is possible to measure the blood pressure based on the estimated diameter.

[0042] Therefore, it is possible to easily and accurately measure the blood pressure by reflecting an ambient temperature change or a body temperature change without a separate device.

[0043] In addition, the first and second pulse wave sensors **130** and **135**, the pressurization unit **187**, and the like are attached to the band **115**, so that the hemadynamometer **100** may be conveniently worn on the wrist **700** or the like.

[0044] Hereinafter, a description will be given of a basic principle of a scheme of measuring the blood pressure described in the present invention with reference to FIGS. **3**A to **4**C.

[0045] FIGS. **3**A to **3**C are referred to for describing various blood vessels and blood flow velocities in the blood vessels.

[0046] FIG. **3**A illustrates a blood vessel **310** having a radius r, FIG. **3**B illustrates a blood vessel **320** having a radius r/2, and FIG. **3**C illustrates a blood vessel **330** having a radius r and including blood clots **332**.

[0047] FIG. **3**A is referred to for describing the blood vessel **310** and a blood flow velocity in the blood vessel **310**.

[0048] In a basic principle of hemodynamics, the blood vessel **310** may be regarded as a pipe having a resistance and an elasticity.

[0049] A blood flow F passing through the blood vessel **310** is proportional to a blood pressure P, and is inversely proportional to a blood flow resistance R. That is, the blood flow F may be expressed by an equation F=P/R. When the equation is transformed into an equation P=F×R (blood pressure=blood flow×blood flow resistance), the blood pressure P increases as the blood flow F or the blood flow resistance R increases, and decreases as the blood flow F or the blood flow resistance R decreases.

[0050] Poiseuille's law is a significant law in hemodynamics. Poiseuille's law is expressed by the following Equation 1.

$$Q = \frac{\Delta P}{R} \quad \text{[Equation 1]}$$

[0051] Here, Q denotes a blood flow velocity, ΔP denotes a difference in blood pressure between a position **K1** and a position **K2**, and R denotes a blood flow resistance.

[0052] According to Poiseuille's law of Equation 1, the blood flow velocity Q is proportional to the difference in blood pressure ΔP in a unit section (length L), and is inversely proportional to the blood flow resistance R.

[0053] The blood flow F or the blood flow velocity Q may be expressed by the following Equation 2.

$$F \text{ or } Q = \frac{\Delta P \cdot r^4 \cdot \pi}{\eta \cdot L \cdot 8} \quad \text{[Equation 2]}$$

[0054] Here, η denotes a viscosity of blood, L denotes a length of the blood vessel **310** between the position **K1** and the position **K2**, ΔP denotes the difference in blood pressure between the position **K1** and the position **K2**, and r denotes a radius of the blood vessel **310**.

[0055] Equations 3 and 4 are obtained using Equations 1 and 2.

$$Q = \frac{\Delta P}{R} = \frac{\Delta P \cdot r^4 \cdot \pi}{\eta \cdot L \cdot 8} \quad \text{[Equation 3]}$$

$$R = \frac{\eta \cdot L \cdot 8}{r^4 \cdot \pi} \quad \text{[Equation 4]}$$

[0056] According to Equation 4, the blood flow resistance R is proportional to the viscosity η and the length L of the blood vessel **310**, and is inversely proportional to the radius r of the blood vessel **310** to the power of four.

[0057] When Poiseuille's law is applied to a blood vessel system of a common person, a difference in blood pressure ΔP may be regarded as being constant since a constant arterial blood pressure is maintained for a short period of time. Similarly, the viscosity η of blood that varies with a haematocrit and a temperature may be regarded as being almost constant. When the length L of the blood vessel **310** is known and is regarded as being constant, only the radius r of the blood vessel **310** is a variable in the equation related to the blood flow resistance R.

[0058] The radius r of the blood vessel **310** is the only factor that changes the blood flow resistance R, and is a significant variable of the blood pressure P.

[0059] For example, when an ambient temperature rapidly decreases as a person moves from the inside where it is warn to the outside where it is cold, a blood vessel muscle contracts to maintain a body temperature due to a homeostatic mechanism. As a result, when the blood vessel **320** has a radius decreased to ½ of the radius r as shown in FIG. **3**B, the blood flow F decreases to 1/16 thereof corresponding to ½ to the power of four on the assumption that the blood pressure P is constant.

[0060] Then, it is difficult to supply a body with oxygen and nutrients as needed and thus, the blood pressure P inevitably increases to supply a sufficient blood flow. As a result of this principle, brain hemorrhage and cerebral aneurysm frequently occur in winter.

[0061] Meanwhile, referring to FIG. **3**C, when the blood clots **332** are generated in the blood vessel **330**, and a portion corresponding to the blood clots **332** has a diameter r, that is, the blood vessel **330** substantially has a radius r/2, the blood flow F decreases to 1/16 thereof corresponding to ½ to the power of four on the assumption that the blood pressure P is constant as shown in FIG. **3**B. Then, it is difficult to supply a body with oxygen and nutrients as needed and thus, the blood pressure P inevitably increases to supply a sufficient blood flow.

[0062] FIG. **4**A to FIG. **4**C are referred to for describing a principle of superposition of pulse waves.

[0063] FIG. **4**A illustrates a direction of a blood flow in a blood vessel **400**.

[0064] The blood vessel **400** has a diameter which is the thickest and largest at the origin of the aorta, and is continuously decreasing toward peripheral blood vessels. In this instance, a backward wave or reflected wave signal and a forward wave signal of a peripheral blood vessel portion generated due to a blood flow resistance R are simultaneously observed.

