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(54) **MODULAR FINGER CUFF**

(71) Applicant: **Edwards Lifesciences Corporation**, Irvine, CA (US)

(72) Inventors: **Olaf Schraa**, Amsterdam (NL); **Peiyuan Li**, Amsterdam (NL)

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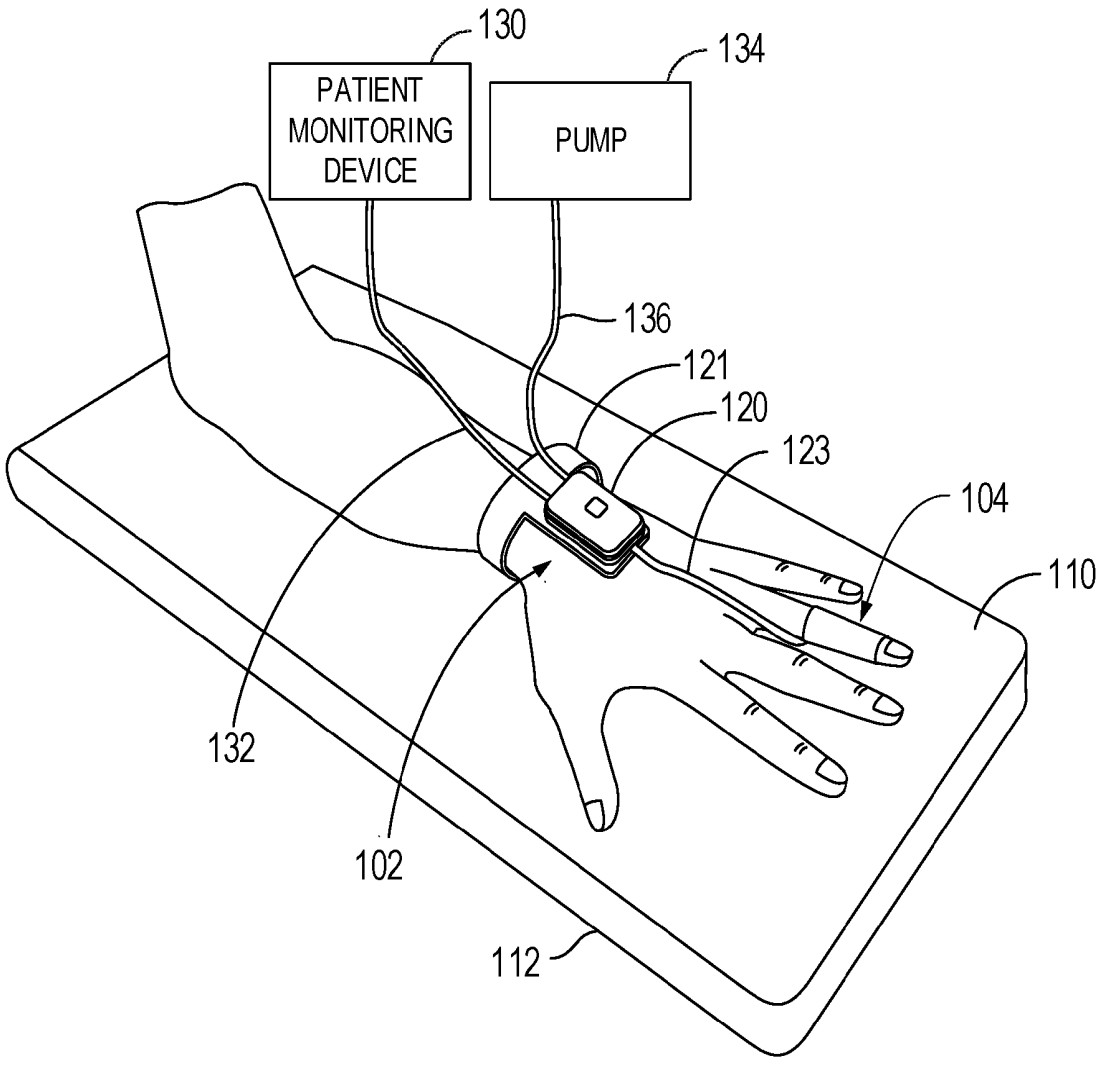
(57) **ABSTRACT**

Disclosed is a finger cuff that is attachable to a patient's finger to be used in measuring the patient's blood pressure by a blood pressure measurement system. The finger cuff includes a plethysmograph that is detachable from the finger cuff. The plethysmograph includes a light emitting diode (LED)-photodiode (PD) pair that aids in measuring the patient's blood pressure by the blood pressure measurement system. The finger cuff further includes a bladder mountable within the finger cuff. The bladder includes a plethysmograph portion such that the plethysmograph is effectively positioned against the plethysmograph portion of the bladder when the finger cuff is attached to the patient's finger.



