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(54) **SKIN PERFUSION PRESSURE MEASURING APPARATUS**

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CPC ***A61B 5/0261*** (2013.01); ***A61B 5/441*** (2013.01); ***A61B 5/704*** (2013.01)

(57) **ABSTRACT**

A measuring apparatus for measuring skin perfusion pressure of an examined region in a subject, the measuring apparatus including: a measuring device configured to measure blood flow in the examined region; a detection unit configured to detect a height of the examined region; and a processing unit configured to determine the skin perfusion pressure of the examined region on the basis of a change in the blood flow in the examined region measured by the measuring device with the height of the examined region being changed and the height of the examined region being detected by the detection unit.

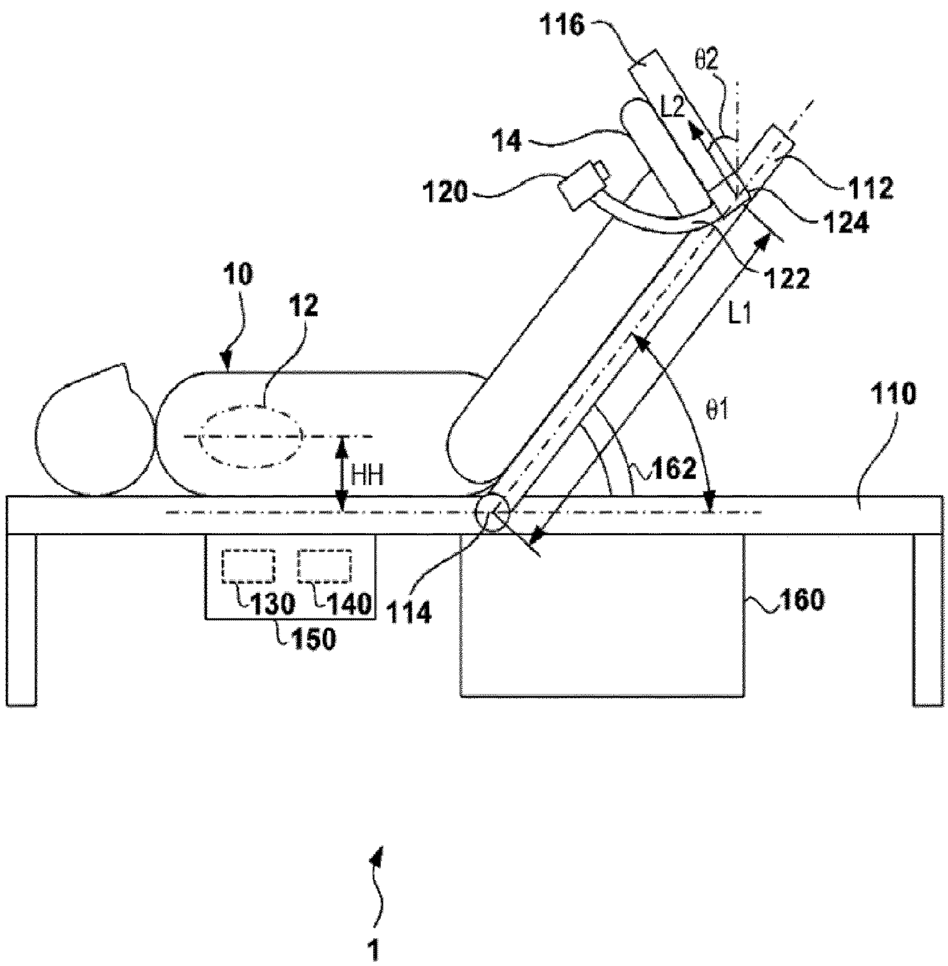


FIG.1