[0065] A pulse wave observed at an arbitrary middle point **406** is a mixed wave, and has a waveform in which a forward wave signal FW overlaps a backward wave signal RW.

[0066] The arbitrary middle point **406** may correspond to a radial artery portion of the wrist **700**.

[0067] FIG. **4**B illustrates that a forward wave signal FW **412** and a backward wave signal RW **414** generated at the middle point **406** of FIG. **4**A are conceptually separated from each other.

[0068] In practice, the signals are indicated as a mixed wave (cuff pulse wave) **410** as illustrated in FIG. **4**C.

[0069] In the present invention, signal processing is performed on the mixed wave **410** to separate the mixed wave **410** into the forward wave signal **412** and the backward wave signal **414**, and a blood pressure is measured using a difference in pulse width or peak value and the like between the forward wave signal **412** and the backward wave signal **414**. In this instance, the separation into the forward wave signal **412** and the backward wave signal **414** may be performed based on at least one of a variation in slope and a variation in amplitude of the mixed wave. The separation into the forward wave signal **412** and the backward wave signal **414** may be performed by the controller **170**.

[0070] A scheme of measuring the blood pressure using the hemadynamometer **100** according to the present embodiment will be described in detail with reference to FIG. **6**A and the following figures.

[0071] FIG. **5** schematically shows an internal configuration of the hemadynamometer **100** of FIG. **1**.

[0072] Referring to FIG. **5**, the hemadynamometer **100** may include the first pulse wave sensor **130**, the second pulse wave sensor **135**, a communication unit **145**, a memory **140**, an audio output unit **160**, the controller **170**, a display **180**, the pressurization unit **187**, and a power supply unit **190**. When the components are implemented in a practical application, two or more components may be combined into one component, or a component may be divided into two or more components.

[0073] The first pulse wave sensor **130** and the second pulse wave sensor **135** are disposed apart from each other. In particular, the sensors are preferably disposed opposite each other around the pressurization unit **187**.

[0074] The first pulse wave sensor **130** and the second pulse wave sensor **135** may be attached to the band **115** together with the pressurization unit **187**. In particular, the first pulse wave sensor **130**, the second pulse wave sensor **135** and the pressurization unit **187** are preferably disposed near the radial artery **702** of the wrist **700** of FIG. **1**.

[0075] The first pulse wave sensor **130** and the second pulse wave sensor **135** detect pulse wave signals at a first position and a second position, respectively, of the radial artery **702**. In particular, each of the sensors may convert a pulse wave signal corresponding to a blood pressure into an electric signal.

[0076] Each of the pulse wave signals detected by the first pulse wave sensor **130** and the second pulse wave sensor **135** may be transmitted to the controller **170**.

[0077] In particular, the first pulse wave sensor **130** and the second pulse wave sensor **135** may transmit the first and second pulse wave signals, respectively, to the controller **170**. Here, the first and second pulse wave signals are detected before a predetermined pressure is applied to the wrist **700** by the pressurization unit **187**. In addition, the first pulse wave sensor **130** and the second pulse wave sensor **135** may transmit the third and fourth pulse wave signals, respectively, to the controller **170**. Here, the third and fourth pulse wave signals are detected after the predetermined pressure is applied to the wrist **700** by the pressurization unit **187**.

[0078] Each of the first to fourth pulse wave signals may be divided into a forward wave signal and a backward wave signal as described with reference to FIGS. **4**A to **4**C. The signals may be separated by the controller **170**.

[0079] The communication unit **145** may provide an interface for communication with an external device. To this end, the communication unit **145** may include at least one of a mobile communication module (not illustrated), a wireless Internet module (not illustrated), a near field communication module (not illustrated), a global positioning system (GPS) module (not illustrated), and the like.

[0080] For example, the communication unit **145** may perform Bluetooth communication, wireless fidelity (WiFi) communication, or the like, thereby transmitting information about a blood pressure measured by the controller **170** to a paired mobile terminal. In this instance, the mobile terminal may be a smart phone or the like capable of performing voice communication.

[0081] The memory **140** may store a program for processing or control of the controller **170** in the hemadynamometer **100**, and perform a function of temporarily storing input or output data.

[0082] In particular, the memory **140** may store the information about the blood pressure measured by the controller **170** in the hemadynamometer **100** together with time information. Furthermore, the memory **140** may store user information.

[0083] The audio output unit **160** may output the information about the measured blood pressure as an audio. The audio output unit **160** may output a message for adjustment of positions of the first pulse wave sensor **130**, the second pulse wave sensor **135** and the pressurization unit **187** as an audio, or output a remeasurement notification message as an audio.

[0084] The audio output unit **160** may output information necessary for an operation of the hemadynamometer as an audio.

[0085] The pressurization unit **187** is disposed between the first pulse wave sensor **130** and the second pulse wave sensor **135**. The pressurization unit **187** may apply a pressure to the wrist **700** to change a diameter of a blood vessel.

[0086] When an input unit **185** receives an input for the measurement of the blood pressure, the pressurization unit **187** may be expanded. For example, when the pressurization unit **187** is an inflatable unit, the pressurization unit **187** is expanded using a pump, thereby decreasing the diameter of the blood vessel.

[0087] Each of the first pulse wave sensor **130** and the second pulse wave sensor **135** detects a pulse wave signal according to a variation in diameter of the blood vessel, and the controller **170** may calculate the blood pressure based on the pulse wave signal according to the variation in diameter of the blood vessel.