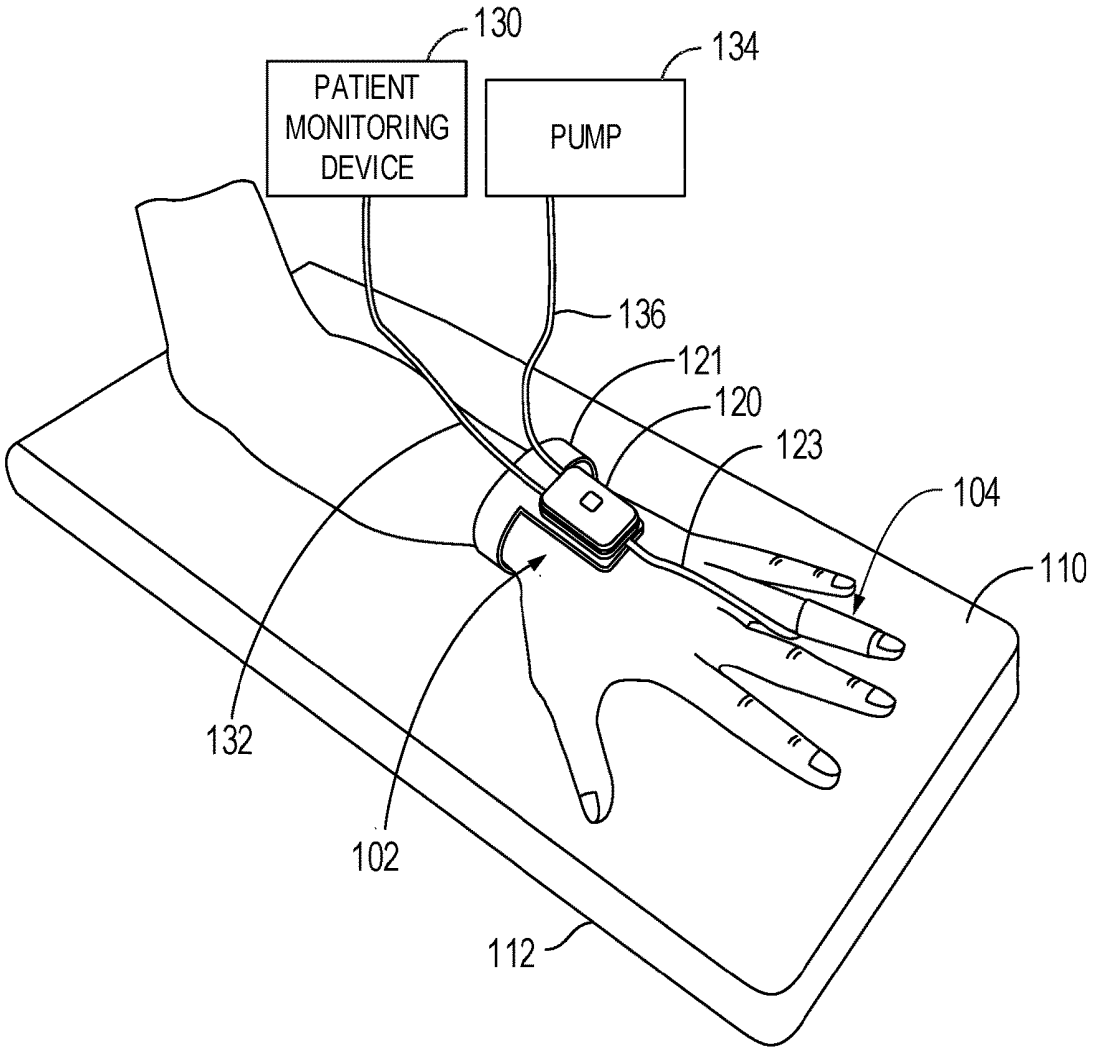

130
134
PATIENT MONITORING DEVICE
PUMP
136
121
120
123
104
110
132
102
112

FIG. 1

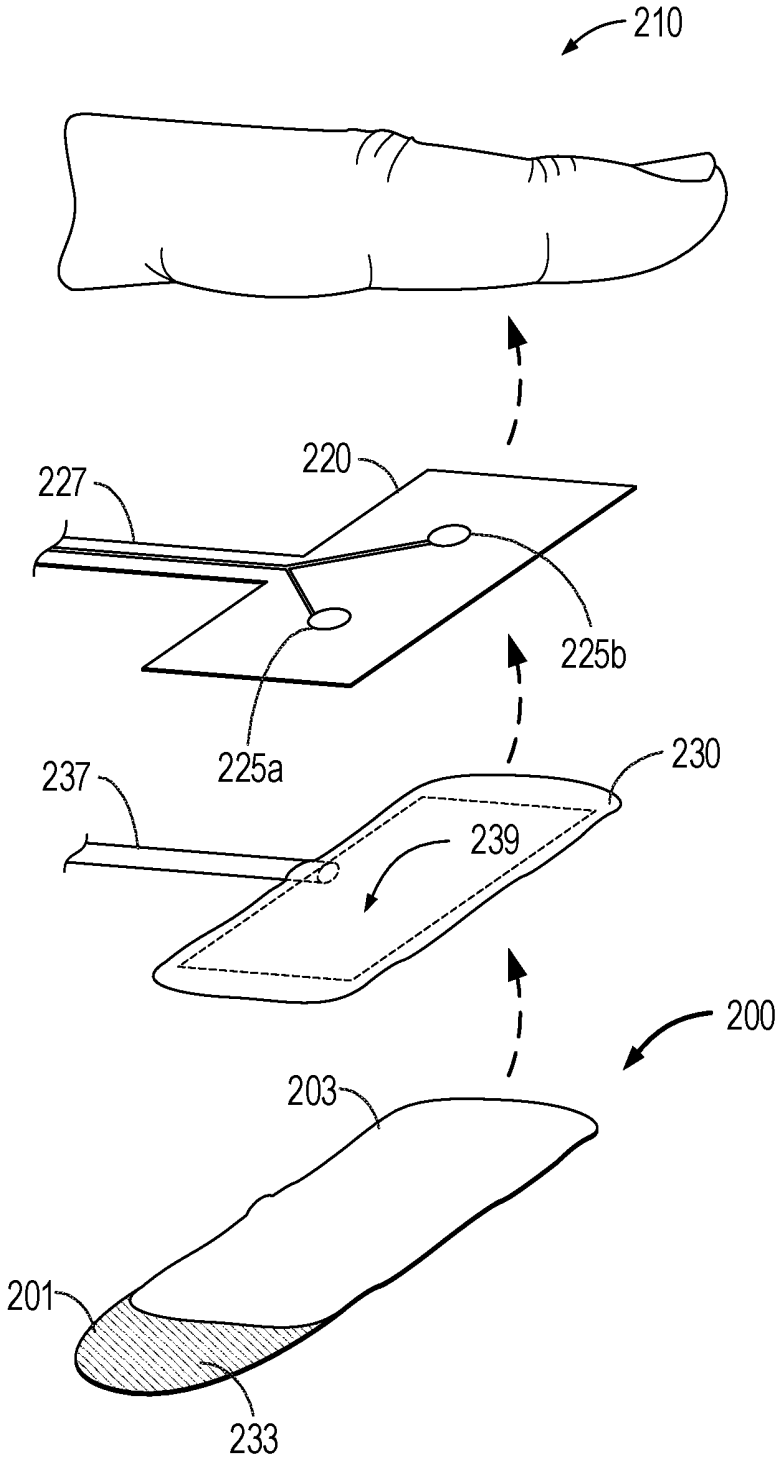


FIG. 2

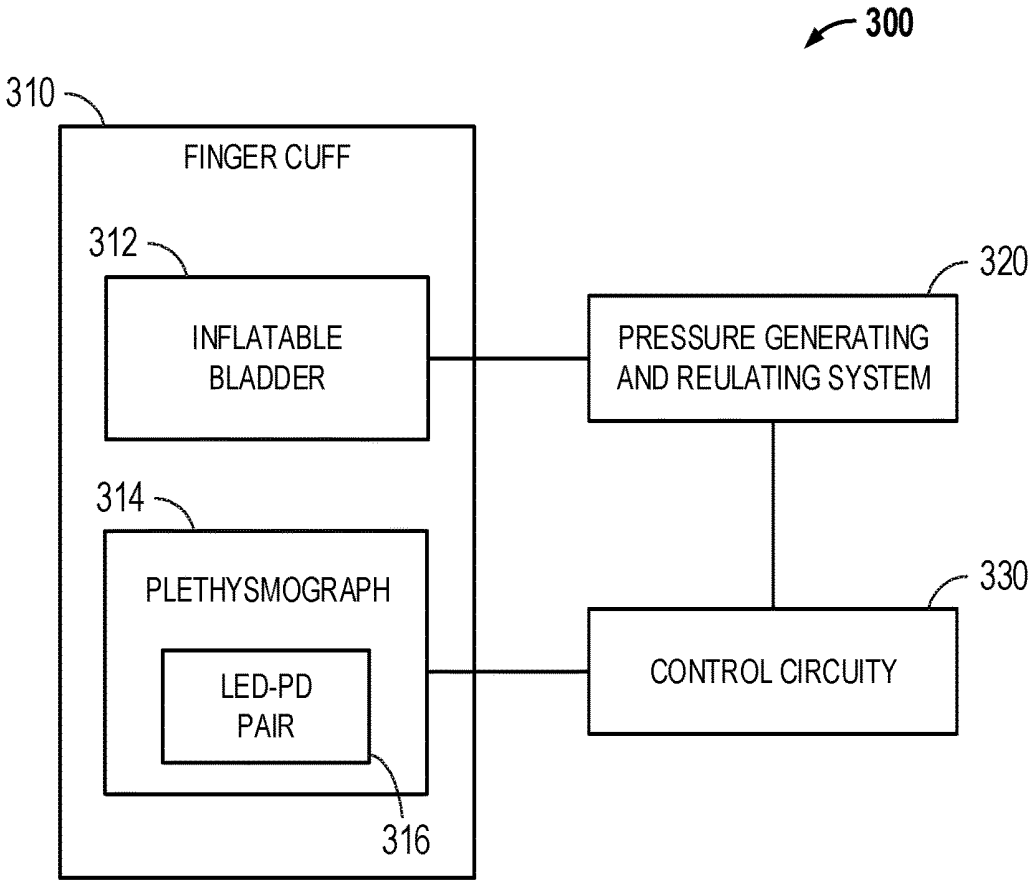

300
310
FINGER CUFF
312
INFLATABLE BLADDER
314
PLETHYSMOGRAPH
LED-PD PAIR
316
320
PRESSURE GENERATING AND REULATING SYSTEM
330
CONTROL CIRCUITY

FIG. 3

MODULAR FINGER CUFF

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority to U.S. Provisional Application No. 62/555,425, filed Sep. 7, 2017, which is incorporated herein by reference.

BACKGROUND

Field

[0002] Embodiments of the invention relate generally to non-invasive blood pressure measurement. More particularly, embodiments of the invention relate to a finger cuff for blood pressure measurement.

Relevant Background

[0003] Volume clamping is a technique for non-invasively measuring blood pressure in which an external pressure is applied to a patient's finger in such a manner that arterial pressure may be balanced by a time varying pressure to maintain a constant arterial volume. In a properly fitted and calibrated