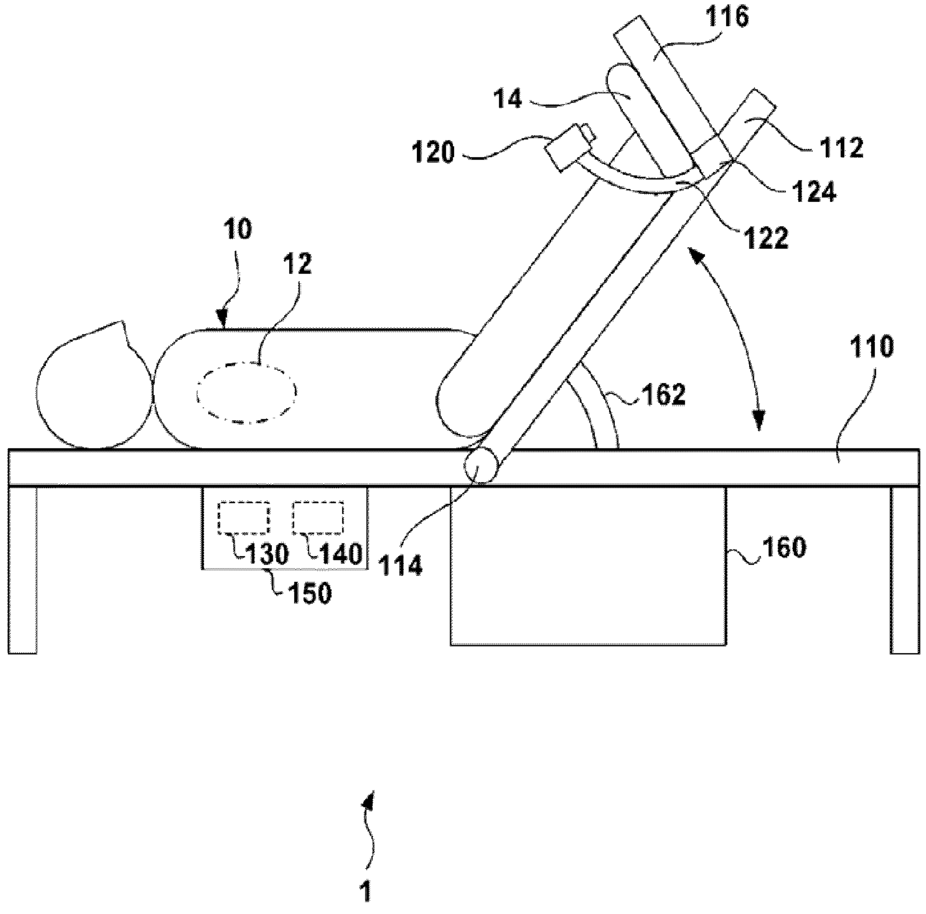


FIG.2

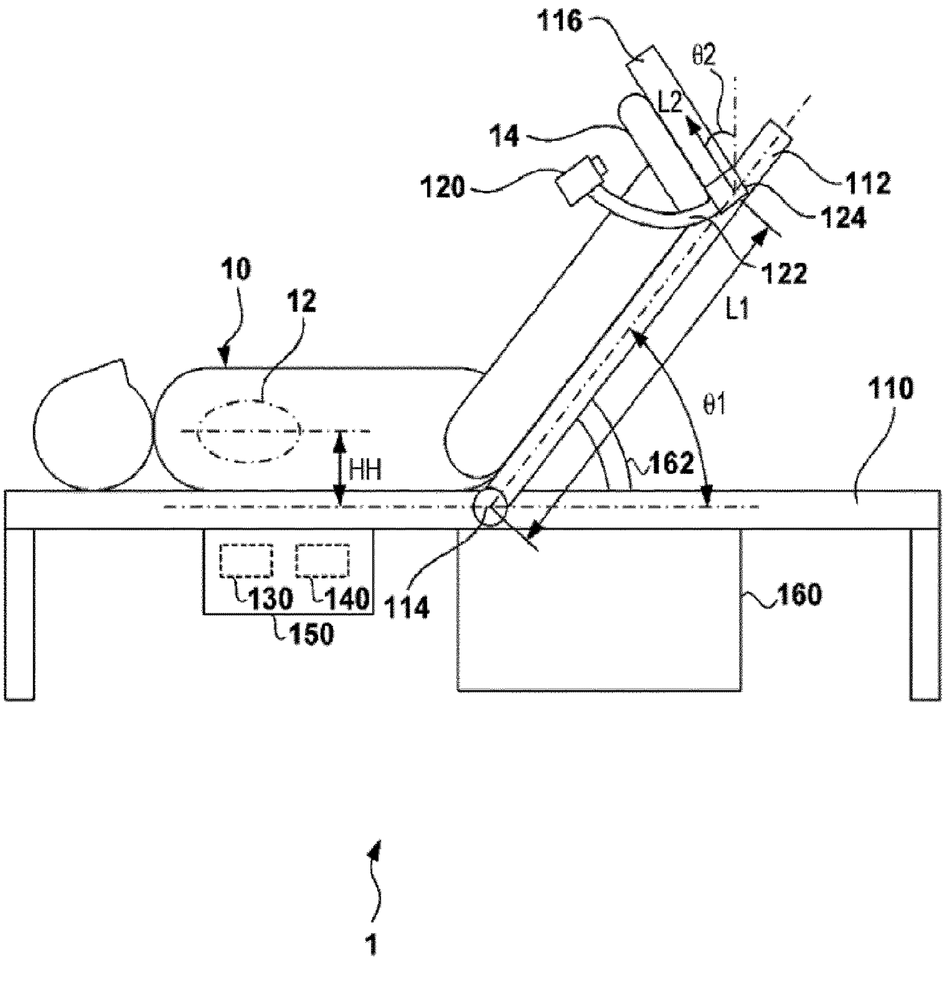

116
θ2
L2
14
112
120
124
122
10
12
L1
110
θ1
HH
162
130
140
114
160
150
1

FIG.3

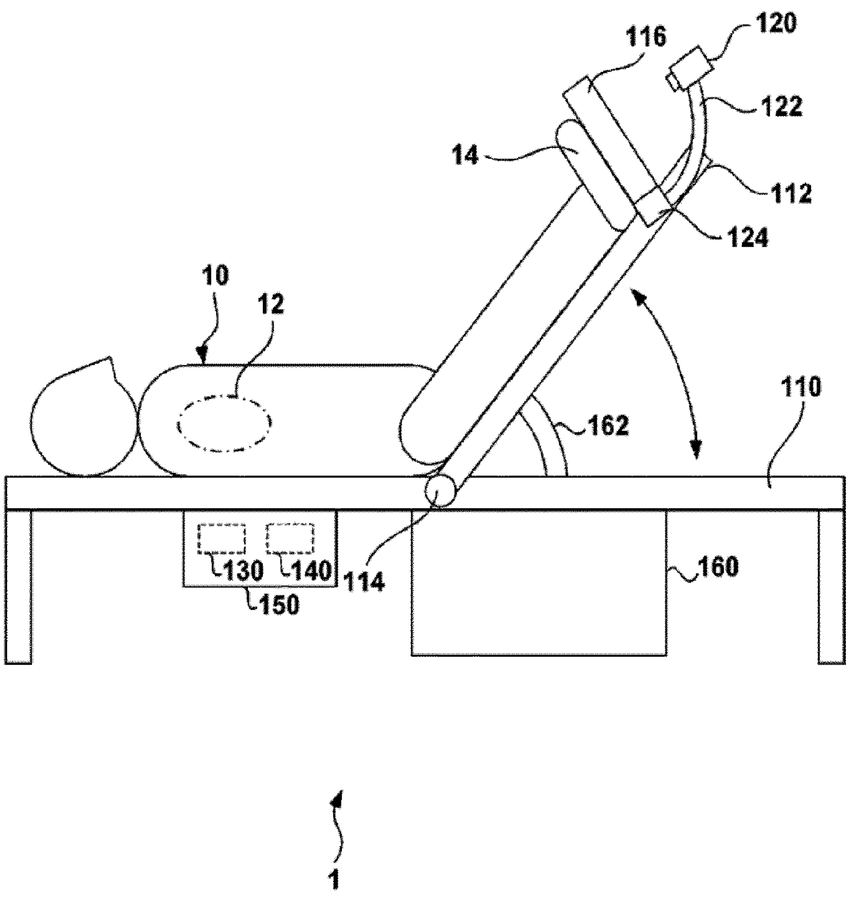


FIG.4

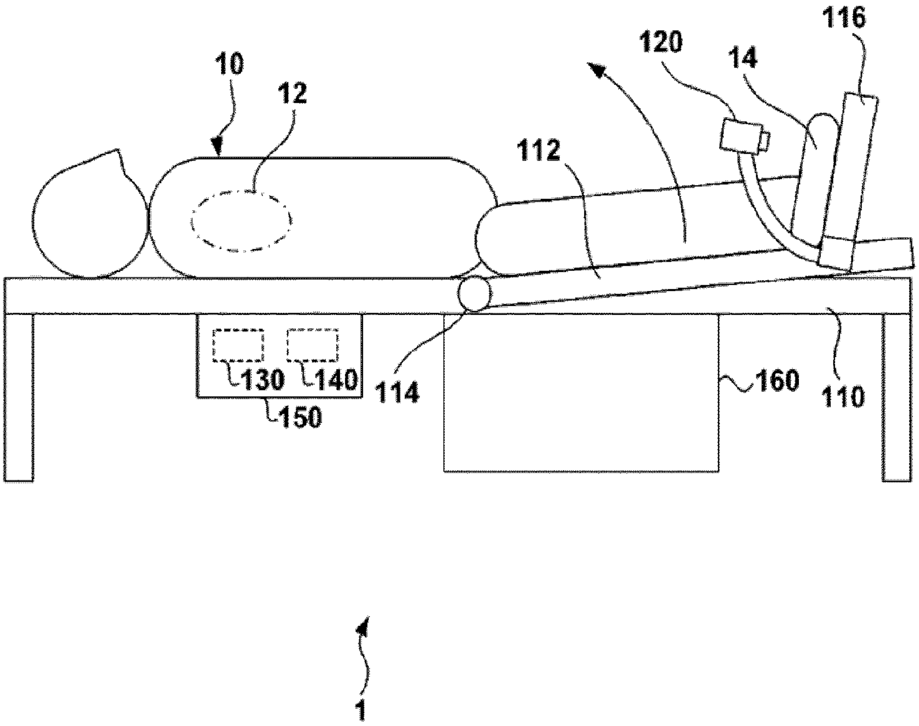
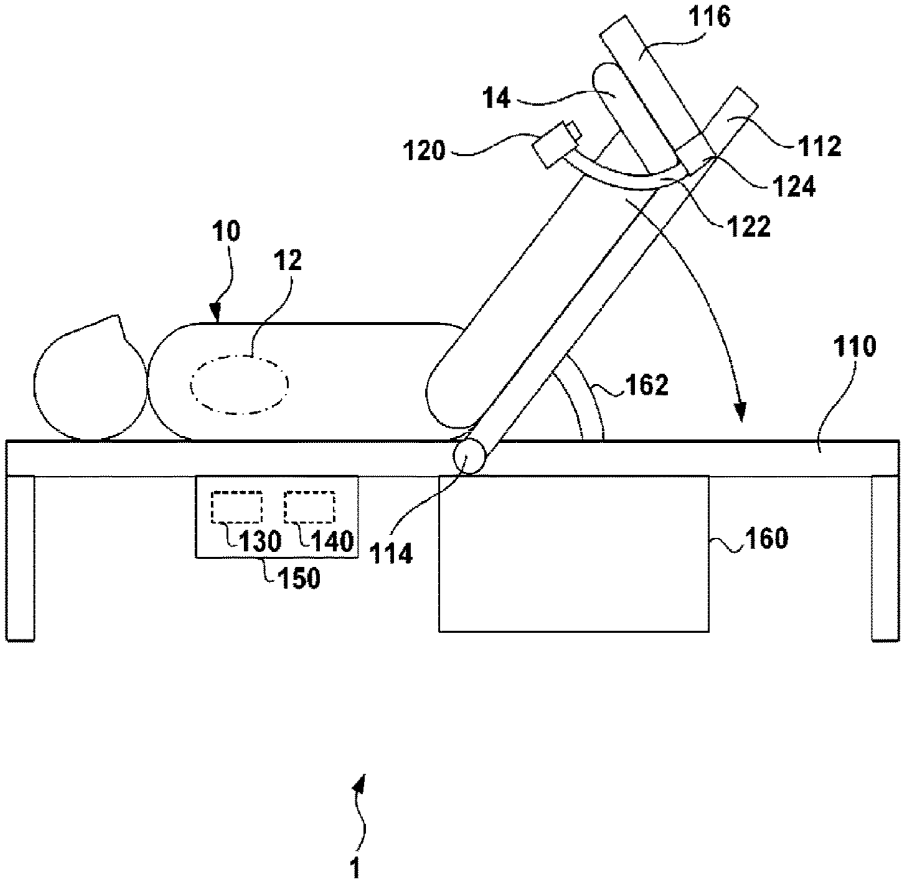


