【0050】
図１１において、ＬＥＤ３１から発せられた光は、その一部が矢印Ｃで示すように指を通って血管にまで到達し、血液中のヘモグロビンからの反射光が矢印Ｄで示すようにフォトトランジスタ３２に届く。なお、ＬＥＤ３１から発せられた光は、その一部が矢印Ｅで示すように指表面で反射してフォトトランジスタ３２に届く。また、ＬＥＤ３１から発せられた光、及び血管から反射した光の一部は、矢印Ｆ、Ｇで示すように、指内で吸収、又は分散してフォトトランジスタ３２に届かない。
【0051】
本例では、発光波長領域が３５０ｎｍから６００ｎｍまでの範囲にあるＬＥＤ３１と、受光波長領域が３００ｎｍから６００ｎｍまでの範囲のフォトトランジスタ３２とを用いてあり、その重なり領域である約３００ｎｍから約６００ｎｍまでの波長領域における検出結果に基づいて生体情報を表示する。かかるセンサユニット３０を用いれば、外光が指の露出部分にあたっても、外光に含まれる光のうち、波長領域が７００ｎｍ以下の光は、指を導光体としてフォトトランジスタ３２（受光部）にまで到達しない。
【0052】
その理由を、図１７を参照して説明する。図１７（ａ）は、光の波長と、皮膚の光透過度との関係を示すグラフであり、折れ線ａは、波長が２００ｎｍの光における透過特性、折れ線ｂは、波長が３００ｎｍの光における透過特性、折れ線ｃは、波長が５００ｎｍの光における透過特性、折れ線ｄは、波長が７００ｎｍの光における透過特性、折れ線ｅは、波長が１μｍの光における透過特性を示す。この図から明らかなように、外光に含まれる光のうち、波長領域が７００ｎｍ以下の光は、指を透過しにくい傾向にあるため、外光がセンサ固定用バンド４０で覆われていない指の部分に照射されても、図１１に点線Ｘで示すように、指を通ってフォトトランジスタ３２まで届かない。これに対し、８８０ｎｍ付近に発光ピークを有するＬＥＤと、シリコン系のフォトトランジスタとを用いると、その受光波長範囲は、３５０ｎｍから１２００ｎｍまでの範囲に及ぶ。すなわち、図１１に矢印Ｙで示すように、指を導光体として受光部にまで容易に届いてしまうような１μｍの波長の光（図１７（ａ）の折れ線ｅで示す光）による検出結果に基づいて脈波を検出すると、外光の変動に起因する誤検出が起こりやすい。
【0053】
なお、外光の影響を受けることなく、脈波情報を得るという観点からすれば、たとえば、図１８に示すように、５４０ｎｍから５７０ｎｍまでの範囲に主要発光領域を有するＧａＰ系のＬＥＤと、受光感度特性を図１９に示すように、２００ｎｍから７００ｎｍ近くまでの範囲に感度領域を有するＧａＰ系のフォトトランジスタを用いてもよい。
【0054】
さらに、約３００ｎｍから約７００ｎｍまでの波長領域の光を利用して、脈波情報を得ているので、血量変化に基づく脈波信号のＳ／Ｎ比が高い。すなわち、　図１７（ｂ）には、酸素と未結合のヘモグロビンの吸光特性を曲線Ｈｂで示し、酸素と結合しているヘモグロビンの吸光特性を曲線ＨｂO2 で示してあるように、血液中のヘモグロビンは、波長が３００ｎｍから７００ｎｍまでの光に対する吸光係数が大きく、従来の検出光である波長が８８０ｎｍの光に対する吸光係数に比して数倍～約１００倍以上大きい。従って、本例のように、ヘモグロビンの吸光特性に合わせて、吸光係数が大きい波長領域（３００ｎｍから７００ｎｍ）の光を検出光として用いると、その検出値は、血量変化に感度よく変化するので、血量変化に基づく脈波の検出率（Ｓ／Ｎ比）が高い。
（実施例の主な効果）
このようにして、本例の腕装着型脈波情報計測装置１は、ランニング中の脈拍数を計測できるなど、その携帯に便利であるとともに、感度および計測結果の信頼性が高い。すなわち、図２０（ａ）に示すように、本例のセンサユニット３０において、透光板３４の外側表面３４１は、基準面（センサ枠３６の外側表面３６１）よりも突出した位置にあるため、指表面は、透光板３４の外側表面３４１の全体に均等に密着した状態となる。また、この状態は、指の位置がややずれても、透光板３４の外側表面３４１の全体に均等に密着

した状態のままである。これに対して、図２０（ｂ）に示すように、従来の構造では、透光板３４Ｄの外側表面３１Ｄを引っ込めてあるため、指を透光板３４Ｄに被せても、透光板３４Ｄの隅部分を覆うことができない。このように、指で覆われない隅部分では、空気の層が介在するため、脈波信号を検出できない。また、従来の構造では、指の位置がややずれただけでも、透光板３４Ｄと指の間の広い範囲にわたって空気の層が介在する状態になってしまうので、携帯中に指が動くと、感度が著しく低下する。

【0055】

さらに、本例のセンサユニット３０では、透光板３４の外側表面３４１が突出している分だけ、図２１に示すように、血管中で滞留している血液（図２１において白丸で示す。）を側方に退けるため、かかる滞留している血液の影響が小さいともいえる。すなわち、フォトトランジスタ３２で検出した信号には、滞留する血液による信号成分と、流れている血液による信号成分とが含まれており、脈拍数は、流れている血液による信号成分から求まる。これに対して、滞留する血液による信号成分は、検出した信号のバックグランド（雑音）であるため、本例のように、滞留している血液を押し退けた状態で計測した方が感度が高いといえる。

【0056】

かかる効果は、図２２ないし図２７に示す検討結果から確認できている。

【0057】

まず、図２２及び図２３には、図２０（ｂ）に示したように、透光板３４Ｄの外側表面３４１Ｄを基準面から０．２ｍｍ引っ込めた構造のセンサユニット（従来例）において、指表面への加重（押圧力）と、検出した信号に含まれる交流成分（実線Ｐ１、Ｐ３）及び直流成分（実線Ｐ２、Ｐ４）のレベルとの関係を評価した結果を示してある。ここで、図２２及び図２３には、繰り返し行った実験のうち、２回の実験結果を示してある。

【0058】

この評価において、交流成分（ＡＣ）は、血管中の血液の流れに基づく信号であり、脈波信号に相当する。これに対して、直流成分（ＤＣ）は、外乱その他の原因に基づく信号である。従って、検出した信号において交流成分が占める比率が大である程、感度が高いといえる。

【0059】

そこで、図２２に示す結果に基づいて直流成分に対する交流成分の比率を求め、この比率とセンサユニットの指表面への加重との関係を図２４に示す。

【0060】

その結果、比較例に係るセンサユニットでは、まず、図２２及び図２３に示すように、大きな加重をかけても、交流成分のレベルは６ｍＶ前後と低い。また、図２４に示すように、約１１０ｇｆ以上の加重をかけなければ、直流成分に対する交流成分の比率が高くならない。

【0061】

一方、図２５及び図２６には、図２０（ａ）に示したように、透光板３４の外側表面３４１を基準面から０．２５ｍｍ突出させた構造のセンサユニット３０（実施例）において、指表面への加重（押圧力）と、検出した信号に含まれる交流成分（実線Ｐ５、Ｐ７）及び直流成分（実線Ｐ６、Ｐ８）との関係を示してある。なお、図２５及び図２６には、繰り返し行った実験のうち、２回の実験結果を示してある。また、図２５に示す結果に基づいて直流成分に対する交流成分の比率を求め、この比率とセンサユニット３０の指表面への加重との関係を図２７に示す。

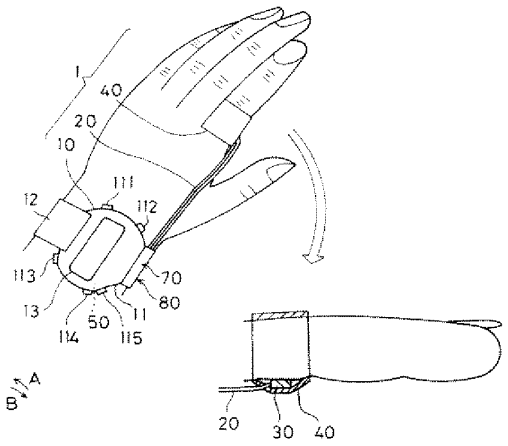
【0062】

その結果、本例のセンサユニット３０では、図２５及び図２６に示すように、比較的小さな加重をかけるだけで、交流成分のレベルは、７ｍＶ以上に達し、かつ、そのレベルは安定している。また、図２５及び図２７に示すように、３０ｇｆ～２３０ｇｆの加重をかければ、直流成分に対する交流成分の比率が大きくて安定していること、すなわち、感度が高いことも確認できた。

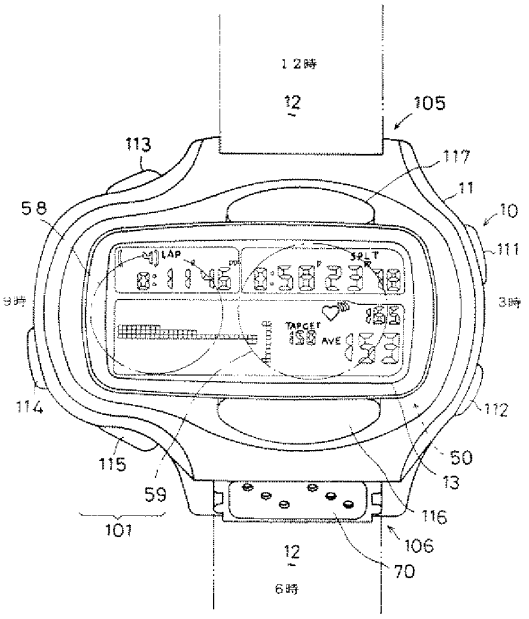
【0063】
それ故、本例のセンサユニット３０は、従来のセンサユニットと相違して、安定した高い感度を得るにも、指に対してセンサユニット３０を押し当てる力が小さくて済み、装着したときの違和感がない。
【0064】
さらに、本例のセンサユニット３０では、図２０（ａ）に示したように、人体アース用端子３８の外側表面３８１が基準面（センサ枠３６の外側表面３６１）から突出しているので、指表面は、人体アース用端子３８に確実に接触する。この場合でも、人体アース用端子３８の外側表面３８１は、透光板３４の外側表面３４１よりも低い位置にあるので、指表面が透光板３４の外側表面３４１に密着するのを妨げることがない。
【0065】
また、人体アース用端子３８は、透光板３４を挟むようにその両側に配置されているため、透光板３４から指が多少ずれても、指と人体アース用端子３８とは確実に接触したままである。
（その他の実施例）
なお、本例では、透光板３４の外側表面３４１は、平坦面になっているが、それに代えて、図２８に示すように、透光板３４Ａの外側表面３４１Ａを凸面に構成してもよい。この場合には、透光板３４Ａの外側表面３４１Ａに軽く指を当てるだけで、透光板３４Ａには、押圧力がかかるので、指表面と透光板３４Ａの外側表面３４１Ａとの密着性を高めることができる。
【0066】
また、本例では、腕装着型であることから、ケーブル２０の先端部にセンサユニット３０（脈波信号検出部）を設けたが、装置本体１０の表面部自身に脈波信号検出部を一体に構成してもよい。
【0067】
さらに、本例では、指表面において脈波を計測したが、生体のその他の表面部位、たとえば手首、耳たぶなどの皮膚表面などにおいて脈波を計測しても、本例と同様な効果を奏する。
【図面の簡単な説明】
【0068】
【図1】本発明の一実施例に係る腕装着型脈波情報計測装置の全体構成、及び使用状態を示す説明図。
【図2】腕装着型脈波情報計測装置の装置本体の平面図。
【図3】腕装着型脈波情報計測装置の装置本体を時の方向からみたときの説明図。
【図4】腕装着型脈波情報計測装置に用いたセンサユニットの平面図。
【図5】図４のＩ－Ｉ´線における断面図。
【図6】図４のII－II´線における断面図。
【図7】図４のIII－III´線における断面図。
【図8】腕装着型脈波情報計測装置に用いたＩｎＧａＮ系青色ＬＥＤの発光スペクトルを示す説明図。
【図9】腕装着型脈波情報計測装置に用いたＩｎＧａＰ系フォトトランジスタの受光特性を示す説明図。
【図10】腕装着型脈波情報計測装置に用いたフィルタ付きのフォトトランジスタユニットの受光特性を示す説明図。
【図11】腕装着型脈波情報計測装置に用いたセンサユニットをバンドによって指に装着した状態を示す説明図。
【図12】腕装着型脈波情報計測装置のデータ処理回路の機能を示すブロック図。
【図13】腕装着型脈波情報計測装置のコネクタ部における電気的な接続関係を示す説明図。
【図14】腕装着型脈波情報計測装置のコネクタ部分に用いたコネクタピースの構造を示す