system, the applied time varying pressure is equal to the arterial blood pressure in the finger. The applied time varying pressure may be measured to provide a reading of the patient's arterial blood pressure.

[0004] This may be accomplished by a finger cuff that is arranged around a finger of a patient. The finger cuff may include an infrared light source, an infrared sensor, and an inflatable bladder. The infrared light may be sent through the finger in which a finger artery is present. The infrared sensor picks up the infrared light and the amount of infrared light registered by the sensor may be inversely proportional to the artery diameter and indicative of the pressure in the artery.

[0005] In the finger cuff implementation, by inflating the bladder of the finger cuff, a pressure is exerted on the finger artery. If the pressure is high enough, it will compress the artery and the amount of light registered by the sensor will increase. The amount of pressure necessary in the inflatable bladder to compress the artery is dependent on the blood pressure. By controlling the pressure of the inflatable bladder such that the diameter of the finger artery is kept constant, the blood pressure may be monitored in very precise detail as the pressure in the inflatable bladder is directly linked to the blood pressure. In a typical present day finger cuff implementation, a volume clamp system is used with the finger cuff. The volume clamp system typically includes a pressure generating system and a regulating system that includes: a pump, a valve, and a pressure sensor in a closed loop feedback system that are used in the measurement of the arterial volume. To accurately measure blood pressure, the feedback loop provides sufficient pressure generating and releasing capabilities to match the pressure oscillations of the patient's blood pressure.

[0006] Unfortunately, a finger cuff is currently disposed of in its entirety once it expires (e.g., after being used on a patient). This is wasteful as an entire finger cuff may be expensive to manufacture. Accordingly, it would be beneficial to recycle and reuse some portions of an expired finger cuff to minimize material waste and reduce manufacturing costs.