[0088] The controller **170** may control operations of the respective units in the hemadynamometer **100** to control an overall operation of the hemadynamometer **100**.

[0089] For example, the controller **170** may measure the blood pressure based on the first and second pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** before a predetermined pressure is applied to the wrist **700** by the pressurization unit **187**, and the third and fourth pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** after the predetermined pressure is applied to the wrist **700** by the pressurization unit **187**.

[0090] The controller **170** may separate the first to fourth forward wave signals and the first to fourth backward wave signals respectively from the first to fourth pulse wave signals based on at least one of a variation in slope and a variation in amplitude of each of the pulse wave signals, and measure the blood pressure based on at least one of a difference in pulse width or a difference in peak value between the first and third backward wave signals and a difference in pulse width or a difference in peak value between the second and fourth forward wave signals.

[0091] The controller **170** may measure the blood pressure in proportion to the difference in pulse width or the difference in peak value.

[0092] When the difference in pulse width is less than or equal to the first predetermined value, the difference in peak value is less than or equal to the second predetermined value, or the first to fourth pulse wave signals have levels less than or equal to the third predetermined value, the controller **170** may control a display **180** or the audio output unit **160** to output the message for adjustment of positions of the first pulse wave sensor **130**, the second pulse wave sensor **135** and the pressurization unit **187**, or the remeasurement notification message.

[0093] The controller **170** may measure the blood pressure based on the first and second pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** in a state in which the first pressure is transmitted to the wrist **700** by the pressurization unit **187**, and the third and fourth pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** in a state in which the second pressure is transmitted to the wrist **700** by the pressurization unit **187**.

[0094] The display **180** may display text, an image, or the like.

[0095] In particular, the display **180** may output the information about the blood pressure.

[0096] The display **180** may output the message for adjustment of positions of the first pulse wave sensor **130**, the second pulse wave sensor **135** and the pressurization unit **187**, or the remeasurement notification message.

[0097] The input unit **185** may include a button and the like to allow an input for the measurement of the blood pressure.

[0098] The power supply unit **190** may supply power necessary for an operation of each component under control of the controller **170**.

[0099] FIG. **6**A illustrates a shape of the blood vessel before a predetermined pressure is applied to the hemadynamometer **100** of FIG. **1**.

[0100] Referring to FIG. **6**A, the pressurization unit **187** in the hemadynamometer **100** is positioned near the radial artery **702**, and the predetermined pressure is to be applied. Therefore, the blood vessel has a diameter **2***r* at the pressurization unit **187**.

[0101] In this instance, each of the first pulse wave sensor **130** and the second pulse wave sensor **135** may measure a pulse wave signal.

[0102] FIG. **6**B illustrates a shape of the blood vessel after the predetermined pressure is applied to the hemadynamometer **100** of FIG. **1**.

[0103] Referring to FIG. **6**B, the pressurization unit **187** in the hemadynamometer **100** is positioned near the radial artery **702**, and the predetermined pressure is applied. Therefore, the blood vessel at the pressurization unit **187** may have a diameter Lx, which is less than 2r.

[0104] In this instance, each of the first pulse wave sensor **130** and the second pulse wave sensor **135** may measure a pulse wave signal.

[0105] When it is presumed that the blood flow is constant without an environmental change based on Poiseuille's law, pulse waves similar to each other are observed at positions of the first pulse wave sensor **130** and the second pulse wave sensor **135** before the pressure is applied as illustrated in FIG. **6**A.

[0106] When the pressure is applied as illustrated in FIG. **6**B, the diameter of the blood vessel decreases to Lx due to the pressure, and the radius of the blood vessel decreases. Thus, a difference in blood pressure ΔP increases to send a constant blood flow.

[0107] Therefore, at the first position K**1** where the first pulse wave sensor **130** is positioned, the blood flow resistance R increases due to a decreased blood vessel diameter at the pressurization unit **187** and thus a backward wave has an increased peak value and an increased pulse width.

[0108] However, at the second position K**2** where the second pulse wave sensor **135** is positioned, the blood flow velocity temporarily increases near a bottleneck due to Beroulli's law. Thus, a forward wave has an increased peak value and a decreased pulse width.

[0109] In the present invention, a relative change of a blood vessel diameter is deduced based on a variation in pulse width and amplitude of each of a forward wave and a backward wave in response to a pressure applied, and the blood pressure may be deduced using a form and velocity analysis (pulse transition time (PTT)) of a pulse wave by deducing the change of the diameter.

[0110] The controller **170** may calculate a blood vessel diameter that decreases as a pulse width of a backward wave at the first position K**1** where the first pulse wave sensor **130** is positioned increases after a pressure is applied, and the controller **170** may calculate a blood vessel diameter that decreases as amplitude of a forward wave at the second position K**2** where the second pulse wave sensor **135** is positioned increases after the pressure is applied.

[0111] Accordingly, the controller **170** may calculate the blood pressure that increases when a blood vessel diameter decreases as a pulse width of a backward wave at the first position K**1** where the first pulse wave sensor **130** is positioned increases after a pressure is applied, and the controller **170** may calculate the blood pressure that increases when a blood vessel diameter decreases as an amplitude of a forward wave at the second position K**2** where the second pulse wave sensor **135** is positioned increases after the pressure is applied.

[0112] This is a measurement scheme distinct from the hemadynamometer **200** of FIG. **2** using a pulse wave sensor, and allows accurate and simple measurement of the blood pressure. In addition, the hemadynamometer **100** may be worn on the wrist **700** or the like, and thus is portable. Thus, user convenience is enhanced.