説明図。
【図15】腕装着型脈波情報計測装置のコネクタ部分に用いたコネクタ部の構造を示す説明図。
【図16】図１４に示すコネクタピースを図１５に示すコネクタ部に装着した状態を示す断面図。
【図17】（ａ）は、光の波長と皮膚の光透過度との関係を示すグラフ図、（ｂ）は、光の波長と各種のヘモグロビンの吸光特性との関係を示す説明図。
【図18】腕装着型脈波情報計測装置に用いることのできるＧａＰ系のＬＥＤの発光スペクトルを示す説明図である。
【図19】腕装着型脈波情報計測装置に用いることのできるＧａＡｓＰ系フォトトランジスタの受光特性を示す説明図である。
【図20】腕装着型脈波情報計測装置のセンサユニットにおいて、指と透光板との密着性を向上する効果を説明するための説明図である。
【図21】腕装着型脈波情報計測装置のセンサユニットにおいて、フォトトランジスタが検出する信号から滞留血の影響を小さくする効果を説明するための説明図である。
【図22】腕装着型脈波情報計測装置のうち、比較例として、透光板を基準面から０．２ｍｍ引っ込ませた構造のセンサユニットにおいて、指へのセンサユニットの押圧力と、フォトトランジスタが検出する交流信号及び直流信号の大きさとの関係を評価した結果を示すグラフである。
【図23】腕装着型脈波情報計測装置のうち、比較例として、透光板を基準面から０．２ｍｍ引っ込ませた構造のセンサユニットにおいて、図２２に示す評価と同じ内容で行った別の実験から得た結果（指へのセンサユニットの押圧力と、フォトトランジスタが検出する交流信号及び直流信号の大きさとの関係）を示すグラフである。
【図24】図２２に示す結果から、指へのセンサユニットの押圧力と、フォトトランジスタが検出した交流信号の直流信号に対する比との関係を求めた結果を示すグラフである。
【図25】腕装着型脈波情報計測装置のうち、実施例として、透光板を基準面から０．２５ｍｍ突出させた構造のセンサユニットにおいて、指へのセンサユニットの押圧力と、フォトトランジスタが検出する交流信号及び直流信号の大きさとの関係を示すグラフである。
【図26】腕装着型脈波情報計測装置のうち、実施例として、透光板を基準面から０．２５ｍｍ突出させた構造のセンサユニットにおいて、図２５に示す評価と同じ内容で行った別の実験から得た結果（指へのセンサユニットの押圧力と、フォトトランジスタが検出する交流信号及び直流信号の大きさとの関係）を示すグラフである。
【図27】図２５に示す結果から、指へのセンサユニットの押圧力と、フォトトランジスタが検出した交流信号の直流信号に対する比との関係を求めた結果を示すグラフである。
【図28】腕装着型脈波情報計測装置に用いた別のセンサユニットの断面図である。
【図29】（ａ）は、従来の脈波情報計測装置に用いたセンサユニットの断面図、（ｂ）は、別のセンサユニットの断面図である。
【符号の説明】
【0069】
１・脈波情報計測装置、１０・装置本体、１２・リストバンド、１３・液晶表示装置（表示部）、２０・ケーブル、３０・センサユニット（脈波信号検出部）、３１・ＬＥＤ、３２・フォトトランジスタ、３４・透光板、３６・センサ枠、３８・人体アース用端子、４０・センサ固定用バンド（ユニット固定手段）、５０・データ処理回路、７０・コネクタ部、８０・コネクタピース、３００・部品収納空間、３４１・透光板の外側表面（指表面との接触面）、３６１・センサ枠の外側表面（基準面）、３８１・人体アース用端子の外側表面（指表面との接触面）

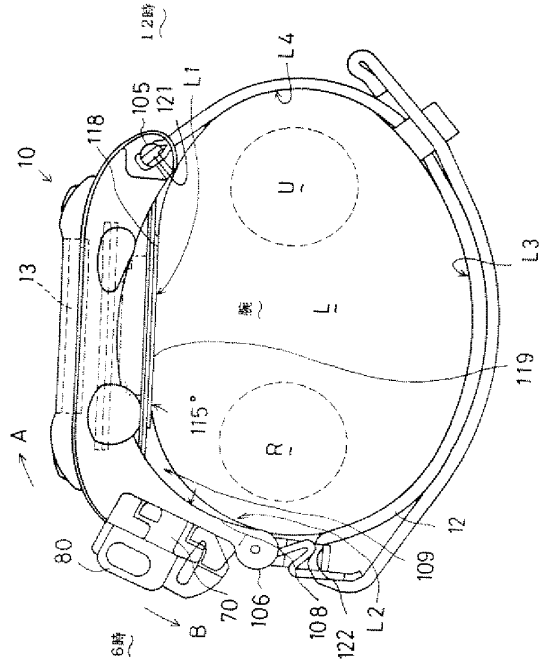
【図1】


1
40
20
10
111
112
12
113
70
80
13
50
11
114
115
A
B
20
30
40

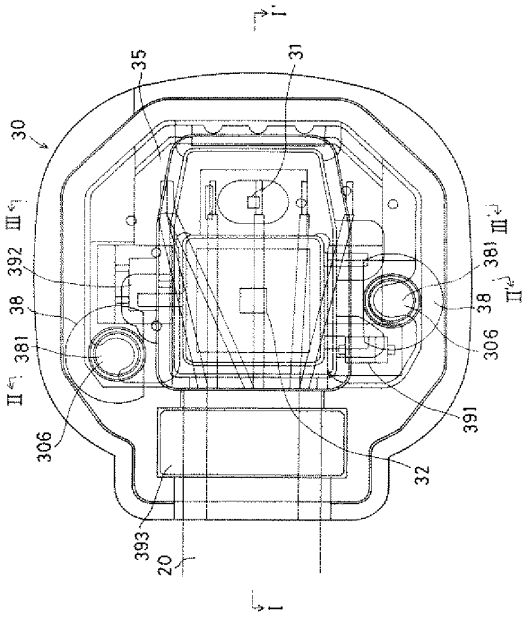
【図2】


12時
12
105
113
117
11
10
58
111
9時
3時
LAP
SPLIT
TARGET
AVE
114
112
115
50
13
59
116
101
106
12
70
6時

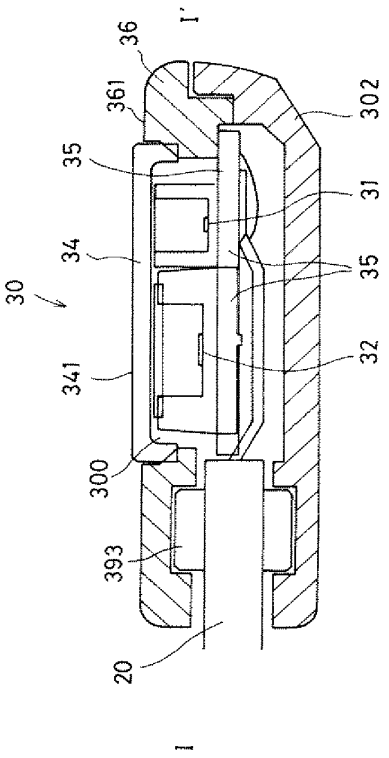
【図3】


12時
L4
L1
105
121
118
10
13
U
L
R
L3
119
115°
A
80
70
B
106
108
122
L2
109
12
6時

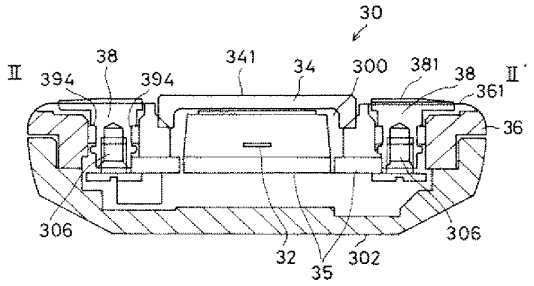
【図4】


I'
35
31
30
III
392
381
III
38
II'
II
381
38
306
306
391
32
393
20
I

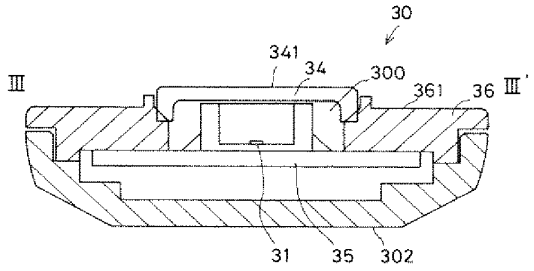
【図5】


I'
36
361
302
35
31
34
35
30
32
341
300
393
20
1

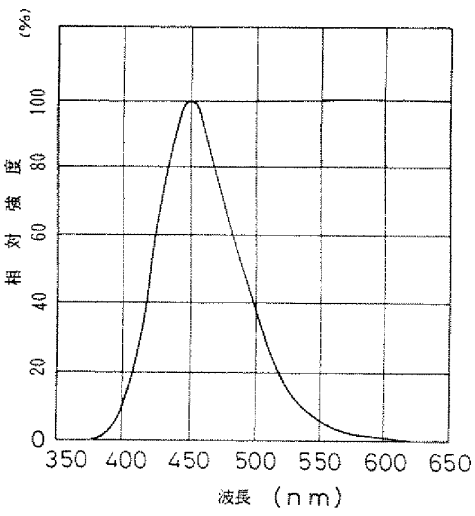
【図6】


30
II
38
394
394
341
34
300
381
38
II'
361
36
306
306
32
35
302

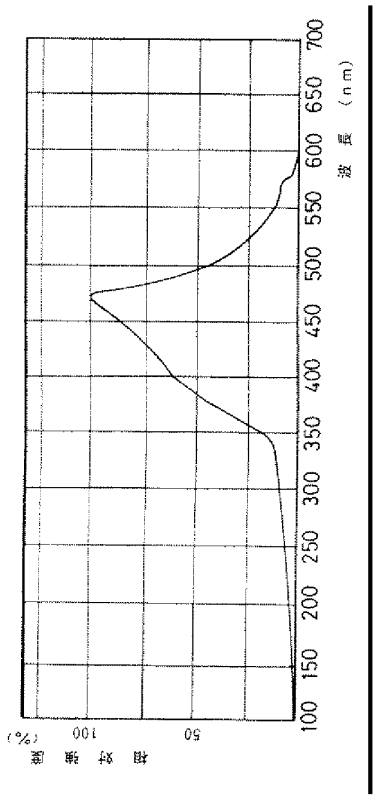
【図7】


30
341
34
III
300
361
36
III'
31
35
302

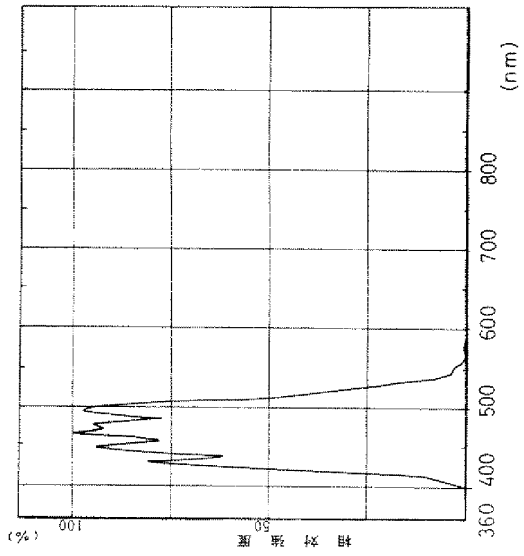
【図8】


(%)
100
80
60
40
20
0
相対強度
350
400
450
500
550
600
650
波長 (nm)

【図9】


700
650
600
550
500
450
400
350
300
250
200
150
100
波長 (nm)
(%)
100
50
相対強度

【図10】



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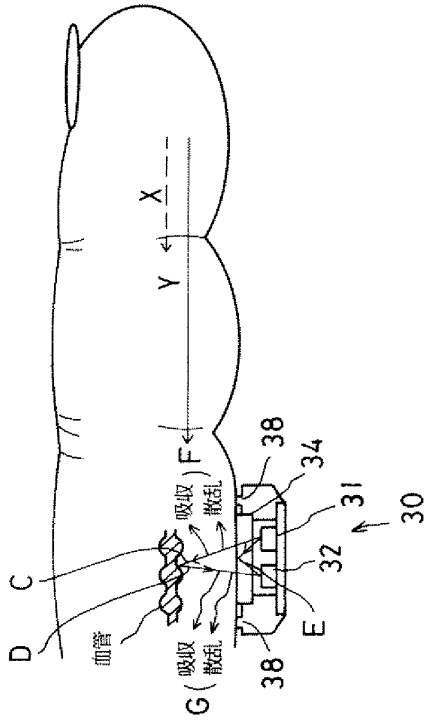