SUMMARY

[0007] Embodiments of the invention may relate to a finger cuff that is applied on a patient's finger to be used in measuring the patient's blood pressure by a blood pressure measurement system. The finger cuff includes a plethysmograph that is detachable from the finger cuff. The plethysmograph includes a light emitting diode (LED)-photodiode (PD) pair that aids in measuring the patient's blood pressure by the blood pressure measurement system. The finger cuff further includes a bladder mountable within the finger cuff. The bladder includes a plethysmograph portion such that the plethysmograph is effectively positioned against the plethysmograph portion of the bladder when the finger cuff is attached to the patient's finger.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a diagram of an example of a blood pressure measurement system according to one embodiment.

[0009] FIG. **2** is a diagram illustrating an example of a finger cuff according to one embodiment.

[0010] FIG. **3** is a block diagram illustrating an example environment in which embodiments of the invention may be practiced.

DETAILED DESCRIPTION

[0011] With reference to FIG. **1**, which illustrates an example of a blood pressure measurement system according to one embodiment, a blood pressure measurement system **102** that includes a finger cuff **104** that may be applied to a patient's finger and a blood pressure measurement controller **120**, which may be attached to the patient's body (e.g., a patient's wrist or hand) is shown.

[0012] The blood pressure measurement system **102** may further be connected to a patient monitoring device **130**, and, in some embodiments, a pump **134**. Further, finger cuff **104** may include a bladder (not shown) and an LED-PD pair (not shown), which are conventional for finger cuffs.

[0013] In one embodiment, the blood pressure measurement system **102** may include a pressure measurement controller **120** that includes: a small internal pump, a small internal valve, a pressure sensor, and control circuitry. In this embodiment, the control circuitry may be configured to: control the pneumatic pressure applied by the internal pump to the bladder of the finger cuff **104** to replicate the patient's blood pressure based upon measuring the plethysmograph signal received from the LED-PD pair of the finger cuff **104**. Further, the control circuitry may be configured to: control the opening of the internal valve to release pneumatic pressure from the bladder; or the internal valve may simply be an orifice that is not controlled. Additionally, the control circuitry may be configured to: measure the patient's blood pressure by monitoring the pressure of the bladder based upon the input from a pressure sensor, which should be the same as patient's blood pressure, and may display the patient's blood pressure on the patient monitoring device **130**.

[0014] In another embodiment, a conventional pressure generating and regulating system may be utilized, in which, a pump **134** is located remotely from the body of the patient. In this embodiment, the blood pressure measurement controller **120** receives pneumatic pressure from remote pump **134** through tube **136** and passes on the pneumatic pressure

through tube **123** to the bladder of finger cuff **104**. Blood pressure measurement device controller **120** may also control the pneumatic pressure (e.g., utilizing a controllable valve) applied to the finger cuff **104** as well as other functions. In this example, the pneumatic pressure applied by the pump **134** to the bladder of finger cuff **104** to replicate the patient's blood pressure based upon measuring the plethysmograph signal received from the LED-PD pair of the finger cuff **104** and measuring the patient's blood pressure by monitoring the pressure of the bladder may be controlled by the blood pressure measurement controller **120** and/or a remote computing device and/or the pump **134** and/or the patient monitoring device **130** to implement the volume clamping method. In some embodiments, a blood pressure measurement controller **120** is not used at all and there is simply a connection from tube **136** from a remote pump **134** including a remote pressure regulatory system to finger cuff **104**, and all processing for the pressure generating and regulatory system, data processing, and display is performed by a remote computing device.

[0015] Continuing with this example, as shown in FIG. **1**, a patient's hand may be placed on the face **110** of an arm rest **112** for measuring a patient's blood pressure with the blood pressure measurement system **102**. The blood pressure measurement controller **120** of the blood pressure measurement system **102** may be coupled to a bladder of the finger cuff **104** in order to provide pneumatic pressure to the bladder for use in blood pressure measurement. Blood pressure measurement controller **120** may be coupled to the patient monitoring device **130** through a power/data cable **132**. Also, in one embodiment, as previously described, in a remote implementation, blood pressure measurement controller **120** may be coupled to a remote pump **134** through tube **136** to receive pneumatic pressure for the bladder of the finger cuff **104**. The patient monitoring device **130** may be any type of medical electronic device that may read, collect, process, display, etc., physiological readings/data of a patient including blood pressure, as well as any other suitable physiological patient readings. Accordingly, power/data cable **132** may transmit data to and from patient monitoring device **130** and also may provide power from the patient monitoring device **130** to the blood pressure measurement controller **120** and finger cuff **104**.