[0113] FIG. **6**C illustrates pulse wave signals detected by first and second pulse wave sensors in the shapes of FIGS. **6**A and **6**B.

[0114] Referring to FIG. **6**C, FIG. **6**C(a) depicts a first forward wave signal Sfa**1** and a first backward wave signal Sba**1** extracted from the first pulse wave signal which is detected by the first pulse wave sensor **130** before a pressure is applied at T**1**.

[0115] FIG. **6**C(b) depicts a third forward wave signal Sfb**1** and a third backward wave signal Sbb**1** extracted from the third pulse wave signal which is detected by the first pulse wave sensor **130** after the pressure is applied at T**2**.

[0116] The controller **170** may measure a pressure based on a difference in pulse width or a difference in peak value between the first and third backward wave signals.

[0117] When FIG. **6**C(a) is compared with FIG. **6**C(b), a peak value Pfa**1** of the first forward wave signal Sfa**1** and a peak value Pfb**1** of the third forward wave signal Sfb**1** are not significantly different from each other and thus are not used when a blood pressure is measured.

[0118] When FIG. **6**C(a) is compared with FIG. **6**C(b), a peak value Pba**1** of the first backward wave signal Sba**1** and a peak value Pbb**1** of the third backward wave signal Sbb**1** are significantly different from each other and thus are used when a blood pressure is measured. It is possible to measure a blood pressure in proportion to a difference between the peak value Pba**1** of the first backward wave signal Sba**1** and the peak value Pbb**1** of the third backward wave signal Sbb**1**.

[0119] When FIG. **6**C(a) is compared with FIG. **6**C(b), a pulse width Wba**1** of the first backward wave signal Sba**1** and a pulse width Wbb**1** of the third backward wave signal Sbb**1** are significantly different from each other and thus are used when a blood pressure is measured. It is possible to measure a blood pressure in proportion to a difference between the pulse width Wba**1** of the first backward wave signal Sba**1** and the pulse width Wbb**1** of the third backward wave signal Sbb**1**.

[0120] It is possible to measure a blood pressure based on both the difference between the peak value Pba**1** of the first backward wave signal Sba**1** and the peak value Pbb**1** of the third backward wave signal Sbb**1** and the difference between the pulse width Wba**1** of the first backward wave signal Sba**1** and the pulse width Wbb**1** of the third backward wave signal Sbb**1**.

[0121] FIG. **6**C(c) depicts a second forward wave signal Sfa**2** and a second backward wave signal Sba**2** extracted from the second pulse wave signal which is detected by the second pulse wave sensor **135** before the pressure is applied at T**1**.

[0122] FIG. **6**C(d) depicts a fourth forward wave signal Sfb**2** and a fourth backward wave signal Sbb**2** extracted from the second pulse wave signal which is detected by the second pulse wave sensor **135** after the pressure is applied at T**2**.

[0123] The controller **170** may measure a pressure based on a difference in pulse width or a difference in peak value between the second and fourth forward wave signals.

[0124] When FIG. **6**C(c) is compared with FIG. **6**C(d), a peak value or a pulse width of the second backward wave signal Sba**2** and a peak value or a pulse width of the fourth backward wave signal Sbb**2** are not significantly different from each other and thus are not used when a blood pressure is measured.

[0125] When FIG. **6**C(c) is compared with FIG. **6**C(d), a peak value Pfa**2** of the second forward wave signal Sfa**2** and a peak value Pfb**2** of the fourth forward wave signal Sfb**2** are significantly different from each other and thus are used when a blood pressure is measured. It is possible to measure a blood pressure in proportion to a difference between the peak value Pfa**2** of the second forward wave signal Sfa**2** and the peak value Pfb**2** of the fourth forward wave signal Sfb**2**.

[0126] When FIG. **6**C(c) is compared with FIG. **6**C(d), a pulse width Wfa**2** of the second forward wave signal Sfa**2** and a pulse width Wfb**2** of the fourth forward wave signal Sfb**2** are significantly different from each other and thus are used when a blood pressure is measured. It is possible to measure a blood pressure in proportion to a difference between the pulse width Wfa**2** of the second forward wave signal Sfa**2** and the pulse width Wfb**2** of the fourth forward wave signal Sfb**2**.

[0127] It is possible to measure a blood pressure based on both the difference between the pulse width Wfa**2** of the second forward wave signal Sfa**2** and the pulse width Wfb**2** of the fourth forward wave signal Sfb**2** and the difference between the peak value Pfa**2** of the second forward wave signal Sfa**2** and the peak value Pfb**2** of the fourth forward wave signal Sfb**2**.

[0128] Unlink FIG. **6**C, it is possible to detect the first and second pulse wave signals by the first pulse wave sensor **130** and the second pulse wave sensor **135**, respectively, after a first pressure is applied, detect the third and fourth pulse wave signals by the first pulse wave sensor **130** and the second pulse wave sensor **135**, respectively, after a second pressure is applied, and measure a blood pressure based on at least one of pulse widths and peak values of the first to fourth pulse wave signals.

[0129] According to a scheme of analyzing a pulse wave signal of FIG. **6**C, the controller **170** may estimate or calculate a thickness of a blood vessel according to Equations 1 to 4 based on a variation in pulse width or a variation in peak value of a forward wave signal or a backward wave signal, and measure or calculate a blood pressure based on the thickness.

[0130] FIGS. **7**A to **7**D illustrate various audios of the hemadynamometer **100** of FIG. **1**.

[0131] FIG. **7**A illustrates that an audio **710** saying "Tighten the band" is output from the audio output unit **160** of the hemadynamometer **100**.