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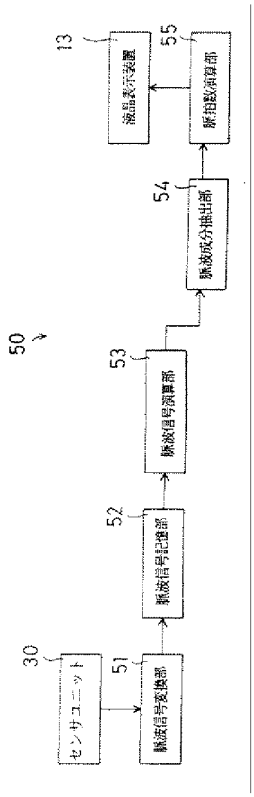

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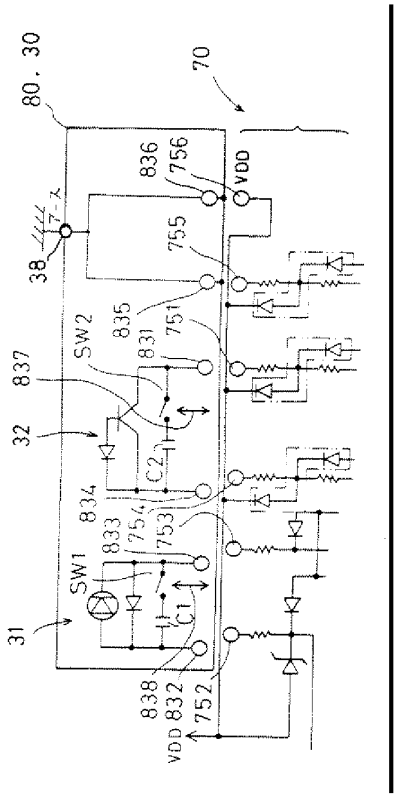

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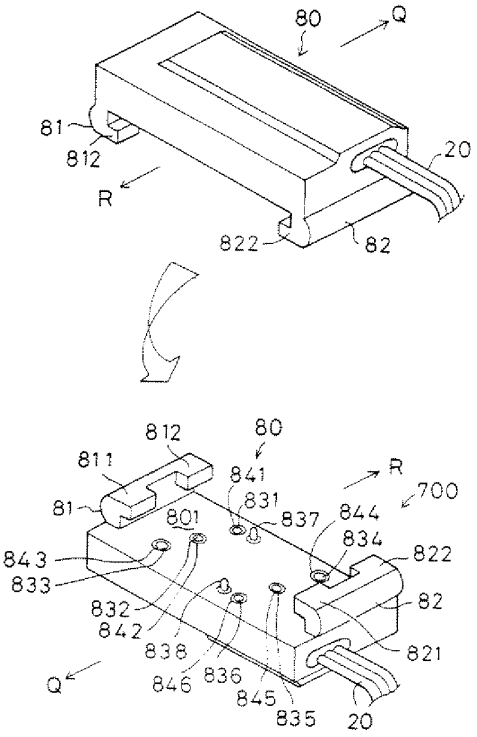

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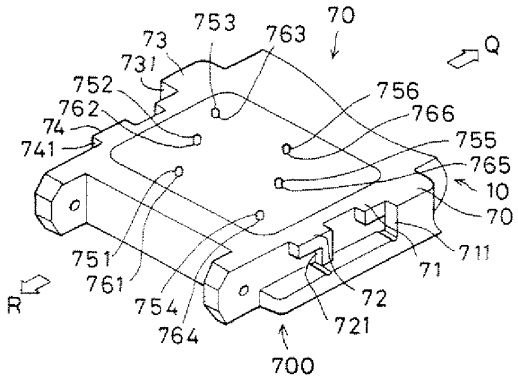

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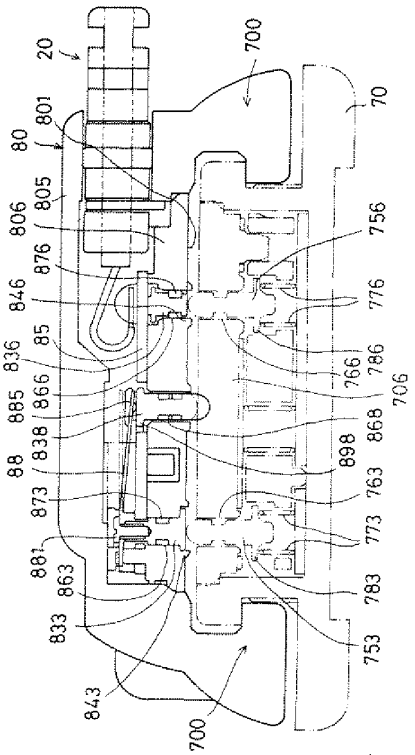
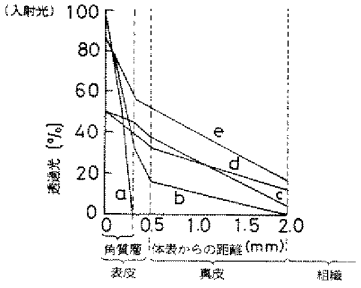
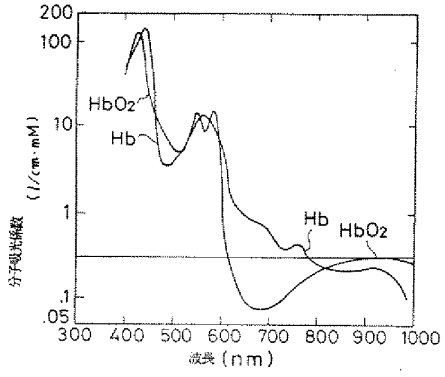


【図17】

(a)



(b)



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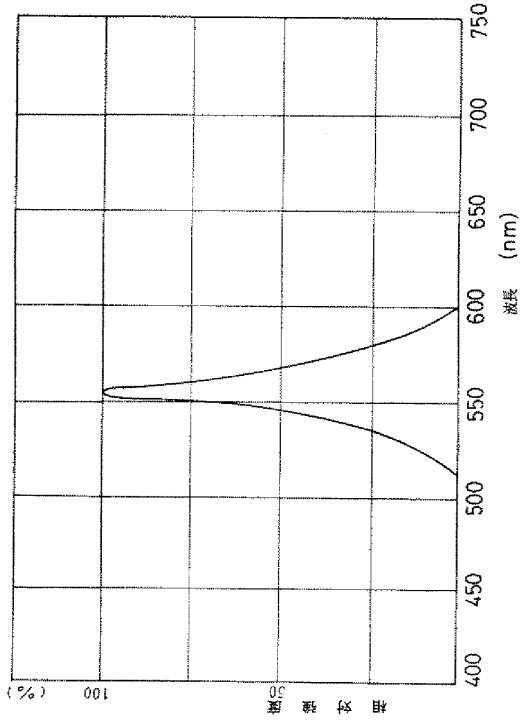

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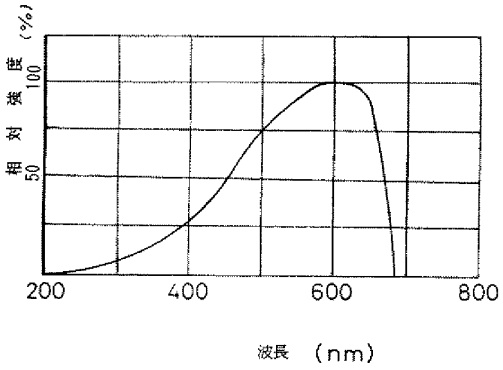

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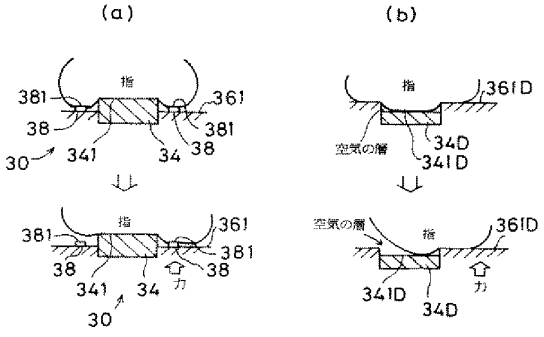

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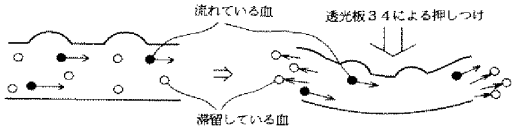

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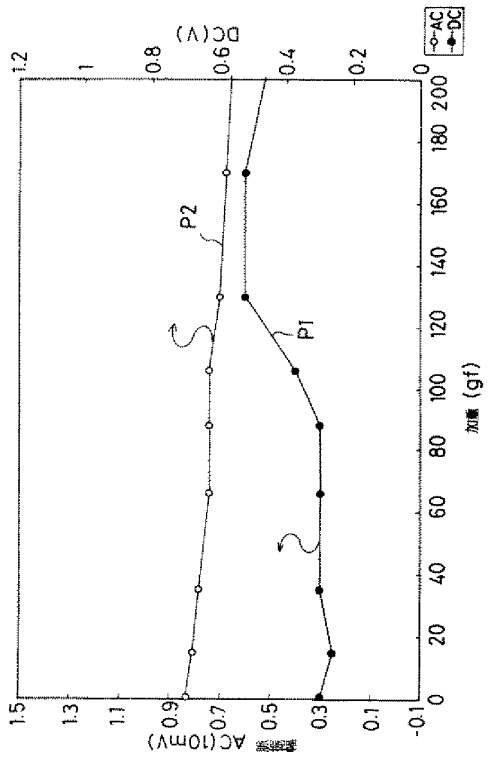
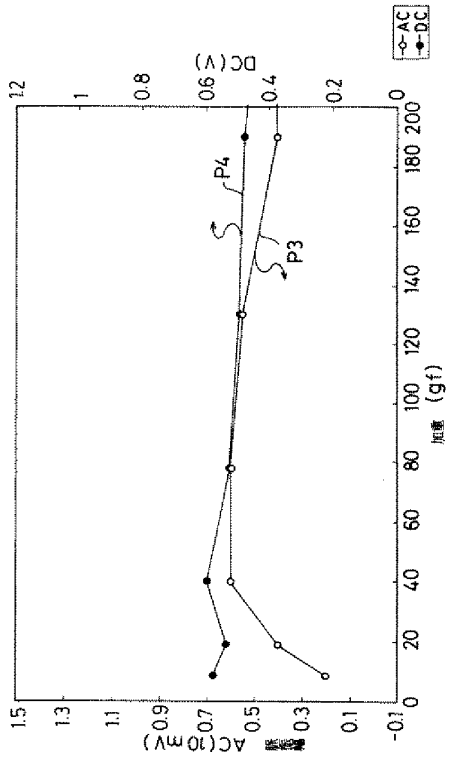


【図23】



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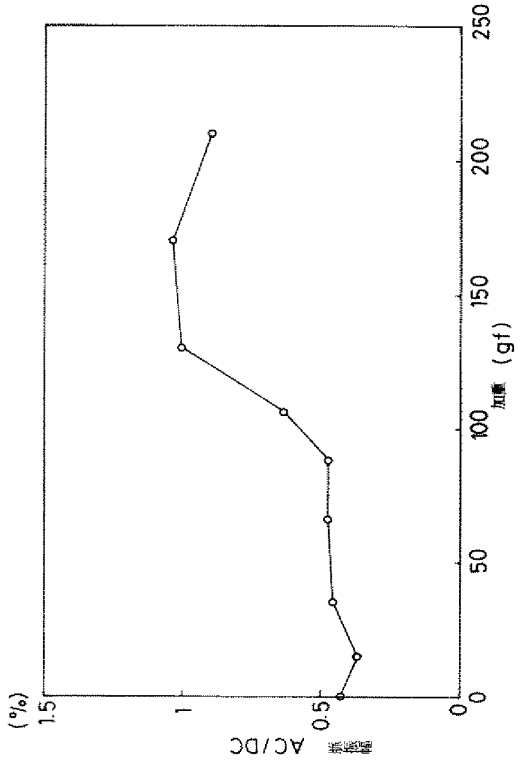
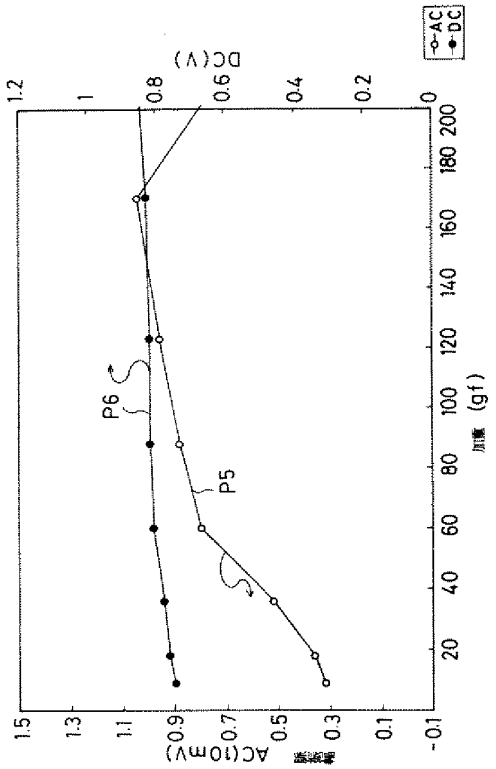