[0016] As can be seen in FIG. **1**, in one example, the finger cuff **104** may be attached to a patient's finger and the blood pressure measurement controller **120** may be attached on the patient's hand or wrist with an attachment bracelet **121** that wraps around the patient's wrist or hand. The attachment bracelet **121** may be metal, plastic, Velcro, etc. It should be appreciated that this is just one example of attaching a blood pressure measurement controller **120** and that any suitable way of attaching a blood pressure measurement controller to a patient's body or in close proximity to a patient's body may be utilized and that, in some embodiments, a blood pressure measurement controller **120** may not be used at all. It should further be appreciated that the finger cuff **104** may be connected to a blood pressure measurement controller described herein, or a pressure generating and regulating system of any other kind, such as a conventional pressure generating and regulating system that is located remotely from the body of the patient (e.g., a pump **134** located remotely from a patient). Any kind of pressure generating and regulating system can be used, including but not limited to the blood pressure measurement controller, and may be described simply as a pressure generating and regulating system that may be used with a finger cuff **104** including an LED-PD pair and a bladder to implement the volume clamping method.

[0017] FIG. **2** is a diagram illustrating an example of a finger cuff **200** according to one embodiment. Referring to FIG. **2**, finger cuff **200** may wrap around a patient's finger **210**. Finger cuff **200** may include a plethysmograph **220** having an LED-PD pair **225***a-b*, and an inflatable bladder **230** mounted on the interior of the finger cuff **200**. In one embodiment, the plethysmograph **220** may be removably attached to (e.g., using removable or reusable adhesive material) a plethysmograph portion **239** of the bladder **230** (as indicated by dotted lines). Similarly, in one embodiment, the bladder **230** may be removably attached to the interior of the finger cuff **200** (e.g., using removable or reusable adhesive material). Accordingly, it should be noted that plethysmograph **220** and/or bladder **230** may be physically separated or detached from one another and from the finger cuff **200** such that the plethysmograph **220**, bladder **230**, or both can be made disposable. However, in some embodiments, either the plethysmograph **220** or the bladder **230** may be permanently attached to the interior surface of the finger cuff **200**.

[0018] In some embodiments, the plethysmograph **220** may be separately applied or placed (e.g., by a healthcare provider) on or around the patient's finger **210** (e.g., middle phalanx of an index, middle, or ring finger). To facilitate the placement of the plethysmograph **220** on the finger **210**, an end, side, or other portion of the plethysmograph **220**, on the interior, may include removable or reusable adhesive material (i.e., an adhesive layer) so that the plethysmograph **220** can be removably attached to the finger **210**. It should be appreciated that this is just an example of an attachment mechanism and that any suitable type may be utilized. Subsequently, the finger cuff **200** and the bladder **230** may be effectively aligned and wrapped over the plethysmograph **220** such that the plethysmograph **220** is effectively positioned within or about the plethysmograph portion **239** of the bladder **230** and abuts against the bladder **230** when the finger cuff **200** is being attached to the patient's finger **210**. Thus, in one embodiment, the plethysmograph **220** may abut against finger **210** (i.e., the patient's skin) in order to obtain the plethysmogram from the patient's finger **210**. Alternatively, in an alternative embodiment, the bladder **230** may abut against finger **210** and the plethysmograph **220** may be mounted below the bladder **230**.

[0019] In some embodiments, the plethysmograph **220** and bladder **230** may be of flexible material. In some embodiments, the plethysmograph **220** may be thin and of opaque, elastic material (e.g., opaque foil). The plethysmograph **220**, for example, may be of a color white, black, or metallic (e.g., aluminum) so that it is opaque for infrared (IR) light. The plethysmograph **220** may be optically insulated from bladder **230** such that deformations and movements of the bladder **230** do not cause a detrimental effect on the plethysmographic (or pleth) signal generated by plethysmograph **220**. For example, when utilizing a volume clamp system, the bladder **230** may be inflated and deflated to match intra-arterial pressure. Such pressure changes in the bladder **230** may influence the intensity of the plethysmogram signal, thereby distorting the measured pressure waveform (e.g., over- or underestimation of the pulse pressure).

Therefore, by optically insulating the plethysmograph **220** from the bladder **230**, such distortion may be minimized or entirely eliminated.

[0020] In some embodiments, the bladder **230** may be a circular bladder having a stiff exterior. In some embodiments, the LED of LED-PD pair **225***a-b* pair may be an organic light emitting diode (OLED).