[0132] For example, when an input for measurement of the blood pressure is received in response to a user operating the input unit **185**, the controller **170** may perform a control operation to output the audio **710** saying "Tighten the band".

[0133] The audio **710** may be output when a user wears the band.

[0134] FIG. **7**B illustrates that an audio **720** saying "Blood pressure is being measured" is output from the audio output unit **160** of the hemadynamometer **100**.

[0135] For example, the controller **170** may perform a control operation to output the audio **720** saying "Blood pressure is being measured" when pulse wave signals are detected by the first pulse wave sensor **130** and the second pulse wave sensor **135** while or after a pressure is applied to an area in which the pressurization unit **187** is located in response to the pressurization unit **187** operating. The audio may allow a user to recognize that the blood pressure is being measured. In this instance, it is preferable that the user minimize motion.

[0136] FIG. **7**C illustrates that an audio **730** saying "Blood pressure is XXXX" is output from the audio output unit **160** of the hemadynamometer **100**.

[0137] When blood pressure measurement is completed, the controller **170** may perform a control operation to output blood pressure information as an audio or a video through the audio output unit **160** or the display **180**.

[0138] When the blood pressure measurement is completed, the controller **170** may transmit the blood pressure information to a mobile terminal **600** paired therewith. Thus, the mobile terminal **600** may manage the measured blood pressure information of a user.

[0139] For example, a health related application for a user installed in the mobile terminal **600** may store and manage information about frequently measured blood pressures, and display the blood pressure information using a graphical user interface for a predetermined period of time.

[0140] FIG. 7D illustrates that an audio **740** saying "Blood pressure will be measured again" is output from the audio output unit **160** of the hemadynamometer **100**.

[0141] For example, the controller **170** may perform a control operation to output the audio **740** saying "Blood pressure will be measured again" when a difference in pulse width between the first and third backward wave signals or a difference in pulse width between the second and fourth forward wave signals is less than or equal to a first predetermined value, a difference in peak value between the first and third backward wave signals or a difference in peak value between the second and fourth forward wave signals is less than or equal to a second predetermined value, or the first to fourth pulse wave signals have levels less than or equal to a third predetermined value.

[0142] In this instance, the controller **170** may perform a control operation to output a message for adjustment of positions of the first pulse wave sensor **130**, the second pulse wave sensor **135** and the pressurization unit **187** such as the audio **710** saying "Tighten the band" of FIG. **7**A as an audio or a video through the audio output unit **160** or the display **180**. Thus, a user may adjust a position or a size of the band worn on the wrist **700** to measure the blood pressure again. As a result, the pressurization unit **187** and the like may be positioned on the radial artery **702**.

[0143] As illustrated in FIGS. 7A to 7D, when various audio messages are output, user convenience may be enhanced. Messages corresponding to FIGS. 7A to 7D may be displayed on the display unit **180**.

[0144] FIG. **8** illustrates an example of a hemadynamometer according to another embodiment of the present invention.

[0145] Referring to FIG. **8**, the hemadynamometer of FIG. **8**, denoted by reference numeral **100***b*, is similar to the hemadynamometer **100** of FIG. **1**, and is different from the hemadynamometer **100** in that second and third pressurization units **188** and **189** are additionally provided.

[0146] The second and third pressurization units **188** and **189** are disposed opposite each other around a pressurization unit **187**, a first pulse wave sensor **130** is disposed between the pressurization unit **187** and the second pressurization unit **188**, and a second pulse wave sensor **135** is disposed between the pressurization unit **187** and the third pressurization unit **189**.

[0147] According to this configuration, the first pulse wave sensor **130** is disposed between the pressurization unit **187** and the second pressurization unit **188**, and the second pulse wave sensor **135** is disposed between the pressurization unit **187** and the third pressurization unit **189**, so that the first and second pulse wave sensors **130** and **135** further stick to a wrist **700**. Therefore, it is possible to more accurately measure the blood pressure at a radial artery **702**.

[0148] FIG. **9**A illustrates that a mobile terminal equipped with the hemadynamometer **100** of FIG. **1** is worn on the wrist **700**.

[0149] Referring to FIG. **9**A, the wearable mobile terminal, denoted by reference numeral **600**, may be a smart watch capable of displaying time information, and displaying a portion of information received by a separate smartphone through communication with the smartphone.

[0150] The wearable mobile terminal **600** of FIG. **9**A may be a mobile terminal capable of independently receiving and transmitting a call separately from a smartphone.

[0151] FIG. **9**B illustrates the wearable mobile terminal **600** of FIG. **9**A.

[0152] Referring to FIG. **9**B, the wearable mobile terminal **600** includes a main body **601** provided with the display unit **680**, and a band **115** connected to the main body **601** and wearable on the wrist **700**. In general, the wearable mobile terminal **600** may have a characteristic which is the same as or similar to a characteristic of the mobile terminal **100** of FIG. **1**.

[0153] The main body **601** includes a case that forms an appearance. As illustrated in FIG. **9**B, the case may include a first case **601***a* having an internal space to accommodate various electronic components and a second case **601***b*. The present invention is not limited thereto, and a single case may have the internal space to implement the unibody mobile terminal **600**.

[0154] The wearable mobile terminal **600** may perform wireless communication, and the main body **601** may have an antenna installed to perform the wireless communication. The performance of the antenna may be extended using the case. For example, the case, which includes a conductive material, may be electrically connected to the antenna to extend a ground area or a radiation area.