【図25】



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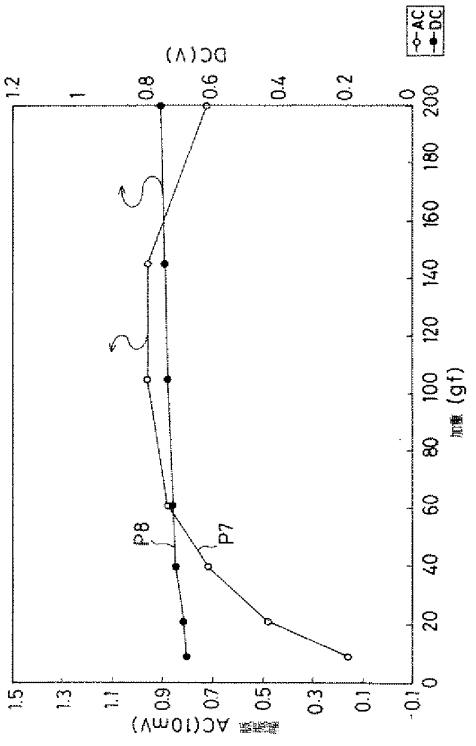

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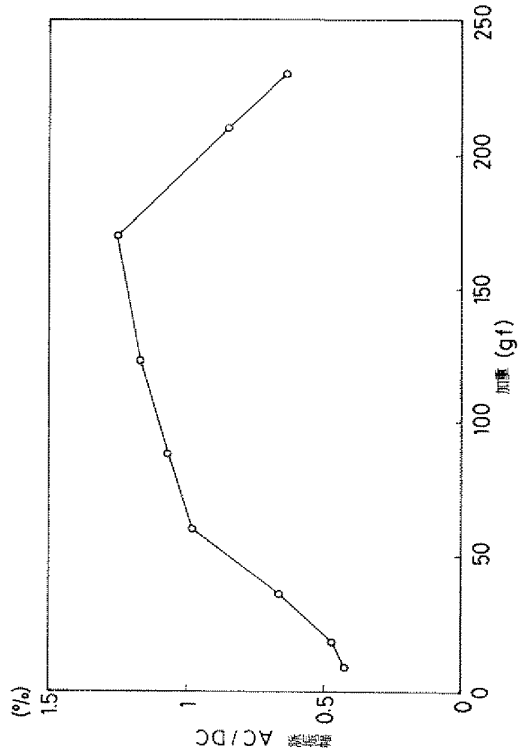

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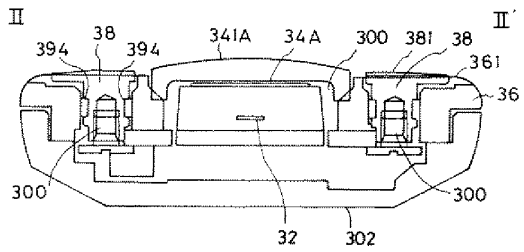

【図29】

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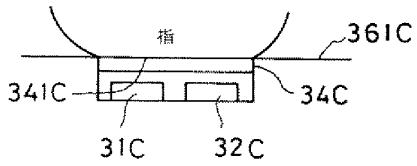

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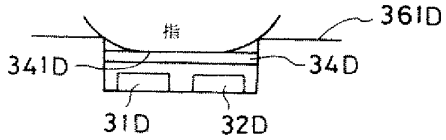

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審査官　伊藤　幸仙

(56)参考文献　特許第３５５４０８５（ＪＰ，Ｂ２）
特開昭６３－１８６６２３（ＪＰ，Ａ）
実開昭５８－０９９６８８（ＪＰ，Ｕ）
特開平０７－１７１１１６（ＪＰ，Ａ）
特開昭６１－１５４６３９（ＪＰ，Ａ）
実開昭５６－０５３４０２（ＪＰ，Ｕ）

(58)調査した分野(Int.Cl.，ＤＢ名)
Ａ６１Ｂ　　５／０２４５

JP2007319232 (A)

(Machine translated text)

Title: Biological Information Measurement Apparatus

Abstract: PROBLEM TO BE SOLVED: To provide a biological information measurement apparatus having a wrist-fitting shape which is fixed to the wrist credibly and stably and assures contact between the skin and a pulse wave sensor. ;SOLUTION: The biological information measurement apparatus 10 has a wristwatch shape and is used for measuring pulse wave by arranging an enclosure 100 on the wrist of a user. A bottom face of the enclosure 100 is formed in a concave surface. A sensor window 11 is formed on a part of the concave surface on the bottom face of the enclosure so that the window projects compared to its surroundings, and the pulse wave sensor is arranged within the sensor window.

Description:

Provided is a biological information measuring device that can be fixed to a wrist in a stable state with a shape that fits a wrist, and that can reliably contact a pulse wave sensor and a skin. The present invention relates to a wristwatch-type biological information measuring apparatus 10 that measures a pulse wave by attaching a casing 100 to a user's wrist, and the bottom surface of the casing 100 has a concave shape. The sensor window 11 is provided in a part of the concave surface of the lower surface so as to protrude from the peripheral portion, and the pulse wave sensor is installed inside the sensor window. .The

biological information measuring device

[0001] The present invention relates to a biological information measuring device that measures biological information such as the main pulse and attached to a user's wrist.

Conventionally, as an apparatus for measuring biological information such as a pulse wave by wearing it on a wrist like a wristwatch, there is a main body integrated type in which a pulse wave sensor is arranged on the back side of the main body. In such a biological information measuring device, a device for improving the contact state with the user's wrist by arranging a non-planar convex translucent plate on the surface of the pulse wave sensor has been devised (Japanese Patent No. 3722203). -Patent Document 1).

[0003] On the other hand, conventionally, it is said that the palm part is more sensitive to pulse wave measurement than the wrist part, and the pulse wave sensor part is attached to a finger or the like, and is connected to a body attached in a wristwatch shape with a cable or the like. An information measuring device is also

known (Japanese Patent No. 3554085-Patent Document 2, Japanese Patent No. 3535916-Patent Document 3, Japanese Patent No. 335917-Patent Document 4).

However, in the sensor-body integrated biological information measuring device, when the pulse wave is measured with the wrist by the pulse wave sensor arranged on the back side of the body housing, the pulse wave sensor is not used because the shape of the human wrist is not flat. There is a problem that it is difficult to stabilize the contact state between the skin and the wrist.

[0005] Further, in a biological information measuring apparatus that performs measurement with a human palm for improving accuracy, a connector pin of a cable that transmits a measurement signal from a pulse wave sensor is inserted into a pin jack on the main body side. There has been a problem that the shape of the biological information measuring device becomes thick due to the thickness of the connector.

[0006] Furthermore, pulse wave measurement with the wrist and pulse wave measurement with the palm have different preference or measurement characteristics depending on the user, and if only one of them can be used, the user is dissatisfied or the measurement accuracy cannot be ensured. There was a problem that was inevitable.
Patent No. 3722203 JP Patent No. 3554085 Publication No. 3535916 discloses No. 3535917 discloses

[0007] The present invention has been made in view of the problems of the prior art described above, in the shape to fit the wrist of the user It is an object of the present invention to provide a biological information measuring apparatus that can be stably mounted, can reliably contact the pulse wave sensor and the skin of the apparatus mounting site, and can accurately measure biological information.

[0008] Another object of the present invention is to provide a biological information measuring apparatus having a thin shape and good wearability.

[0009] The present invention can further cope with a user who is dissatisfied with either wrist measurement or finger measurement by adopting a structure capable of easily switching between wrist measurement and palm measurement of the pulse wave. It is an object of the present invention to provide a biological information measuring apparatus that can perform measurement with higher accuracy as a whole by using both wrist measurement and palm measurement together.

[0010] One feature of the present invention is a wristwatch-type biological information measuring apparatus that measures a pulse wave by attaching a casing to a user's wrist, wherein the casing has a concave bottom surface, and the

casing has a concave shape. In the biological information measuring device, a sensor window is provided in a part of the concave surface of the lower surface of the sensor window so as to protrude from the peripheral portion, and a pulse wave sensor is installed inside the sensor window.

[0011] In the biological information measuring device of the above invention, the concave surface of the lower surface of the housing can be an analytical curved surface.

[0012] Further, in the biological information measuring device of the above invention, the concave surface of the lower surface of the housing can be a cylindrical concave surface.

[0013] Further, in the biological information measuring device of the above invention, the concave surface of the lower surface of the housing can be a conical concave surface.

[0014] In the biological information measuring apparatus of the above invention, the concave surface of the lower surface of the housing can be an elliptical concave surface.

[0015] In the biological information measuring apparatus of the above invention, the convex top of the sensor window can be a flat surface.

[0016] In the biological information measuring device of the above invention, the height of the convex top portion of the sensor window can be set to a height that does not protrude outward from the lower surface of the housing.

[0017] In the biological information measuring device of the above invention, the sensor window may be configured by a flat surface that can be filled with a part of the concave surface of the lower surface of the housing.

[0018] Further, in the biological information measuring apparatus according to the above invention, the sensor window can be provided at a position shifted in a bending direction from the position of the curved center line on the lower surface of the housing.

[0019] In the biological information measuring device of the above invention, the wrist-worn belt connected to the two opposite side surfaces of the casing and the center position on the side surface of the casing where the belt is not connected are shifted. And a connector for connecting a signal cable for transmitting a pulse wave signal from an external pulse wave sensor.

[0020] In the biological information measuring apparatus according to the invention,

the pulse wave signal from the external pulse wave sensor is prioritized when the signal cable is connected to the connector, and the signal cable is connected to the connector. When there is not, an input pulse wave signal switching means for switching a pulse wave signal to be used so as to give priority to the pulse wave signal from the pulse wave sensor built in the housing can be provided.

[0021] The biological information measuring apparatus according to the present invention may further include a gain adjusting unit that adjusts an amplification factor according to the input pulse wave signal selected by the input pulse wave switching unit.

[0022] Further, in the biological information measuring device of the above invention, the sensor window may be provided at a position closer to the connector than a center point on the lower surface of the housing.

[0023] Another feature of the present invention is a wristwatch-type biological information measuring apparatus that measures a pulse wave by attaching the casing to a user's wrist, and includes a first pulse wave installed on the lower surface of the casing. A sensor, a second pulse wave sensor connected to a connector provided in the housing via a signal cable, a measurement signal of the first pulse wave sensor, and a measurement signal of the second pulse wave sensor; Among the measurement stability determination means for determining whether the measurement stability is good or not, and the measurement stability determination means among the first pulse wave sensor and the second pulse wave sensor. The biological information measuring apparatus includes an analysis unit that performs pulse wave detection using a measurement signal from a pulse wave sensor that outputs the determined measurement signal.

[0024] According to the present invention, since the bottom surface of the housing is concave to fit the wrist and the pulse wave sensor is convex, the biological information measuring device can be stably fixed to the user's wrist. In addition, the contact state between the pulse wave sensor and the skin can be ensured, the pulse wave can be measured reliably, the casing can be made thin, and the wearability can be improved.

[0025] Further, according to the present invention, it is possible to cope with a user who is dissatisfied with either wrist measurement or finger measurement by adopting a structure capable of easily switching between pulse wave wrist measurement and palm measurement. By using both wrist measurement and palm measurement of the pulse wave, it is possible to improve accuracy as a whole as compared with the case of using only one of them.

Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings.

(First Embodiment) FIG. 1 shows a functional configuration of a biological information measuring apparatus 10 according to a first embodiment of the present invention, and FIG. 2 shows its appearance.

As shown in FIG. 2, the biological information measuring apparatus 10 of the present embodiment is used by attaching it to a wrist of a user like a wristwatch, and is attached to each of two opposing side surfaces of the housing 100. A belt 101 is connected, an information display unit 19 is provided on the top surface of the housing 100, and an operation unit 20 for mode switching operation and backlight lighting operation is provided. In the case of the present embodiment, the lower surface of the housing 100 is formed in a concave shape in which the belt center line direction is a curved direction. A main body-integrated first pulse wave measurement unit 11 is installed on the lower surface side of the casing 100 which is a concave surface. In addition, the connector 110 for connecting the signal cable 12A for transmitting the signal of the external second pulse wave measurement unit 12 is a side surface that is 90 degrees away from the belt connection surface, and the side surface 102 that comes to the user's hand side in a normal wearing state. It is installed.