FIG.5



SKIN PERFUSION PRESSURE MEASURING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a bypass continuation of PCT Application No. PCT/JP2015/075282, filed on Sep. 7, 2015, which claims priority to Japanese Application No. 2014-228319, filed on Nov. 10, 2014. These applications are hereby incorporated by reference in their entireties.

BACKGROUND

[0002] The present disclosure relates to a measuring apparatus that measures the skin perfusion pressure.

[0003] Peripheral blood flow evaluation in peripheral arterial disease is useful, for example, as a method for checking the progress of arteriosclerosis or checking whether there is blood flow required for healing of a wound. One method used for peripheral blood flow evaluation involves measuring skin perfusion pressure.

[0004] JP 2009-506871W describes a perfusion pressure monitoring system as a skin perfusion pressure measuring apparatus. The skin perfusion pressure monitoring system is provided with an optical probe (sensor), a pressure cuff, and a skin perfusion pressure tool. The optical probe is disposed on an inner face side of the pressure cuff so as to come close to the skin of the limb of a patient. The skin perfusion pressure tool expands the pressure cuff to stop blood flow and then contracts the pressure cuff, and measures the pressure when the blood flow resumes.

[0005] In a method of performing pressurization using a pressure cuff, as in the measuring apparatus described in JP 2009-506871 W, attachment of the pressure cuff to a wound region inflicts pain on a subject. When the pain is excessive, the measurement is difficult to perform. Further, even when pressure is applied to a region other than a wound region using the pressure cuff, pain caused by the pressure maybe inflicted on a subject, which is not preferred. Further, when there is calcification in the blood vessel, it may be impossible to stop the blood flow by pressurization.

SUMMARY

[0006] Certain embodiments described in the present disclosure make it possible to measure skin perfusion pressure without applying pressure to an examined region.

[0007] In one embodiment, a measuring apparatus that measures skin perfusion pressure of an examined region in a subject is provided. The measuring apparatus includes a measuring device that measures blood flow in the examined region, a detection unit that detects a height of the examined region, and a processing unit that obtains the skin perfusion pressure of the examined region on the basis of a change in the blood flow in the examined region measured by the measuring device with the height of the examined region being changed and the height of the examined region detected by the detection unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a diagram illustrating a measuring apparatus of one embodiment of the present invention.

[0009] FIG. **2** is a diagram illustrating the principle of detecting the height of an examined region in the measuring apparatus of one embodiment of the present invention.

[0010] FIG. **3** is a diagram illustrating a usage example of the measuring apparatus of one embodiment of the present invention.

[0011] FIG. **4** is a diagram illustrating a measuring method by the measuring apparatus of one embodiment of the present invention.

[0012] FIG. **5** is a diagram illustrating a measuring method by the measuring apparatus of one embodiment of the present invention.

DETAILED DESCRIPTION

[0013] Hereinbelow, embodiments of the present invention will be described with reference to the accompanying drawings.

[0014] FIG. **1** schematically illustrates a measuring apparatus **1** according to one embodiment of the present invention. The measuring apparatus **1** is configured to measure the skin perfusion pressure of an examined region **14** in a subject **10**. The measuring apparatus **1** measures the skin perfusion pressure using a change in the blood pressure in the examined region **14** by changing the height of the examined region **14**. Specifically, the measuring apparatus **1** obtains the skin perfusion pressure of the examined region **14** on the basis of the height of the examined region **14** when the examined region **14** in a state having blood flow is brought into a state with blood flow stopped in response to a change in the height of the examined region **14**. Alternatively, the measuring apparatus **1** obtains the skin perfusion pressure of the examined region **14** on the basis of the height of the examined region **14** when the examined region **14** in a state with blood flow stopped is brought into a state with blood flow resumed in response to a change in the height of the examined region **14**.