[0155] The main body **601** may include the display unit **680** disposed on a front surface to output information, and the display unit **680** may be implemented as a touchscreen having a touch sensor. As illustrated in FIG. **9**B, a window (not shown) of the display unit **680** may be mounted on the first case **601***a* to form a front surface of a terminal body together with the first case **601***a*.

[0156] The main body **601** may include an audio output unit **653**, a camera **621**, a microphone **623**, a user input unit **630**, and the like. When the display unit **680** is implemented as a touchscreen, the display unit **680** may function as the user input unit **630**. Therefore, the main body **601** may not have a separate key.

[0157] The band **115** is worn on the wrist **700** to surround the wrist **700**, and may be formed using a flexible material to be easily worn. For example, the band **115** may be made of a material such as leather, rubber, silicon, synthetic resin, or the like. In addition, the band **115** may be attached to and detached from the main body **601**, and be replaced by various forms of bands according to user preference.

[0158] In addition, the band **115** may be used to extend the performance of the antenna. For example, the band may include a ground extension unit (not illustrated) electrically connected to the antenna to extend a ground area.

[0159] The band **115** may include a fastener **602**. The fastener **602** may be implemented by a buckle, a hook structure for snap-fit, Velcro (trade name), or the like. The fastener **602** may include a flexible section or material. FIG. **9**B illustrates an example in which the fastener **602** is implemented by a buckle.

[0160] FIG. **10** shows an internal configuration of the wearable mobile terminal **600** of FIG. **9**A or **9**B.

[0161] Referring to FIG. **10**, the mobile terminal **600** may include a wireless communication unit **610**, an audio/video (A/V) input unit **620**, a user input unit **630**, a sensing unit **640**, an output unit **650**, a memory **660**, an interface unit **625**, a controller **670**, and a power supply unit **690**.

[0162] The wireless communication unit **610** may include a broadcast reception module **611**, a mobile communication module **613**, a wireless Internet module **615**, a sound communication unit **617**, a GPS module **619**, and the like.

[0163] The broadcast reception module **611** may receive at least one of a broadcast signal and broadcast related information from an external broadcast management server through a broadcast channel.

[0164] The broadcast signal and/or the broadcast related information received through the broadcast reception module **611** may be stored in the memory **660**.

[0165] The mobile communication module **613** transmits and receives a radio signal to and from at least one of a base station, an external terminal, and a server in a mobile communication network. Here, the radio signal may include a voice call signal, a video call signal, or various forms of data based on transmission and reception of a text/multimedia message.

[0166] The wireless Internet module **615** refers to a module for wireless Internet access. The wireless Internet module **615** may be provided on the inside or the outside of the mobile terminal **600**.

[0167] The sound communication unit **617** may perform sound communication. The sound communication unit **617** may output a sound by additionally providing predetermined information data to audio data to be output in a sound communication mode. In addition, the sound communication unit **617** may extract predetermined information data from a sound received from the outside in a sound communication mode.

[0168] The GPS module **619** may receive location information from a plurality of GPS satellites.

[0169] The A/V input unit **620** is used to input an audio or a video, and may include a camera **621**, a microphone **623**, and the like.

[0170] The user input unit **630** generates key input data which is input to control an operation of a terminal by a user. To this end, the user input unit **630** may include a keypad, a dome switch, a touch pad (static pressure/electrostatic), and the like. In particular, when the touch pad forms a multilayer structure with the display unit **680**, the touch pad may be referred to as a touchscreen.

[0171] The sensing unit **640** may generate a sensing signal for control of an operation of the mobile terminal **600** by detecting a current state of the mobile terminal **600** such as an open or closed state of the mobile terminal **600**, a position of the mobile terminal **600**, contact between a user and the mobile terminal **600**, and the like.

[0172] The sensing unit **640** may include a proximity sensor **641**, a pressure sensor **643**, a motion sensor **645**, and the like. The motion sensor **645** may detect a motion, a location, and the like of the mobile terminal **600** using an acceleration sensor, a gyro sensor, a gravity sensor, and the like. In particular, the gyro sensor is a sensor for measurement of angular velocity, and may detect a rotation direction (angle) with respect to a reference direction.

[0173] The output unit **650** may include the display unit **680**, an audio output unit **653**, an alarm unit **655**, a haptic module **657**, and the like.

[0174] The display unit **680** displays and outputs information processed by the mobile terminal **600**. For example, information received from the wireless communication unit **610** is displayed.

[0175] As described in the foregoing, when the display unit **680** and the touch pad form a multilayer structure, and are configured as a touchscreen, the display unit **680** may be used as an input device capable of inputting information by user touch in addition to an output device.

[0176] The audio output unit **653** outputs audio data received from the wireless communication unit **610** or stored in the memory **660**. The audio output unit **653** may include a speaker, a buzzer, and the like.

[0177] With regard to the present embodiment, the audio output unit **653** may output information related to a measured blood pressure as an audio. Alternatively, the audio output unit **653** may output a message for adjustment of positions of a first pulse wave sensor **130**, a second pulse wave sensor **135** and a pressurization unit **187** as an audio, or output a remeasurement notification message as an audio.

[0178] The audio output unit **653** may output information necessary for an operation of the hemadynamometer **100** as an audio.

[0179] The alarm unit **655** outputs a signal for notification of event occurrence of the mobile terminal **600**. For example, a signal may be output as a vibration.

[0180] The haptic module **657** generates various tactile effects perceivable by a user. A vibration effect is a representative example of a tactile effect generated by the haptic module **657**.

[0181] The memory **660** may store a program for processing and control of the controller **670**, and perform a function of temporarily storing input or output data (for example, a phone book, a message, a static image, a moving image, and the like).