As shown in FIG. 1, the biological information measuring device 10 of the present embodiment is installed on the lower surface of the housing 100, and a first pulse wave measuring unit 11 that measures pulse waves, and the biological information measuring device. 10 is connected to the outside with a cable 12A, for example, the second pulse wave measurement unit 12 that measures the pulse wave on the finger pad surface by wrapping it around a finger, and the presence or absence of connection between the second pulse wave measurement unit 12 or the measurement state And a pulse wave switching unit 13 for selecting one of the first pulse wave measurement unit 11 and the second pulse wave measurement unit 12 for pulse wave measurement, and an amplifier for amplifying and filtering the measured pulse wave waveform The filter unit 14, the gain adjusting unit 15 that adjusts the amplification factor of the amplifier / filter unit 14 according to the measurement state, the static acceleration due to the dynamic acceleration generated by the movement of the user's wrist and the gravitational acceleration accompanying the posture. Measurement to detect both dynamic acceleration Unit 16, A / D conversion unit 17 for A / D converting the output of first pulse wave measurement unit 11 or second pulse wave measurement unit 12 and the output of acceleration measurement unit 16, and A / D conversion unit 17 capture An analysis unit 18 for analyzing the data, a data storage unit 19 for storing the result of analysis by the analysis unit 18, a display unit 20 for displaying the measurement state, time, status, etc., mode switching operation and display unit 20 An operation unit 21 for performing operation such as turning on a backlight, an operation frequency switching unit 22 for switching an operation frequency according to a mode, and communication for transmitting data stored in the data storage unit 19

to an external terminal. Unit 23, a battery 24 that supplies power to the entire biological information measuring apparatus 10, a battery voltage monitoring unit 25 that monitors the voltage of the battery 24, and a control unit 26 that controls the entire function.

[0030] The operation unit 21 is a push switch that allows a user to operate mode switching such as a time mode and a measurement mode, and to give a backlight lighting instruction. The display unit 20 is a display device that displays time, pulse rate, pulse wave measurement state, battery, memory, communication state, and sleep time as a result, and is configured by an LCD. The data storage unit 19 uses a flash memory, and stores measurement data such as sleep time history, pulse interval data, and body movement data as measurement results.

The acceleration measuring unit 16 is for detecting body movement, and is, for example, an acceleration sensor that measures acceleration of −2G to 2G in three axis directions, and is mounted in the biological information measuring apparatus main body 10.

[0032] The first pulse wave measurement unit 11 and the second pulse wave measurement unit 12, which will be described in detail later, are composed of a green LED and a photodiode (PD), which irradiates light on the skin surface of the wrist, fingers, or palm, thereby reducing the capillary. The pulse wave is measured by capturing the fluctuation of reflected light that changes due to the change in blood flow in the blood vessel with a photodiode. The amplifier / filter unit 14 converts the output current from the photodiode of the first pulse wave measurement unit 11 or the second pulse wave measurement unit 12 into a voltage by the current-voltage conversion unit, amplifies the voltage by the amplifier, and a high-pass filter. (For example, cut-off frequency: 0.1 Hz) and a low-pass filter (for example, cut-off frequency: 50 Hz), and then output to the A / D converter 17. The A / D conversion unit 17 performs 10-bit A / D conversion on the input from the amplifier / filter unit 14 to convert it into a digital quantity and inputs it to the control unit 26. The gain adjusting unit 15 calculates the amplitude of the pulse waveform input to the control unit 26, and controls the amplification factor of the amplifier / filter unit 14 based on the relationship between the amplitude and the set threshold value.

The analysis unit 18 performs body movement amount detection based on the triaxial acceleration waveform input to the control unit 26 after being measured by the acceleration measurement unit 16 and A / D converted by the A / D conversion unit 17. . Further, as the awakening / sleep determination at the end of the measurement, it is determined whether or not the subject is awake based on the body movement data, and the sleep time is calculated. Further, the analysis unit 18 performs measurement with the first pulse wave measurement unit 11 or the second pulse wave measurement unit 12, performs A / D conversion with the A / D

conversion unit 17 via the amplifier / filter unit 14, and inputs the result to the control unit 26. The pulse wave interval data is detected for the pulse wave waveform thus obtained.

[0034] Further, the analysis unit 18 obtains the amount of body movement from the acceleration data in the three-axis directions acquired from the acceleration measurement unit 16, further performs awakening / sleep determination based on the amount of body motion, and based on the result of the awakening / sleep determination, After the start of measurement, the time at which the transition from awakening to sleep is detected as the sleep onset time, and the time at which the transition from the awakening to sleep after going back to the end of the measurement is detected as the awakening time.

Further, the analysis unit 18 samples pulse wave data from the pulse wave measured by the first pulse wave measurement unit 11 or the second pulse wave measurement unit 12, and acquires pulse interval data from the series of pulse wave data. And stored in the data storage unit 19.

The communication unit 16 is a part that performs data communication with a personal computer, a PDA terminal, a mobile phone, or the like. If the device 10 measures and accumulates data for sleeping on multiple days and the free space in the data storage unit 19 decreases, for example, the USB port of the personal computer is connected to the USB port of the personal computer using the USB cable. By connecting, data is saved in a hard disk on a personal computer in a format that can be analyzed with the specified analysis software, and analyzed with the analysis software.

[0037] The power supply of the biological information measuring apparatus 10 of the present embodiment is always ON, and when the biological measurement is not performed, the internal clock is greatly reduced to reduce power consumption, and only the time display is performed as in a normal wristwatch. Do. When performing biometric measurement, the operation unit 21 switches the mode to the biometric measurement mode. In addition, the sleep time display and the like are displayed by setting the result mode. The communication mode is switched by connecting a USB cable to the communication unit 23 and connecting to an external device via USB. Since charging is performed using the power line of the USB cable, charging is performed simultaneously in the communication mode.

[0038] Modes that can be set by the operation unit 21 include a time mode, a biological measurement mode, and a result display mode. The display information of the display unit 20 includes date, pulse rate, time, pulse wave level meter, memory accumulation amount, battery remaining amount, communication display as each status, and a heart symbol blinking in synchronization with the pulse. .

The battery voltage monitoring unit 25 monitors the power supply voltage from the capacity-voltage characteristics of the battery 24 to obtain and display the remaining battery level.

[0040] As described above, the first pulse wave measurement unit 11 and the second pulse wave measurement unit 12 use a photoelectric pulse wave sensor configured by a combination of a light emitting diode (LED) and a photodiode (PD). ing. In this photoelectric pulse wave sensor, a pulse wave is detected by irradiating the inside of the skin with light from an LED and capturing the intensity of reflected light that changes with blood flow change by PD by the light absorption characteristics of hemoglobin.

[0041] The first pulse wave measurement unit 11 is disposed on the lower surface of the casing of the biological information measurement device 10, but it is necessary to make a firm contact with the skin in order to measure the pulse wave accurately and stably. If the shape of the lower surface of the apparatus housing is flat, the human wrist is not flat, and the contact state of the pulse wave sensor with the skin is not stable. Therefore, in the biological information measuring apparatus 10 of the present embodiment, as shown in detail in FIG. 2, the shape of the lower surface of the apparatus housing is made concave so that the contact state with the skin can be maintained well overall. . However, since a space may be generated between the skin and the first pulse wave measurement unit 11 simply by making it concave, a transparent window composed of a convex curved surface and a plane is installed near the center, The first pulse wave measurement unit 11 is disposed at that position. If it does in this way, the whole apparatus housing | casing can closely_contact | adhere to a wrist and the 1st pulse wave measurement part 11 can be made to contact skin stably.

[0042] In consideration of the ease of processing the housing and the like, it is desirable that the concave surface on the lower surface of the housing 100 be an analytical curved surface. For example, a cylindrical concave surface as shown in FIG. 3, a conical concave surface as shown in FIG. 4, and an elliptical spherical concave surface as shown in FIG. 5 are desirable. Further, the position where the convex transparent sensor window, that is, the first pulse wave measurement unit 11 is provided is assumed to be attached to the wrist when the device 10 is arranged at the center of the lower surface of the housing 100. In other words, it hits the position of the long palmar muscle tendon of the user, the contact state is not stable, and is greatly affected by the movement of the wrist. Therefore, the position where the first pulse wave measurement unit 11 is provided is shifted from the central part of the lower surface of the apparatus housing 100 in the bending direction (the circumferential direction of the wrist to be worn or the belt direction) so that the influence can be reduced. I have to. Further, the long palmar tendon of the user's wrist is positioned in the gap formed by the convex curved surface of the first pulse wave measurement unit 11 and the concave surface of the casing 100,

and the casing 100 is belted by the long palmar muscle tendon. Shifting in the direction can be suppressed, and the apparatus 10 can be stably mounted. Furthermore, as shown by an imaginary line in FIG. 3, in order to further improve the stable wearability, the ridge 111 is arranged so that the long palmar tendon is sandwiched between the first pulse wave measuring unit 11 at the time of wearing. It can also be formed on the lower surface 100 of the housing.

The height of the first pulse wave measurement unit 11 is a height that does not protrude outward from the surface 120 formed by the peripheral edge of the lower surface of the housing 100. As shown in FIG. 6, the first pulse wave measurement unit 11 may have a flat shape that can be embedded by embedding a part of the concave surface of the lower surface of the housing 100.

The biological information measuring apparatus 10 according to the present embodiment can be used with not only the first pulse wave measuring unit 11 but also the second pulse wave measuring unit 12 attached to the outside of the casing for measuring the pulse wave. The human body has more arterioles near the skin surface than the wrist. Therefore, in the pulse wave measurement by the photoelectric pulse wave sensor, the level of the pulse wave that can be detected is larger when measured with the palm than when measured with the wrist. Therefore, when accurate measurement is not possible with the wrist, it is desirable to perform measurement with the palm by wrapping the second pulse wave measurement unit 12 around the finger. In that case, it is bothersome to let the user connect the connector 110 to the second pulse wave measurement unit 12 and further instruct the measurement site with the operation unit 21 again. Therefore, in the biological information measuring apparatus 10 of the present embodiment, when the second pulse wave measurement unit 12 is connected to the connector 110, the user is regarded as an intention to measure the pulse wave with the palm instead of the wrist. The pulse wave switching unit 13 automatically switches so that the measurement signal of the second pulse wave measurement unit 12 is prioritized and the pulse wave measurement is performed.

As shown in FIG. 7 and FIG. 8, the second pulse wave measurement unit 12 measures the pulse wave on the palm 130 side, for example, wrapped around the little finger 131. A finger other than the little finger 131 and a palm 130 other than the finger may be used. As for the position of the connector 110 that connects the second pulse wave measuring unit 12 and the biological information measuring device 10, as shown in FIGS. 9 (a) and 9 (b), a housing that exists in a direction perpendicular to the direction of the belt 101. On the side surface 102 of the body 100. Moreover, if the connector 110 is provided at the center of the side surface 102, the wrist bending operation of the user is hindered, so that the position is shifted in either the upper or lower direction in the belt direction from the center.

The pulse wave switching unit 13 confirms whether or not the second pulse wave

measurement unit 12 is connected when the user operates the operation unit 21 to enter the pulse wave measurement mode. The following two examples will be described as the method.

The first example is a method of making a determination by giving a device to the shape of the connector 110. FIG. 10 shows the shape of the connector 110, and FIG. 11 shows a determination process flowchart of the pulse wave switching unit 13. In addition to the LED pole, LED cathode, PD anode, and PD cathode necessary for the LED and PD of the second pulse wave measurement unit 12, the pulse wave switching unit 13 is connected to the connector 110 on the biological information measurement device 10 side. In order to monitor, a pin connected to the IO pin of the CPU and a pin connected to the ground (GND) are prepared, and the two poles are short-circuited on the cable 12A side of the second pulse wave measurement unit 12. Note that the IO pin of the CPU is pulled up to the power supply voltage. Then, the power supply voltage is applied to the IO pin when the connector is not connected, but becomes 0 V when the connector is connected. The pulse wave switching unit 13 checks the voltage level of the monitoring IO pin at the start of the pulse wave measurement mode (step S11). If the pulse wave switching unit 13 is at the H level, the first pulse wave measurement unit 11 is used (step S12). If so, it is determined that the second pulse wave measurement unit 12 is used (step S13).

Here, the shape of the connector 110 is not limited to this, and the connector 110 may be pulled down in advance and set to the H level when connected. Further, when the PD and LED pins can be made common (for example, when the PD is used at zero bias) (for example, the LED cathode and the PD anode), the number of lead wires 12A to the second pulse wave measurement unit 12 can be reduced. it can. Further, the pulse wave switching unit 13 dynamically responds to insertion / removal of the second pulse wave measurement unit 12 during measurement by monitoring the connection state of the connector periodically during measurement as well as at the start of measurement. be able to.

[0049] The second example is a method of determining whether or not the second pulse wave measurement unit 12 is connected from the measurement waveform. FIG. 12 is a flowchart of the determination process. First, the pulse wave switching unit 13 selects the second pulse wave measurement unit 12 at the start of measurement (step S21), and measures a pulse wave for a certain time, for example, 10 seconds, sufficient to count at least a plurality of pulse waves. (Step S22). FIG. 13 shows an example of a pulse wave waveform when the second pulse wave measurement unit 12 is connected and measurement is performed at the finger pad, and FIG. 14 shows a pulse wave waveform when the second pulse wave measurement unit 12 is not connected. It is an example. The waveform when the second pulse wave measurement unit 12 is not connected hardly changes in the vicinity of the offset voltage. After a lapse of a certain time, the pulse wave switching unit 13 checks whether there is a pulse wave fluctuation that exceeds a

threshold value set on both sides of the offset voltage or one (step S23), and if there is no fluctuation, the second pulse wave It is determined that the measurement unit 12 is not connected (or is not correctly measured even if connected), and thereafter, it is determined that the first pulse wave measurement unit 11 is used (step S26).