[0015] When the specific gravity of mercury is 13.6 and the specific gravity of blood is 1.055, a pressure difference generated by a height difference of 1.43 cm is 1 mmHg. For example, when the heart **12** of the subject **10** is used as a reference, a blood pressure at a position higher than the heart **12** by 1.43 cm becomes lower than a blood pressure at the heart **12** by 1 mmHg. When the examined region **14** is gradually moved upward, the arterial blood pressure at the examined region **14** gradually decreases, and the blood flow may come to a stop in the end. On the contrary, when the examined region **14** lifted to a height where the blood flow in the examined region **14** comes to a stop is gradually moved downward, the blood flow in the examined region **14** resumes in the end.

[0016] The measuring apparatus **1** includes a measuring device **120** that measures blood flow in the examined region **14**, a detection unit **130** that detects the height of the examined region **14**, and a processing unit **140**. The detection unit **130** and the processing unit **140** may be stored in an electronic component box **150**. The detection unit **130** and the processing unit **140** may be configured as one processor or one electronic component.

[0017] The detection unit **130** may be configured to detect the height of the examined region **14** relative to the position of the heart **12** (the height where the heart **12** is located) of the subject **10**. The processing unit **140** obtains the skin perfusion pressure of the examined region **14** on the basis of a change in the blood flow in the examined region **14** measured by the measuring device **120** with the height of the examined region **14** being changed relative to the position of the heart **12**, the height being detected by the detection unit

130. The processing unit **140** may be configured to obtain the skin perfusion pressure of the examined region **14** on the basis of a value obtained by converting the height of the examined region **14** relative to the position (height) of the heart **12** of the subject **10** into a blood pressure (arterial blood pressure).

[0018] As illustrated in FIG. **4**, the processing unit **140** acquires the height of the examined region **14** when blood flow in the examined region **14** comes to a stop in response to an upward movement of the examined region **14** from the detection unit **130** and obtains the skin perfusion pressure of the examined region **14** on the basis of the acquired height. Alternatively, as illustrated in FIG. **5**, the processing unit **140** acquires the height of the examined region **14** when the blood flow in the examined region **14** resumes in response to a downward movement of the examined region **14** from the detection unit **130** and obtains the skin perfusion pressure of the examined region **14** on the basis of the acquired height.

[0019] The measuring apparatus **1** may further be provided with a change mechanism **160** that changes the height of the examined region **14**. The change mechanism **160** may automatically change the height of the examined region **14**, or may change the height of the examined region **14** in response to an operation by a measurer or by the force of a measurer. In an example, the measuring apparatus **1** is provided with a fixed table **110** which supports the subject **10** in a lying posture and a movable table **112** which supports the limb (e.g., the leg) of the subject **10**. The movable table **112** maybe turnably supported by a pivotal support member **114** which is attached to the fixed table **110**. The change mechanism **160** maybe configured to drive the movable table **112** by an actuator (e.g., a motor) through a movable arm **162**.

[0020] A fixing unit **116** that fixes the toe, which may be the examined region **14**, is attached to the movable table **112**. The fixing unit **116** may be configured such that the angle of the fixing unit **116** is adjustable with respect to the movable table **112**. The measuring apparatus **1** may further be provided with a holding unit **122** that holds the measuring device **120** so as to maintain a relative position between the measuring device **120** and the examined region **14** when the height of the examined region **14** is being changed.

[0021] The holding unit **122** may include an attitude changing mechanism **124** that changes the attitude of the measuring device **120** so that the examined region **14** comes into a measurable area for the measuring device **120**. As can be understood from a comparison between FIGS. **1** and **3**, the attitude changing mechanism **124** may include a mechanism that turns the holding unit **122** holding the measuring device **120**. In FIG. **1**, the instep of the foot as the examined region **14** is observed (measured) by the measuring device **120**. In FIG. **3**, the sole of the foot as the examined region **14** is observed (measured) by the measuring device **120**. The fixing unit **116** may be configured to allow the measuring device **120** to measure blood flow in the examined region **14** through the fixing unit **116**. Specifically, the fixing unit **116** may be configured to transmit light for measurement. This is achieved, for example, by the fixing unit **116** composed of a material that transmits light or the fixing unit **116** having a structure including an opening so as not to cover the examined region **14**. As illustrated in FIG. **3** as an example, when the eyes of the subject **10** are located within the field of view of the measuring device **120** and the measuring device **120** emits light such as laser light, a light blocking member may be disposed between the eyes of the subject **10** and the examined region **14**.