[0182] The interface unit **625** functions as an interface with all external devices connected to the mobile terminal **600**. The interface unit **625** may receive data or power from an external device to deliver the data or power to each component in the mobile terminal **600**, and allow data in the mobile terminal **600** to be transmitted to an external device.

[0183] The hemadynamometer **100** described with reference to FIGS. **1** to **7**D may be included in the mobile terminal **600** as a blood pressure measurement unit **100**. The blood pressure measurement unit **100** includes the first pulse wave sensor **130**, the second pulse wave sensor **135** and the pressurization unit **187**, which will not be further described by referring to FIGS. **1** to **7**D.

[0184] The hemadynamometer **100***b* described with reference to FIG. **8** may be employed in the mobile terminal **600**.

[0185] In general, the controller **670** controls the overall operation of the mobile terminal **600** by controlling an operation of each unit. For example, the controller **670** may perform related control and processing for a voice call, data communication, a video call, and the like. In addition, the controller **670** may include a multimedia reproduction module **681** for reproduction of multimedia. The multimedia reproduction module **681** may be configured as hardware in the controller **670**, and be configured as software separately from the controller **670**.

[0186] It is possible to control an operation of the blood pressure measurement unit **100** related to the present invention.

[0187] For example, the controller **670** may measure a blood pressure based on first and second pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** before a predetermined pressure is applied to the wrist **700** by the pressurization unit

187, and third and fourth pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** after the predetermined pressure is applied to the wrist **700** by the pressurization unit **187**.

[0188] The controller **670** may separate first to fourth forward wave signals and first to fourth backward wave signals respectively from the first to fourth pulse wave signals, and measure the blood pressure based on at least one of a difference in pulse width or a difference in peak value between the first and third backward wave signals and a difference in pulse width or a difference in peak value between the second and fourth forward wave signals.

[0189] The controller **670** may measure the blood pressure in proportion to the difference in pulse width or the difference in peak value.

[0190] The controller **670** may control the display unit **680** or the audio output unit **653** to output a message for adjustment of positions of the first pulse wave sensor **130**, the second pulse wave sensor **135** and the pressurization unit **187**, or a remeasurement notification message when the difference in pulse width is less than or equal to a first predetermined value, the difference in peak value is less than or equal to a second predetermined value, or the first to fourth pulse wave signals have levels less than or equal to a third predetermined value.

[0191] The controller **670** may measure the blood pressure based on the first and second pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** in a state in which a first pressure is applied to the wrist **700** by the pressurization unit **187**, and the third and fourth pulse wave signals detected respectively by the first pulse wave sensor **130** and the second pulse wave sensor **135** in a state in which a second pressure is applied to the wrist **700** by the pressurization unit **187**.

[0192] With regard to the present embodiment, the display unit **680** may output blood pressure information.

[0193] The display unit **680** may output a message for adjustment of positions of the first pulse wave sensor **130**, the second pulse wave sensor **135** and the pressurization unit **187**, or output a remeasurement notification message.

[0194] The power supply unit **690** receives external power and internal power under control of the controller **670**, and supplies power necessary for an operation of each component.

[0195] The block diagram of the mobile terminal **600** shown in FIG. **10** is a block diagram for the present embodiment. The respective components of the block diagram may be combined, additionally provided, or omitted according to specifications of the mobile terminal **600** which is actually implemented. Two or more components may be combined into one component, or a component may be divided into two or more components as necessary. In addition, a function performed by each block is for describing the present embodiment, and a specific operation or device does not limit the scope of the present invention.

[0196] The configurations and schemes of the embodiments described above are not applied in a restricted manner to the hemadynamometer and the mobile terminal equipped with the hemadynamometer according to the embodiments of the present invention. All or a portion of the embodiments may be selectively combined so that the embodiments may be variously changed.

[0197] The hemadynamometer and the mobile terminal including the same according to the embodiments of the present invention may simply and accurately measure a blood pressure by including a first pulse wave sensor and a second pulse wave sensor which are disposed apart from each other, and each convert a pulse wave signal corresponding to the blood pressure into an electric signal, a pressurization unit which is disposed between the first pulse wave sensor and the second pulse wave sensor to apply a pressure to a wrist to change a diameter of a blood vessel, and a controller to measure the blood pressure based on first and second pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor before a predetermined pressure is applied to the wrist by the pressurization unit, and third and fourth pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor after the predetermined pressure is applied to the wrist by the pressurization unit.

[0198] In particular, it is possible to estimate a diameter of a blood vessel by detecting pulse waves at two or more positions in the blood vessel while changing the diameter of the vessel using the pressurization unit, and it is possible to measure the blood pressure based on the estimated diameter.

[0199] Therefore, it is possible to easily and accurately measure the blood pressure by applying a variation in ambient temperature or body temperature without a separate device.

[0200] In addition, the hemadynamometer may be conveniently worn on the wrist or the like, so that the first and second pulse wave sensors, the pressurization unit, and the like are attached to a band.

[0201] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, the present invention is not limited to the embodiments described above, and those skilled in the art will appreciate that various modifications are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims. The modifications should not be understood separately from the technical spirit and perspective of the present invention.

1. A hemadynamometer comprising:

a first pulse wave sensor and a second pulse wave sensor disposed apart from each other, each of the first pulse wave sensor and the second pulse wave sensor converting a pulse wave signal corresponding to a blood pressure into an electric signal;

a pressurization unit disposed between the first pulse wave sensor and the second pulse wave sensor to apply a pressure to a wrist to change a diameter of a blood vessel; and

a controller to measure the blood pressure based on first and second pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor before a predetermined pressure is applied to the wrist by the pressurization unit, and third and fourth pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor after the predetermined pressure is applied to the wrist by the pressurization unit.