On the other hand, if there is a pulse wave fluctuation exceeding the threshold value in step S23, the peak interval exceeding the threshold value is an interval that seems to be a pulse wave (for example, 0.5 seconds to 1.5 seconds or less). Whether the second pulse wave measuring unit 12 is connected or not if it is detected more than a certain number of times, for example, 5 times or more in 10 seconds (step S24). It is determined that the two pulse wave measurement unit 12 is used (step S25), otherwise it is determined that the second pulse wave measurement unit 12 is not connected (or is not correctly measured even if connected), and thereafter Then, it is determined that the first pulse wave measurement unit 11 is used (step S26).

The amplifier / filter unit 14 amplifies the change in the output current of the PD and removes noise components other than the pulse wave (for example, hum noise). The first pulse wave measurement unit 11 measures the pulse wave at the wrist, and the second pulse wave measurement unit 12 measures the pulse wave at the palm. As described above, since the levels of the pulse waveform at the wrist and the palm are different, the gain adjusting unit 15 sets an amplification factor suitable for each in order for the analyzing unit 18 to analyze the measured waveform with high accuracy. That is, the amplification factor specific to the first pulse wave measurement unit 11 and the second pulse wave measurement unit 12 is set in advance, and the amplification factor set to the one selected by the pulse wave switching unit 13 is set. The amplification factor may be adjusted in a plurality of stages, and may be dynamically adjusted according to the amplitude level of the waveform.

(Second Embodiment) A biological information measuring apparatus according to a second embodiment of the present invention will be described. A feature of the second embodiment is that the first pulse wave measurement unit 11 and the second pulse wave measurement unit 12 are used at the same time, and the biological information is measured by dynamically selecting the one having the better measurement accuracy. It has the function of accumulating data. The functional configuration of the biological information measuring apparatus 10 of the present embodiment is the same as that of the first embodiment shown in FIG. 1, and the external appearance of the hardware is also the first embodiment shown in FIG. Is the same as In the present embodiment, the pulse wave switching unit 13 dynamically selects one of the first pulse wave measurement unit 11 and the second pulse wave measurement unit 12 that has better measurement accuracy, and performs measurement with the better measurement accuracy. It functions to output the measurement signal of the unit to the amplifier / filter unit 14.

[0053] Basically, it is said that the accuracy of pulse wave measurement is better in the palm part than in the wrist part, but the opposite may occur depending on the user's situation (cooling, posture, etc.). Therefore, the measurement accuracy is further improved by such a method.

[0054] At the start of measurement, based on the flowchart of FIG. 12, the pulse wave switching unit 13 selects the second pulse wave measurement unit 12 (step S21), and for a certain period of time sufficient to count at least a plurality of pulse waves, For example, a pulse wave for 10 seconds is measured (step S22). Then, based on the same determination as in the first embodiment, it is checked whether there is a pulse wave fluctuation exceeding the threshold value set on both the upper and lower sides of the offset voltage (step S23). It is determined that the wave measurement unit 12 is not connected (or is not correctly measured even if connected), and it is determined that the first pulse wave measurement unit 11 is preferentially used (step S26).

On the other hand, if there is a pulse wave fluctuation exceeding the threshold value in step S23, the peak interval exceeding the threshold value is an interval that seems to be a pulse wave (for example, 0.5 seconds to 1.5 seconds or less). Whether the second pulse wave measuring unit 12 is preferentially used (step S25). Otherwise, it is determined that the first pulse wave measurement unit 11 is preferentially used (step S26).

After the selection determination of the preferential use measurement unit at the start of measurement, the process proceeds to the flowchart of FIG. First, the pulse wave measuring unit that is determined to be preferentially used between the first pulse wave measuring unit 11 and the second pulse wave measuring unit 12 is preferentially used (step S31). The analysis unit 18 detects a peak interval from the measured pulse waveform, or detects a pulse interval from a threshold value cross of a raw waveform or a differentiated waveform (step S32), and the number of pulse wave detections within a time that is a certain time past from the present is detected. It is determined whether or not a certain value or more (for example, 30 times or more per minute). If so, the measurement at the pulse wave measurement unit that is determined to be used preferentially is continued as being correctly measured. Otherwise, the pulse wave switching unit 13 switches to the other pulse wave measurement unit as not being measured correctly (step S34).

[0057] Then, in the same manner as described above, the analysis unit 18 detects the pulse wave interval (step S35), and determines whether or not the number of pulse wave detections within a time period that is a certain time past from the present is greater than or equal to a certain value. (Step S36). Here, if the number of detected pulse waves within a certain time is equal to or greater than a certain value, it is assumed that measurement is correctly performed, and the

measurement at the other pulse wave measuring unit is continued. Otherwise, the pulse wave switching unit 13 switches to the pulse wave measurement unit that is first used preferentially and performs pulse wave measurement, assuming that measurement has not been performed correctly (step S34). Thereafter, by continuing this series of processing, the pulse wave is always measured with a better accuracy. The processing for the pulse wave signal measured by the pulse wave measuring unit is the same as that of the first embodiment.

As described above, according to the biological information measuring apparatus of the present embodiment, the pulse wave measurement is performed while always switching between the pulse wave measurement of the wrist part of the user and the pulse wave measurement of the palm part of the user. Since the biological information is analyzed based on the pulse wave signal, accurate biological information analysis is possible.

[0059] FIG. 2 is a block diagram showing a functional configuration of the biological information measuring apparatus according to the first embodiment of the present invention. The top view and side view which show the external appearance of the biological information measuring device of the said embodiment. The bottom view and side view which show the housing | casing which makes a cylindrical concave surface a lower surface shape in the biological information measuring device of the said embodiment. The bottom view and side view which show the housing | casing which makes a conical concave surface a lower surface shape in the biological information measuring device of the said embodiment. The bottom view and side view which show the housing | casing which makes an elliptical spherical concave surface a lower surface shape in the biological information measuring device of the said embodiment. In the living body information measuring device of the above-mentioned embodiment, a bottom view and a side view showing the relation between the shape of the bottom surface of the housing and the first pulse wave measuring unit formed there. The bottom view which shows the use condition of the biological information measuring device of the said embodiment. Sectional drawing which shows the use condition of the 2nd pulse-wave measurement part in the biological information measuring device of the said embodiment. The top view which shows the installation place of the connector which connects the signal cable of the 2nd pulse wave measurement part in the biological information measuring device of the said embodiment. Explanatory drawing of the pin assignment of the connector by the side of the signal cable of the 2nd pulse wave measurement part in the biological information measuring device of the said embodiment, and the connector by the side of a housing | casing. The flowchart of an example of the selection judgment process of the 1st pulse wave measurement part and the 2nd pulse wave measurement part in the biological information measuring device of the said embodiment. The flowchart of another example of the selection judgment process of the 1st pulse wave measurement part and the 2nd pulse wave measurement part in the biological information measuring device of the said

embodiment. The graph of the regular pulse wave measurement signal input from the 2nd pulse wave measurement part in the living body information measuring device of the above-mentioned embodiment. The graph of the pulse wave measurement signal input from the connector for a 2nd pulse wave measurement part connection in the state where the 2nd pulse wave measurement part is not connected in the living body information measurement device of the above-mentioned embodiment. The flowchart of the selection judgment processing of the 1st pulse wave measurement part and the 2nd pulse wave measurement part in the living body information measuring device of a 2nd embodiment of the present invention.

Claim(s):

1. A wristwatch-type biological information measuring apparatus for measuring a pulse wave by attaching a housing to a user's wrist,
wherein the shape of
the bottom surface of the housing is a concave surface, and a part of the concave surface of the bottom surface of the housing is
A biological information measuring device , wherein a sensor window is provided so as to protrude from a peripheral portion, and a pulse wave sensor is installed inside the sensor window.

2. The biological information measuring apparatus according to claim 1, wherein the concave surface of the lower surface of the housing is an analytical curved surface.

3. The biological information measuring apparatus according to claim 2, wherein the concave surface of the lower surface of the housing is a cylindrical concave surface.

4. The biological information measuring device according to claim 2, wherein the concave surface of the lower surface of the housing is a conical concave surface.

5. The biological information measuring device according to claim 2, wherein the concave surface of the lower surface of the housing is an elliptical concave surface.

6. The biological information measuring device according to any one of claims 1 to 5, wherein the sensor window has a flat top surface.

7. The biological information measuring device according to claim 1, wherein the height of the convex top portion of the sensor window is a height that does not protrude outward from the lower surface of the housing.

8. The biological information measuring apparatus according to claim 1, wherein the sensor window is configured by a flat surface that can be formed by filling a part

of a concave surface of the lower surface of the housing.

9. The biological information measuring apparatus according to claim 1, wherein the sensor window is provided at a position shifted in a bending direction from a position of a curved center line on the lower surface of the housing.

10. From a wrist-worn belt connected to two opposite side surfaces of the housing, and an external pulse wave sensor provided at a position shifted from the center position on the side surface of the housing where the belt is not connected. The biological information measuring device according to claim 1, further comprising: a connector for connecting a signal cable that transmits the pulse wave signal of the signal.

11. When the signal cable is connected to the connector, the pulse wave signal from the external pulse wave sensor is given priority. When the signal cable is not connected to the connector, the pulse from the pulse wave sensor built in the housing is given. The biological information measuring device according to claim 10, further comprising an input pulse wave signal switching unit that switches a pulse wave signal used so as to prioritize the wave signal.

12. The biological information measuring apparatus according to claim 11, further comprising gain adjusting means for adjusting an amplification factor according to an input pulse wave signal selected by the input pulse wave switching means.

13. The biological information measuring apparatus according to claim 10, wherein the sensor window is provided at a position closer to the connector than a center point on the lower surface of the housing.

14. A wristwatch-type biological information measuring device for measuring a pulse wave by attaching a housing to a user's wrist,
the first pulse wave sensor installed on the lower surface of the housing;
The second pulse wave sensor connected to the connector provided in the housing via a signal cable,
the measurement signal of the first pulse wave sensor and the measurement signal of the second pulse wave sensor are compared. Among the measurement stability determining means for determining the quality of the measurement stability and
the first pulse wave sensor and the second pulse wave sensor, the measurement stability determining means determines that the measurement stability is good. A biological information measuring apparatus comprising: an analysis unit that performs pulse wave detection using a measurement signal from a pulse wave sensor that outputs a measurement signal.

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2007-319232
(P2007-319232A)
(43)公開日　平成19年12月13日(2007.12.13)

(51)Int.Cl.	F I			テーマコード（参考）
A61B 5/0245 (2006.01)	A61B	5/02	310P	4C017
	A61B	5/02	310A	

審査請求 未請求　請求項の数 14　OL　（全 16 頁）

(21)出願番号　特願2006-150047 (P2006-150047)
(22)出願日　平成18年5月30日 (2006.5.30)

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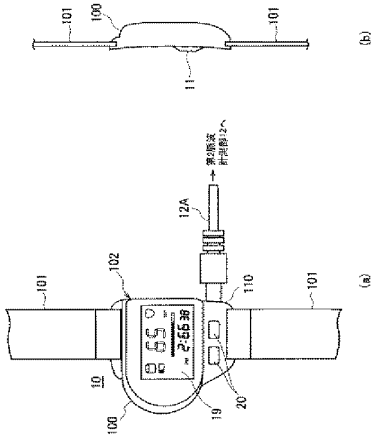
最終頁に続く

(54)【発明の名称】生体情報計測装置

(57)【要約】
【課題】手首にフィットする形状で確実に安定した状態でその手首部に固定でき、かつ脈波センサと皮膚の接触状態を確実にできる生体情報計測装置を提供する。
【解決手段】本発明は、筐体１００をユーザの手首に装着して脈波を計測する腕時計型の生体情報計測装置１０であって、筐体１００の下面の形状を凹面とし、筐体の下面の凹面の一部にその周辺部よりも突出するようにセンサ窓１１を設け、センサ窓の内部に脈波センサを設置したことを特徴とする。
【選択図】図２