[0022] The measuring device **120** may be configured to measure blood flow at a plurality of positions in the examined region **14** of the subject **10**. The processing unit **140** may be configured to generate an image representing a skin perfusion pressure distribution in the examined region **14** on the basis of changes in the blood flow at the plurality of positions in the examined region **14** measured by the measuring device **120**. The generated image may be output to an output unit (e.g., a display unit or a printer, not illustrated). For example, a laser Doppler blood flow imaging device such as PeriScan PIM III, available from Perimed AB, can be used as the measuring device **120**. Alternatively, a laser speckle blood flowmeter such as Laser Speckle Contrast Analysis (LASCA) system, available from Perimed AB, can be used as the measuring device **120**. In addition, a plurality of probes that are brought into intimate contact with the examined region **14** to measure blood flow may be provided.

[0023] The stoppage or the resumption of blood flow in the examined region **14** maybe determined when the stoppage or the resumption of blood flow has been observed (measured) by the measuring device **120** in an area having a predetermined ratio to the entire area of the examined region **14** or when the stoppage or the resumption of blood flow has been observed (measured) by the measuring device **120** at a predetermined number of positions which are preset inside the examined region **14**. The measuring device **120** may be configured to measure blood flow at one specific position in the examined region **14**.

[0024] The principle of detecting the height of the examined region **14** by the detection unit **130** will be described as an example with reference to FIG. **2**. The height of the examined region **14** from the pivotal support member **114** is represented by $L1\sin\theta1+L2\cos\theta2$, where L1 denotes the distance from the center of the pivotal support member **114** to a coupling site between the movable table **112** and the fixing unit **116**, θ1 denotes the angle between the fixed table **110** and the movable table **112**, L2 denotes the distance from the movable table **112** at the fixing unit **116**, and θ2 denotes the angle between the fixing unit **116** and a vertical plane. The distance L2 can be specified from coordinates within the field of view of the measuring device **120**. When a height difference HH between the pivotal support member **114** and the heart **12** is taken into consideration, the height of the examined region **14** relative to the heart **12** is represented by $L1\sin\theta1+L2\cos\theta2-HH$.

[0025] The distance L1, the angle θ1, and the angle θ2 may be provided to the detection unit **130** from a sensor which reads these L1, θ1, and θ2 or may be input to the detection unit **130** by a measurer. The distance L2 may be specified on the basis of a position in information (image) output from the measuring device **120**. Note that the information (image) output from the measuring device **120** or the height in the field of view of the measuring device **120** may be considered to be constant.

[0026] Alternatively, the detect ion unit **130** may detect the height of the examined region **14** on the basis of a measurement result provided from a sensor (not illustrated) that measures the height of the examined region **14**. The sensor may be, for example, a laser displacement meter.

[0027] Although, in the present embodiment, the height of the examined region **14** is changed by moving the movable table **112** up and down around the pivotal support member **114** as a rotation shaft with respect to the fixed table **110** whose height is fixed, the present invention is not limited thereto. The position of the heart **12** of the subject **10** may be moved up and down by moving the fixed table **110** up and down around the pivotal support member **114** as a rotation shaft without changing the position of the movable table **112** to change the relative height between the examined region **14** and the heart **12** . Further, it is also possible to change the relative position between the examined region **14** and the heart **12** by changing both the position of the fixed table **110** and the position of the movable table **112**.

[0028] The present invention is not limited to the above embodiment, and various changes and modifications can be made without departing from the scope and the range of the invention. Thus, the following claims are appended to make the range of the invention public.