[0021] Also, as shown in FIG. **2**, the LED-PD pair **225***a-b* may be coupled or connected to a cable **227** through a connector (not shown), which may be attached to plethysmograph **220**, to provide power to and receive data (i.e., electrical signals) from the LED-PD pair **225***a-b*. Additionally, the bladder **230** may be coupled or connected to a tube **237** (also through a connector, in some embodiments) to provide pneumatic pressure to the bladder **230**.

[0022] Further, finger cuff **200** may include a first side **201** and a second side **203**. In one embodiment, the first side **201** on the interior may include a first connecting portion **233** (e.g., a Velcro type portion) that connects with a second connecting portion, e.g., a Velcro type portion, on the exterior of the second side **203** of the finger cuff **200**. In another embodiment, the first connecting portion **233** may include removable or reusable adhesive material that can be removably attached to the exterior surface of the second side **203** of the finger cuff **200**. It should be appreciated that these are just some examples of an attachment mechanism and that any suitable type may be utilized.

[0023] As has been described, the plethysmograph **220** and/or bladder **230** may be physically separated or detached from one another and from the finger cuff **200** such that the plethysmograph **220**, bladder **230**, or both can be made disposable. Because only some of these items are disposable, the remaining portions of the finger cuff may be re-usable such that the whole finger cuff does not have to be disposed of after usage thereby minimizing material waste and reducing manufacturing costs.

[0024] FIG. **3** is a block diagram illustrating an example environment **300** in which embodiments of the invention may be practiced. As shown, finger cuff **310** may include an inflatable bladder **312** and a plethysmograph **314**. The inflatable bladder **312** may be pneumatically connected to a pressure generating and regulating system **320**. The pressure generating and regulating system **320** may generate, measure, and regulate pneumatic pressure that inflates or deflates the bladder **312**, and may include elements such as a pump, a valve, a sensor, control circuitry, and/or other suitable elements. When the bladder **312** is inflated, the finger cuff **310** applies a pressure to the patient's finger.

[0025] In one embodiment, the plethysmograph **314** may make continuous volumetric measurements (or plethysmogram) of arterial blood flows within the finger. In one embodiment, the plethysmograph **314** may include a LED-PD pair **316**. The LED may be used to illuminate the finger skin and light absorption or reflection may be detected with the photodiode. Therefore, the plethysmogram may be generated based on the signal received from the photodiode.

[0026] The pressure generating and regulating system **320** and the plethysmograph **314** may be connected to a control circuitry **330**. The control circuitry **330** may instruct the pressure generating and regulating system **320** to inflate or deflate the bladder **312** based on a pressure setting, may receive data from the plethysmograph **314**, and may carry out necessary data manipulations.

[0027] It should be appreciated that aspects of the invention previously described may be implemented in conjunction with the execution of instructions by processors, circuitry, controllers, control circuitry, etc. As an example, control circuity may operate under the control of a program, algorithm, routine, or the execution of instructions to execute methods or processes in accordance with embodiments of the invention previously described. For example, such a program may be implemented in firmware or software (e.g. stored in memory and/or other locations) and may be implemented by processors, control circuitry, and/or other circuitry, these terms being utilized interchangeably. Further, it should be appreciated that the terms processor, microprocessor, circuitry, control circuitry, circuit board, controller, microcontroller, etc., refer to any type of logic or circuitry capable of executing logic, commands, instructions, software, firmware, functionality, etc., which may be utilized to execute embodiments of the invention.

[0028] The various illustrative logical blocks, processors, modules, and circuitry described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose processor, a specialized processor, circuitry, a microcontroller, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A processor may be a microprocessor or any conventional processor, controller, microcontroller, circuitry, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[0029] The steps of a method or algorithm described in connection with the embodiments disclosed herein may be embodied directly in hardware, in a software module/firmware executed by a processor, or any combination thereof. A software module may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. An exemplary storage medium is coupled to the processor such the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor.

[0030] The previous description of the disclosed embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without departing from the spirit or scope of the invention. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

What is claimed is:

1. A finger cuff attachable to a patient's finger to be used in measuring the patient's blood pressure by a blood pressure measurement system, the finger cuff comprising:

a plethysmograph including a light emitting diode (LED)-photodiode (PD) pair that aids in measuring the

patient's blood pressure by the blood pressure measurement system, the plethysmograph being detachable from the finger cuff; and

a bladder mountable within the finger cuff, the bladder including a plethysmograph portion such that the plethysmograph is effectively positioned against the plethysmograph portion of the bladder when the finger cuff is attached to the patient's finger.