【特許請求の範囲】
【請求項1】
筐体をユーザの手首に装着して脈波を計測する腕時計型の生体情報計測装置であって、
前記筐体下面の形状を凹面とし、
前記筐体の下面の凹面の一部にその周辺部よりも突出するようにセンサ窓を設け、
前記センサ窓の内部に脈波センサを設置したことを特徴とする生体情報計測装置。
【請求項2】
前記筐体下面の凹面は、解析曲面であることを特徴とする請求項１に記載の生体情報計測装置。
【請求項3】
前記筐体下面の凹面は、円柱型凹面であることを特徴とする請求項２に記載の生体情報計測装置。
【請求項4】
前記筐体下面の凹面は、円錐型凹面であることを特徴とする請求項２に記載の生体情報計測装置。
【請求項5】
前記筐体下面の凹面は、楕円球型凹面であることを特徴とする請求項２に記載の生体情報計測装置。
【請求項6】
前記センサ窓は、その凸頂部を平坦面にしたことを特徴とする請求項１～５のいずれかに記載の生体情報計測装置。
【請求項7】
前記センサ窓の凸頂部の高さは、前記筐体下面より外側に突出しない高さにしたことを特徴とする請求項１～６のいずれかに記載の生体情報計測装置。
【請求項8】
前記センサ窓は、前記筐体下面の凹面の一部を埋めることでできる平面で構成したことを特徴する請求項１～５のいずれかに記載の生体情報計測装置。
【請求項9】
前記センサ窓は、前記筐体下面の曲面中心線の位置よりも湾曲方向にずれた位置に設けたことを特徴とする請求項１～８のいずかに記載の生体情報計測装置。
【請求項10】
前記筐体の相対する２側面に接続された手首装着用のベルトと、
前記筐体の前記ベルトの接続されていない側面における中心位置からずれた位置に設けられた、外部脈波センサからの脈波信号を伝送する信号ケーブルを接続するためのコネクタとを備えたことを特徴とする請求項１～９のいずれかに記載の生体情報計測装置。
【請求項11】
前記コネクタに前記信号ケーブルが接続されたときに前記外部脈波センサからの脈波信号を優先し、前記コネクタに前記信号ケーブルが接続されていないときには筐体内蔵の脈波センサからの脈波信号を優先するように利用する脈波信号を切り替える入力脈波信号切替手段を備えたことを特徴とする請求項１０に記載の生体情報計測装置。
【請求項12】
前記入力脈波切替手段により選択された入力脈波信号に応じて増幅率を調節するゲイン調節手段を具備したことを特徴とする請求項１１に記載の生体情報計測装置。
【請求項13】
前記センサ窓を、前記筐体下面における中心点よりも前記コネクタ寄りの位置に設けたことを特徴とする請求項１０～１２のいずれかに記載の生体情報計測装置。
【請求項14】
筐体をユーザの手首に装着して脈波を計測する腕時計型の生体情報計測装置であって、
前記筐体下面に設置された第１の脈波センサと、

前記筐体に設けられたコネクタに信号ケーブルを介して接続された第２の脈波センサと、

前記第１の脈波センサの計測信号と前記第２の脈波センサの計測信号とを比較して計測安定性の良否を判定する計測安定性判定手段と、

前記第１の脈波センサと第２の脈波センサとのうち、前記計測安定性判定手段により計測安定性が良いと判断された計測信号を出力する方の脈波センサによる計測信号を用いて【発明の詳細な説明】段とを備えたことを特徴とする生体情報計測装置。

【技術分野】

【0001】

本発明は、ユーザの手首に装着して主に脈波等の生体情報を計測する生体情報計測装置に関するものである。

【背景技術】

【0002】

従来、腕時計のように手首に装着して脈波等の生体情報を計測する装置として、本体裏側に脈波センサを配置した本体一体型のものがある。そのような生体情報計測装置では、脈波センサの表面に平面でない凸状の透光板を配置してユーザの手首との接触状態を良くするための工夫がされている（特許第３７２２２０３号公報－特許文献１）。

【0003】

一方、従来から、脈波計測は手首部よりも手掌部の方が感度が良いとされ、脈波センサ部を指等に取り付け、腕時計状に装着した本体とケーブル等で接続した生体情報計測装置も知られている（特許第３５５４０８５号公報－特許文献２、特許第３５３５９１６号公報－特許文献３、特許第３５３５９１７号公報－特許文献４）。

【0004】

ところが、センサ・本体一体型の生体情報計測装置では、本体筐体の裏側に配置した脈波センサにより手首で脈波を計測する場合、人の手首の形状が平面でないため脈波センサと手首の皮膚との接触状態を安定させることが難しい問題点があった。

【0005】

また、精度向上のため人の手掌部で計測を行う生体情報計測装置では、脈波センサ部からの計測信号を伝送するケーブルのコネクタピンを本体側のピンジャックに挿入する構造にするとコネクタの厚み等により生体情報計測装置の形状が厚くなってしまう問題点があった。

【0006】

さらに、手首での脈波計測、手掌での脈波計測はユーザによって好みあるいは計測特性に差があり、どちらか一方だけしか使用できない場合は不満を持つユーザや計測精度を確保できないユーザが出ることが避けられない問題点があった。

【特許文献1】特許第３７２２２０３号公報

【特許文献2】特許第３５５４０８５号公報

【特許文献3】特許第３５３５９１６号公報

【特許文献4】特許第３５３５９１７号公報

【発明の開示】

【発明が解決しようとする課題】

【0007】

本発明、上述した従来技術の問題点に鑑みてなされたもので、ユーザの手首にフィットする形状にして安定した装着ができ、しかも脈波センサと装置装着部位の皮膚とを確実に接触させることができ、正確に生体情報を計測できる生体情報計測装置を提供することを目的とする。

【0008】

本発明はまた、形状を薄くして装着性の良い生体情報計測装置を提供することを目的とする。

【0009】

本発明はさらに、脈波の手首計測と手掌計測とを簡単に切り替えられる構造とすることで、手首計測または指計測のどちらかに不満を持つユーザにも対応でき、また、脈波の手首計測と手掌計測を併せて使用することで、どちらか一方の使用の場合よりも全体として精度の良い計測を可能にする生体情報計測装置を提供することを目的とする。

【課題を解決するための手段】

【0010】

本発明の１つ特徴は、筐体をユーザの手首に装着して脈波を計測する腕時計型の生体情報計測装置であって、前記筐体下面の形状を凹面とし、前記筐体の下面の凹面の一部にその周辺部よりも突出するようにセンサ窓を設け、前記センサ窓の内部に脈波センサを設置した生体情報計測装置にある。

【0011】

上記発明の生体情報計測装置では、前記筐体下面の凹面を解析曲面とすることができる。

【0012】

また、上記発明の生体情報計測装置では、前記筐体下面の凹面を円柱型凹面とすることができる。

【0013】

また、上記発明の生体情報計測装置では、前記筐体下面の凹面を円錐型凹面とすることができる。

【0014】

また、上記発明の生体情報計測装置では、前記筐体下面の凹面を楕円球型凹面とすることができる。

【0015】

また、上記発明の生体情報計測装置では、前記センサ窓の凸頂部を平坦面とすることができる。

【0016】

また、上記発明の生体情報計測装置では、前記センサ窓の凸頂部の高さを前記筐体下面より外側に突出しない高さとすることができる。

【0017】

また、上記発明の生体情報計測装置では、前記センサ窓を、前記筐体下面の凹面の一部を埋めることでできる平面で構成したものとすることができる。

【0018】

また、上記発明の生体情報計測装置では、前記センサ窓を、前記筐体下面の曲面中心線の位置よりも湾曲方向にずれた位置に設けることができる。

【0019】

また、上記発明の生体情報計測装置では、前記筐体の相対する２側面に接続された手首装着用のベルトと、前記筐体の前記ベルトの接続されていない側面における中心位置からずれた位置に設けられた、外部脈波センサからの脈波信号を伝送する信号ケーブルを接続するためのコネクタとを備えたものとすることができる。

【0020】

また、上記発明の生体情報計測装置では、前記コネクタに前記信号ケーブルが接続されたときに前記外部脈波センサからの脈波信号を優先し、前記コネクタに前記信号ケーブルが接続されていないときには筐体内蔵の脈波センサからの脈波信号を優先するように利用する脈波信号を切り替える入力脈波信号切替手段を備えたものとすることができる。

【0021】

また、上記発明の生体情報計測装置では、前記入力脈波切替手段により選択された入力脈波信号に応じて増幅率を調節するゲイン調節手段を具備したものとすることができる。

【0022】

さらに、上記発明の生体情報計測装置では、前記センサ窓を前記筐体下面における中心点よりも前記コネクタ寄りの位置に設けたものとすることができる。

【0023】
本発明の別の特徴は、筐体をユーザの手首に装着して脈波を計測する腕時計型の生体情報計測装置であって、前記筐体下面に設置された第１の脈波センサと、前記筐体に設けられたコネクタに信号ケーブルを介して接続された第２の脈波センサと、前記第１の脈波センサの計測信号と前記第２の脈波センサの計測信号とを比較して計測安定性の良否を判定する計測安定性判定手段と、前記第１の脈波センサと第２の脈波センサとのうち、前記計測安定性判定手段により計測安定性が良いと判断された計測信号を出力する方の脈波センサによる計測信号を用いて脈波検出を行う解析手段とを備えた生体情報計測装置にある。
【発明の効果】
【0024】
本発明によれば、筐体の下面を手首にフィットする凹面状にし、また脈波センサを凸形状としたので、当該生体情報計測装置をユーザの手首に安定した状態で固定することができ、かつ脈波センサと皮膚の接触状態を確実にすることができ、脈波計測を確実に行なえ、筐体を薄く、装着性の良いものにできる。
【0025】
また、本発明によれば、脈波の手首計測と手掌計測を簡単に切り替えられる構造とすることで、手首計測または指計測のどちらかに不満を持つユーザにも対応でき、また、脈波の手首計測と手掌計測を併せて使用することで、どちらか一方のみの使用する場合よりも全体として精度の向上を図れる。
【発明を実施するための最良の形態】
【0026】
以下、本発明の実施の形態を図に基づいて詳説する。
【0027】
（第１の実施の形態）図１は、本発明の第１の実施の形態の生体情報計測装置１０の機能構成を示し、図２はその外観を示している。
【0028】
図２に示すように、本実施の形態の生体情報計測装置１０は、腕時計状にユーザの手首に装着して使用するものであり、筐体１００の相対する２側面それぞれに装着用ベルト１０１が接続してあり、筐体１００の上面に情報表示部１９が設けてあり、またモード切替操作、バックライト点灯操作のための操作部２０が設けてある。本実施の形態の場合、筐体１００の下面はベルト中心線方向が湾曲方向となる凹面型に形成されている。そして、この筐体１００の凹面となった下面側に本体一体型の第１脈波計測部１１が設置してある。また、外部の第２脈波計測部１２の信号を伝送する信号ケーブル１２Ａを接続するコネクタ１１０がベルト接続面から９０度離れた側面で、正規の装着状態でユーザの手先側に来る側面１０２に設置してある。
【0029】
図１に示すように、本実施の形態の生体情報計測装置１０は、筐体１００の下面に設置され、脈波の計測を行う第１脈波計測部１１と、生体情報計測装置１０に外部からケーブル１２Ａで接続し、例えば指に巻き付ける等して指腹面で脈波の計測を行う第２脈波計測部１２と、第２脈波計測部１２の接続の有無あるいは計測の状態に応じて脈波計測のために第１脈波計測部１１と第２脈波計測部１２とのいずれかを選択する脈波切替部１３と、計測した脈波波形の増幅およびフィルタリングを行うアンプ・フィルタ部１４と、計測状態に応じてアンプ・フィルタ部１４の増幅率を調節するゲイン調節部１５と、ユーザの手首部の動きに伴って発生する動的加速度および姿勢に伴う重力加速度による静的加速度の双方を検出する加速度計測部１６と、第１脈波計測部１１もしくは第２脈波計測部１２の出力と加速度計測部１６の出力をＡ／Ｄ変換するＡ／Ｄ変換部１７と、Ａ／Ｄ変換部１７が取り込んだデータを解析する解析部１８と、解析部１８が解析した結果を記憶するデータ記憶部１９と、計測状態や時刻、ステータス等の表示を行う表示部２０と、モード切替操作や表示部２０のバックライトの点灯操作等を行うための操作部２１と、モードに応じて動作周波数の切替を行う動作周波数切替部２２と、データ記憶部１９に記憶したデータ

の外部端末への送信等を行う通信部２３と、当該生体情報計測装置１０全体の電源供給を行うバッテリー２４と、バッテリー２４の電圧を監視するバッテリー電圧監視部２５と、各機能全体の制御を司る制御部２６から構成されている。

【0030】

操作部２１は、ユーザが時刻モード、計測モード等のモード切り替えを操作し、またバックライト点灯指示を行うプッシュスイッチである。表示部２０は、時刻、脈拍数、脈波計測状態、バッテリー、メモリ、通信の各状態及び結果としての睡眠時間を表示する表示装置であり、ＬＣＤで構成されている。データ記憶部１９にはフラッシュメモリが用いられ、計測結果としての睡眠時間の履歴、脈拍間隔データ、体動量データ等の計測データを記憶する。