REFERENCE NUMERAL LIST

[0029] **10**: subject

[0030] **12**: heart

[0031] **14**: examined region

[0032] **110**: fixed table

[0033] **112**: movable table

[0034] **116**: fixing unit

[0035] **120**: measuring device

[0036] **130**: detection unit

[0037] **140**: processing unit

[0038] **160**: change unit

1. A measuring apparatus for measuring skin perfusion pressure of an examined region in a subject, the measuring apparatus comprising:

a measuring device configured to measure blood flow in the examined region;

a detection unit configured to detect a height of the examined region; and

a processing unit configured to determine the skin perfusion pressure of the examined region on the basis of a change in the blood flow in the examined region measured by the measuring device with the height of the examined region being changed and the height of the examined region being detected by the detection unit.

2. The measuring apparatus according to claim **1**, wherein the detection unit is configured to detect the height of the examined region relative to a position of the heart of the subject.

3. The measuring apparatus according to claim **2**, wherein the processing unit is configured to determine the skin perfusion pressure of the examined region on the basis of a value obtained by converting the height of the examined region relative to the position of the heart of the subject into a blood pressure.

4. The measuring apparatus according to claim **1**, wherein the processing unit is configured to:

acquire, from the detection unit, the height of the examined region when (i) the blood flow in the examined region comes to a stop in response to relative movement of the examined region to a position above the heart and/or (ii) the blood flow in a stopped state in the examined region resumes in response to relative movement of the examined region to a position closer to the heart, and

obtain the skin perfusion pressure of the examined region on the basis of the acquired height.

5. The measuring apparatus according to claim **1**, further comprising a change mechanism configured to change a relative height between the examined region and the heart.

6. The measuring apparatus according to claim **1**, wherein:

the measuring device is configured to measure blood flow at a plurality of positions in the examined region of the subject, and

the processing unit is configured to generate an image representing a skin perfusion pressure distribution in the examined region on the basis of changes in the blood flow at the plurality of positions in the examined region measured by the measuring device.

7. The measuring apparatus according to claim **1**, further comprising a holding unit configured to hold the measuring device so as to maintain a relative position between the measuring device and the examined region when the height of the examined region is being changed.

8. The measuring apparatus according to claim **7**, wherein the holding unit includes an attitude changing mechanism configured to change an attitude of the measuring device such that the examined region comes into a measurable area for the measuring device.

9. The measuring apparatus according to claim **1**, further comprising a fixing unit configured to fix the examined region.

10. The measuring apparatus according to claim **9**, wherein the fixing unit is configured to allow the measuring device to measure the blood flow in the examined region through the fixing unit.

11. The measuring apparatus according to claim **1**, wherein the measuring device is a laser Doppler blood flow imaging device.

12. The measuring apparatus according to claim **1**, wherein the measuring device is laser speckle blood flowmeter.

13. A method for measuring skin perfusion pressure of an examined region in a subject, the method comprising:

with a measuring device, measuring measure blood flow in the examined region;

with a detection unit, detecting a height of the examined region; and

with a processing unit, determining the skin perfusion pressure of the examined region on the basis of a change in the blood flow in the examined region measured by the measuring device with the height of the examined region being changed and the height of the examined region being detected by the detection unit.

* * * * *

专利名称(译)	皮肤灌注压力测量仪		
公开(公告)号	US20170231511A1	公开(公告)日	2017-08-17
申请号	US15/585744	申请日	2017-05-03
[标]申请(专利权)人(译)	泰尔茂株式会社		
申请(专利权)人(译)	泰尔茂株式会社		
当前申请(专利权)人(译)	泰尔茂株式会社		
[标]发明人	KURIO MASARU		
发明人	KURIO, MASARU		
IPC分类号	A61B5/026 A61B5/00		
CPC分类号	A61B5/0261 A61B5/704 A61B5/441 A61B5/004 A61B5/02007 A61B5/0295 A61B5/702 A61B5/7246 A61B5/7282		
优先权	2014228319 2014-11-10 JP		
外部链接	Espacenet USPTO		

摘要(译)

一种用于测量对象中被检查区域的皮肤灌注压的测量装置，该测量装置包括：测量装置，被配置为测量被检查区域中的血流量;检测单元，被配置为检测被检查区域的高度;处理单元，被配置为基于由测量装置测量的被检查区域中的血流量的变化来确定被检查区域的皮肤灌注压力，其中被检查区域的高度被改变以及被检查区域的高度被检测单元检测到。