2. The finger cuff of claim **1**, wherein the bladder is detachable from the finger cuff.

3. The finger cuff of claim **1**, wherein:

the LED-PD pair is coupled to a cable that provides power to the LED-PD pair and receives electrical signals from the LED-PD pair, and

the bladder is coupled to a tube that provides pneumatic pressure to the bladder.

4. The finger cuff of claim **1**, wherein the plethysmograph includes opaque and elastic material.

5. The finger cuff of claim **4**, wherein an interior of the plethysmograph includes an adhesive layer that is removably attached to the patient's finger to facilitate placement of the plethysmograph on or around the patient's finger.

6. The finger cuff of claim **4**, wherein the opaque and elastic material includes a white, black or metallic foil.

7. The finger cuff of claim **1**, wherein the plethysmograph is optically insulated from the bladder to minimize or eliminate distortion of a pleth signal received from the LED-PD pair.

8. The finger cuff of claim **1**, wherein either the bladder or the plethysmograph abuts against the patient's finger.

9. The finger cuff of claim **1**, further comprising a first side and a second side, the first side including a first connecting portion and the second side including a second connecting portion, wherein the first connecting portion is removably attached to the second connecting portion to wrap the finger cuff around the patient's finger.

10. A method to measure a patient's blood pressure by a blood pressure measurement system utilizing a finger cuff, the finger cuff including a bladder mountable within the finger cuff, and a plethysmograph detachable from the finger cuff and having a light emitting diode (LED)-photodiode (PD) pair, the method comprising:

placing the plethysmograph on a patient's finger such that the LED-PD pair aids in measuring the patient's blood pressure by the blood pressure measurement system;

aligning the bladder over the plethysmograph such that the plethysmograph is effectively positioned against a plethysmograph portion of the bladder;

placing the bladder over the plethysmograph such that the bladder abuts against the plethysmograph; and

securing the finger cuff including the plethysmograph and the bladder around the patient's finger.

11. The method of claim **10**, wherein the bladder is detachable from the finger cuff.

12. The method of claim **10**, wherein:

the LED-PD pair is coupled to a cable that provides power to the LED-PD pair and receives electrical signals from the LED-PD pair, and

the bladder is coupled to a tube that provides pneumatic pressure to the bladder.

13. The method of claim **10**, wherein the plethysmograph includes opaque and elastic material.

14. The method of claim **13**, wherein an interior of the plethysmograph includes an adhesive layer that is removably attached to the patient's finger to facilitate placement of the plethysmograph on the patient's finger.

15. The method of claim **13**, wherein the opaque and elastic material includes a white, black or metallic foil.

16. The method of claim **10**, wherein the plethysmograph is optically insulated from the bladder to minimize or eliminate distortion of a pleth signal received from the LED-PD pair.

17. The method of claim **10**, wherein either the bladder or the plethysmograph abuts against the patient's finger.

18. The method of claim **10**, wherein securing the finger cuff around the patient's finger comprises:

pulling a first side of the finger cuff towards a second side of the finger cuff, and

attaching a first connecting portion of the first side to a second connecting portion of the second side, wherein the first connecting portion is removably attached to the second connecting portion to wrap the finger cuff around the patient's finger.

* * * * *

专利名称(译)	模块化手指袖口		
公开(公告)号	US20190069847A1	公开(公告)日	2019-03-07
申请号	US16/117071	申请日	2018-08-30
[标]申请(专利权)人(译)	爱德华兹生命科学公司		
申请(专利权)人(译)	爱德华生命科学公司		
当前申请(专利权)人(译)	爱德华生命科学公司		
[标]发明人	SCHRAA OLAF LI PEIYUAN		
发明人	SCHRAA, OLAF LI, PEIYUAN		
IPC分类号	A61B5/00 A61B5/021		
CPC分类号	A61B5/6826 A61B5/02141 A61B5/6843 A61B5/02108 A61B5/02427 A61B5/02241 A61B5/02255		
优先权	62/555425 2017-09-07 US		
外部链接	Espacenet USPTO		

摘要(译)

公开了一种指套，其可附接到患者的手指以用于通过血压测量系统测量患者的血压。指套包括可从指套拆卸的体积描记器。体积描记器包括发光二极管（LED）-光电二极管（PD）对，其有助于通过血压测量系统测量患者的血压。指套还包括可安装在指套内的囊。囊袋包括体积描记器部分，使得当手指套箍附接到患者的手指时，体积描记器有效地定位在膀胱的体积描记器部分上。