2. The hemadynamometer according to claim **1**, wherein the first pulse wave sensor, the second pulse wave sensor and the pressurization unit are attached to a band wearable on the wrist, wherein each of the first pulse wave sensor and the second pulse wave sensor converts a pulse wave signal detected at a radial artery in the wrist into an electric signal.

3. The hemadynamometer according to claim **1**, wherein the controller separates first to fourth forward wave signals and first to fourth backward wave signals respectively from the first to fourth pulse wave signals, and measures the blood pressure based on at least one of a difference in pulse width or a difference in peak value between the first and third backward wave signals and a difference in pulse width or a difference in peak value between the second and fourth forward wave signals.

4. The hemadynamometer according to claim **3**, wherein the controller measures the blood pressure in proportion to the difference in pulse width or the difference in peak value.

5. The hemadynamometer according to claim **3**, wherein the first pulse wave sensor, the second pulse wave sensor and the pressurization unit are attached to a band wearable on the wrist,

wherein the controller performs a control operation to output a message for adjustment of positions of the first pulse wave sensor, the second pulse wave sensor and the pressurization unit, or a remeasurement notification message when the difference in pulse width is less than or equal to a first predetermined value, the difference in peak value is less than or equal to a second predetermined value, or the first to fourth pulse wave signals have levels less than or equal to a third predetermined value.

6. The hemadynamometer according to claim **1**, wherein the controller measures the blood pressure based on the first and second pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor in a state in which a first pressure is transmitted to the wrist by the pressurization unit, and the third and fourth pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor in a state in which a second pressure is transmitted to the wrist by the pressurization unit.

7. The hemadynamometer according to claim **1**, further comprising a second pressurization unit and a third pressurization unit disposed apart from each other around the pressurization unit,

wherein the first pulse wave sensor is disposed between the pressurization unit and the second pressurization unit, and the second pulse wave sensor is disposed between the pressurization unit and the third pressurization unit.

8. The hemadynamometer according to claim **1**, further comprising an audio output unit to output information about the measured blood pressure as an audio.

9. The hemadynamometer according to claim **1**, further comprising a communication unit to transmit information about the measured blood pressure to a paired mobile terminal.

10. A mobile terminal comprising:

a communication unit;

a display to display information received from the communication unit;

a pulse wave sensor and a second pulse wave sensor disposed apart from each other, each of the first pulse wave sensor and the second pulse wave sensor converting a pulse wave signal corresponding to a blood pressure into an electric signal;

a pressurization unit disposed between the first pulse wave sensor and the second pulse wave sensor to apply a pressure to a wrist to change a diameter of a blood vessel; and

a controller to measure the blood pressure based on first and second pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor before a predetermined pressure is applied to the wrist by the pressurization unit, and third and fourth pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor after the predetermined pressure is applied to the wrist by the pressurization unit.

11. The mobile terminal according to claim **10**, wherein the display is attached to a band wearable on the wrist,

wherein the first pulse wave sensor, the second pulse wave sensor and the pressurization unit are disposed on a rear surface of the display.

12. The mobile terminal according to claim **10**, wherein the controller separates first to fourth forward wave signals and first to fourth backward wave signals respectively from the first to fourth pulse wave signals, and measures the blood pressure based on at least one of a difference in pulse width or a difference in peak value between the first and third backward wave signals and a difference in pulse width or a difference in peak value between the second and fourth forward wave signals.

13. The mobile terminal according to claim **12**, wherein the controller measures the blood pressure in proportion to the difference in pulse width or the difference in peak value.

14. The mobile terminal according to claim **12**, wherein the first pulse wave sensor, the second pulse wave sensor and the pressurization unit are attached to a band wearable on the wrist,

wherein the controller performs a control operation to output a message for adjustment of positions of the first pulse wave sensor, the second pulse wave sensor and the pressurization unit, or a remeasurement notification message when the difference in pulse width is less than or equal to a first predetermined value, the difference in peak value is less than or equal to a second predetermined value, or the first to fourth pulse wave signals have levels less than or equal to a third predetermined value.

15. The mobile terminal according to claim **10**, wherein the controller measures the blood pressure based on the first and second pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor in a state in which a first pressure is transmitted to the wrist by the pressurization unit, and the third and fourth pulse wave signals detected respectively by the first pulse wave sensor and the second pulse wave sensor in a state in which a second pressure is transmitted to the wrist by the pressurization unit.

* * * * *

专利名称(译)	Hemadynamometer和包括相同的移动终端		
公开(公告)号	[US20170215748A1]()	公开(公告)日	2017-08-03
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申请(专利权)人(译)	LG电子株式会社.		
当前申请(专利权)人(译)	LG电子株式会社.		
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摘要(译)

公开了一种血压计和包括该血压计的移动终端。血压计包括彼此分开设置的第一和第二脉搏波传感器，每个脉冲波传感器将对应于血压的脉搏波信号转换成电信号，加压单元用于向手腕施加压力以改变血管的直径，基于在由加压单元向腕部施加预定压力之前由第一和第二脉搏波传感器分别检测到的第一和第二脉冲波信号测量血压的控制器，以及分别由检测到的第三和第四脉冲波信号。在通过加压单元将预定压力施加到手腕之后的第一和第二脉搏波传感器。因此，可以简单且准确地测量血压。