【0031】

加速度計測部１６は体動を検出するためのもので、例えば３軸方向の－２Ｇ～２Ｇの加速度を計測する加速度センサであり、生体情報計測装置本体１０内に搭載されている。

【0032】

詳しくは後述する第１脈波計測部１１と第２脈波計測部１２は、緑色ＬＥＤとフォトダイオード（ＰＤ）から成り、手首あるいは手指、手掌の皮膚表面に光を照射し、毛細血管内の血流変化により変化する反射光の変動をフォトダイオードで捉えることで脈波を計測する。アンプ・フィルタ部１４は、第１脈波計測部１１もしくは第２脈波計測部１２のフォトダイオードからの出力電流を電流電圧変換部で電圧に変換し、増幅器で電圧を増幅して、ハイパスフィルタ（例えばカットオフ周波数：０．１Ｈｚ）とローパスフィルタ（例えばカットオフ周波数：５０Ｈｚ）を施した後にＡ／Ｄ変換部１７に出力する。Ａ／Ｄ変換部１７はこのアンプ・フィルタ部１４からの入力を１０ビットＡ／Ｄ変換してデジタル量に変換して制御部２６に入力する。ゲイン調節部１５では制御部２６に入力された脈波波形の振幅を算出し、これと設定した閾値との関係からアンプ・フィルタ部１４の増幅率を制御する。

【0033】

解析部１８は、加速度計測部１６にて計測しＡ／Ｄ変換部１７にてＡ／Ｄ変換後、制御部２６に入力された３軸の加速度波形を元に体動量検出を行う。また計測終了時に覚醒／睡眠判定として、体動量データに基づいて被験者が覚醒しているか否かを判定し、睡眠時間を算出する。さらに、解析部１８は、第１脈波計測部１１もしくは第２脈波計測部１２で計測しアンプ・フィルタ部１４を介してＡ／Ｄ変換部１７でＡ／Ｄ変換し制御部２６に入力された脈波波形に対して、脈波の間隔データの検出を行う。

【0034】

また、解析部１８は、加速度計測部１６から取得した３軸方向の加速度データから体動量を求め、さらにそれに基づいて覚醒／睡眠判定を行い、この覚醒／睡眠判定の結果に基づき、計測開始後覚醒から睡眠に遷移した時刻を入眠時刻、逆に計測終了から遡って覚醒から睡眠に遷移した時刻を覚醒時刻として検出し、その差分により睡眠時間を算出する。

【0035】

さらに、解析部１８は、第１脈波計測部１１もしくは第２脈波計測部１２の計測した脈波から脈波データをサンプリングし、一連の脈波データから脈拍間隔データを取得し、データ記憶部１９に記憶する。

【0036】

通信部１６はパソコンやＰＤＡ端末、携帯電話等との間でデータ通信を行う部分である。本装置１０が複数日の睡眠時のデータを計測、蓄積してデータ記憶部１９の空き領域が少なくなれば、例えばパソコンのＵＳＢポートとの間をこの通信部１６を利用してＵＳＢケーブルにて接続することで、所定の解析ソフトウェア上で解析可能な形式でデータをパソコン上のハードディスク等に保存し、解析ソフトで解析を行う。

【0037】

本実施の形態の生体情報計測装置１０の電源は常時ＯＮであり、生体計測を行わないときは内部クロックを大幅に下げて低消費電力とし、通常の腕時計と同様に時刻表示のみを

行う。そして生体計測を行う場合には、操作部２１にてモードを生体計測モードに切り替える。また睡眠時間表示等は結果モードにすることで表示を行う。また通信モードには通信部２３にＵＳＢケーブルを接続し、外部機器とＵＳＢ接続することで切り替える。尚、充電はこのＵＳＢケーブルの電源ラインを利用して行うので、通信モード時には同時に充電することになる。

【0038】

操作部２１により設定できるモードには、時刻モード、生体計測モード、結果表示モードがある。表示部２０の表示情報としては、日付、脈拍数、時刻、脈波レベルメータ、各ステータスとしてメモリ蓄積量、バッテリー残量、通信中表示、さらに、脈拍と同期して点滅するハートマーク等がある。

【0039】

バッテリー電圧監視部２５は、バッテリー２４の容量－電圧特性から電源電圧を監視することでバッテリー残量を求め、表示する。

【0040】

上述したように第１脈波計測部１１および第２脈波計測部１２には、発光ダイオード（ＬＥＤ）とフォトダイオード（ＰＤ）との組み合わせで構成される光電脈波センサを使用している。この光電脈波センサでは、ＬＥＤから光を皮膚内部に照射し、ヘモグロビンによる吸光特性により血流変化に伴って変化する反射光の強度をＰＤで捉えることにより脈波を検出する。

【0041】

第１脈波計測部１１は生体情報計測装置１０の筐体下面に配置されるが、精度良く安定的に脈波を計測するためには皮膚としっかり接触させる必要がある。装置筐体の下面の形状が平面となっていると、人の手首は平面となっていないために脈波センサの皮膚への接触状態が安定しない。そこで、本実施の形態の生体情報計測装置１０では、図２に詳しいように、装置筐体の下面の形状を凹面とすることで、皮膚との接触状態を全体的に良く保てるようにしている。ただし、凹面としただけでは皮膚と第１脈波計測部１１との間に空間が発生してしまう場合もあるため、中央付近に凸形状の曲面と平面で構成された透明窓を設置し、その位置に第１脈波計測部１１を配置している。このようにすると、装置筐体全体が手首と密着し、かつ、第１脈波計測部１１が安定して皮膚に接触するようにできる。

【0042】

尚、筐体加工の簡便さ等考慮すると、筐体１００の下面の凹面は解析曲面となっていることが望ましい。例えば、図３のような円柱型凹面、図４のような円錐型凹面、図５のような楕円球型凹面が望ましい。また、凸形状の透明なセンサ窓、つまり第１脈波計測部１１を設ける位置としては、筐体１００の下面中央部に配置すると、当該装置１０は手首に装着することを想定しているためにユーザの長掌筋腱の位置に当たってしまい、接触状態が安定せず、かつ手首の動きにより大きく影響を受けてしまう。そのため、第１脈波計測部１１を設ける位置は、装置筐体１００の下面中央部から湾曲方向（装着する手首の周方向、あるいはベルト方向）にずれた位置にして、その影響を軽減できるようにしている。さらに、第１脈波計測部１１の凸形状曲面と筐体１００の凹面とでできた隙間にユーザの手首の長掌筋腱が位置することになり、長掌筋腱により筐体１００がベルト方向へずれるのを抑止でき、装置１０の安定装着を可能にしている。またさらに、図３に想像線にて示したように、安定装着性をさらに向上させるために、装着時に長掌筋腱を第１脈波計測部１１との間で挟めるように凸条１１１を筐体下面１００に形成することもできる。

【0043】

第１脈波計測部１１の高さは、筐体１００の下面の周縁が形成する面１２０より外に突出しない高さとしている。図６に示すように、第１脈波計測部１１は、筐体１００の下面の凹面の一部を埋め込むことでできる平坦形状にしてもよい。

【0044】

本実施の形態の生体情報計測装置１０は、脈波の計測に関して、第１脈波計測部１１だ

けでなく、第２脈波計測部１２を筐体外部に取り付けて使用できる。人体はその手首よりも手掌の方が細動脈等が皮膚表面近くに多くある。そのため、光電脈波センサによる脈波計測は、手掌で計測する方が手首で計測するよりも検出できる脈波のレベルが大きい。そのため、手首では正確に計測できない場合には指に第２脈波計測部１２を巻きつける等して手掌で計測することが望ましい。その場合に、ユーザに第２脈波計測部１２をコネクタ１１０を接続させ、さらに操作部２１で再度計測部位を指示させるのは煩わしさを感じさせる。そのため、本実施の形態の生体情報計測装置１０では、第２脈波計測部１２がコネクタ１１０に接続された場合には、ユーザに手首でなく手掌で脈波を計測しようという意思であるとみなし、脈波切替部１３により自動的に第２脈波計測部１２の計測信号を優先して脈波計測を行うように切り替える。

【0045】

図７、図８に示すように、第２脈波計測部１２は例えば小指１３１に巻き付けて手掌１３０側で脈波を計測する。小指１３１以外の指、指以外の手掌１３０の部分でも構わない。第２脈波計測部１２と生体情報計測装置１０とをつなぐコネクタ１１０の位置については、図９（ａ），（ｂ）に示したように、ベルト１０１の方向と直角な方向に存在する筐体１００の側面１０２上とする。しかも、この側面１０２の中央部にコネクタ１１０を設けると、ユーザの手首曲げ動作を妨げるため、中央部よりもベルト方向の上下どちらかの方向にずらせた位置にしている。

【0046】

脈波切替部１３は、ユーザが操作部２１を操作して脈波計測モードとした際に、第２脈波計測部１２が接続されているかどうかを確認する。その方法として以下の２例について説明する。

【0047】

１つ目の例は、コネクタ１１０の形状に工夫を持たせることによって判断する方法である。図１０はコネクタ１１０の形状を示し、図１１は脈波切替部１３の判断処理フローチャートを示している。第２脈波計測部１２のＬＥＤ、ＰＤに必要なＬＥＤアノード、ＬＥＤカソード、ＰＤアノード、ＰＤカソードの４極以外に、生体情報計測装置１０側のコネクタ１１０では脈波切替部１３が接続状態を監視するためにＣＰＵのＩＯピンに繋がっているピンとグランド（ＧＮＤ）に繋がっているピンとを用意し、第２脈波計測部１２のケーブル１２Ａ側ではその２極をショートさせている。尚、該当のＣＰＵのＩＯピンは電源電圧にプルアップしておく。すると、コネクタ非接続時はＩＯピンには電源電圧が印可されているが、コネクタ接続時は０Ｖとなる。脈波切替部１３は、脈波計測モード開始時に監視用ＩＯピンの電圧レベルをチェックし（ステップＳ１１）、Ｈレベルであれば第１脈波計測部１１を使用し（ステップＳ１２）、Ｌレベルであれば第２脈波計測部１２を使用すると判断する（ステップＳ１３）。

【0048】

ここで、コネクタ１１０の形状はこれに限るものではなく、予めプルダウンしておき接続時にＨレベルになるようにしてもよい。また、ＰＤをゼロバイアスで使用する場合等、ＰＤとＬＥＤのピンを共通化できる場合（例えばＬＥＤカソードとＰＤアノード）は、第２脈波計測部１２へのリード線１２Ａの数を減らすことができる。また、脈波切替部１３は計測開始時だけでなく、計測中にも周期的にコネクタの接続状態を監視することで計測中の第２脈波計測部１２の抜き差しにも動的に対応することができる。

【0049】

２つ目の例は、計測波形から第２脈波計測部１２が接続されているか否かを判断する方法である。図１２はその判断処理フローチャートである。まず、脈波切替部１３は計測開始時に第２脈波計測部１２を選択し（ステップＳ２１）、少なくとも複数個の脈波をカウントするに十分な一定時間、例えば１０秒間の脈波を計測する（ステップＳ２２）。図１３は第２脈波計測部１２が接続され指腹部で計測している場合の脈波波形の例で、図１４は第２脈波計測部１２が接続されていない場合の脈波波形の例である。第２脈波計測部１２が接続されていない場合の波形は、オフセット電圧近傍でほとんど変化しない。一定時

間経過後、脈波切替部１３は、オフセット電圧の上下両方、あるいは片方に設定した閾値を超える脈波変動があるかどうかを調べ（ステップＳ２３）、その変動がない場合は第２脈波計測部１２が接続されていない（あるいは接続されていても正しく計測できていない）と判断し、以後、第１脈波計測部１１を使用すると判断する（ステップＳ２６）。

【0050】

他方、ステップＳ２３で、閾値を超える脈波変動があった場合は、閾値を超えるピークの間隔が脈波と思われる間隔で（例えば０．５秒以上１．５秒以内）周期的に一定回数以上、例えば１０秒間で５回以上出現しているかどうかを調べ（ステップＳ２４）、一定回数以上検出していれば第２脈波計測部１２が接続されているものと判断して第２脈波計測部１２を使用すると判断し（ステップＳ２５）、そうでなければ第２脈波計測部１２が接続されていない（あるいは接続されていても正しく計測できていない）と判断し、以後、第１脈波計測部１１を使用すると判断する（ステップＳ２６）。

【0051】

アンプ・フィルタ部１４は、ＰＤの出力電流の変化を増幅するとともに脈波以外のノイズ成分（例えばハムノイズ）の除去を行う。第１脈波計測部１１は手首部での脈波を計測し、第２脈波計測部１２は手掌部での脈波を計測する。上述の通り、手首部と手掌部での脈波波形のレベルが異なるため、解析部１８が精度良く計測波形の解析を行うために、ゲイン調節部１５はそれぞれに適した増幅率に設定する。つまり、予め第１脈波計測部１１と第２脈波計測部１２に固有の増幅率を設定しておき、脈波切替部１３が選択した方に設定された増幅率に設定する。増幅率を複数段階に調節できるようにしておき、波形の振幅レベルに応じて動的に調節するようにしてもよい。

【0052】

（第２の実施の形態）本発明の第２の実施の形態の生体情報計測装置について、説明する。第２の実施の形態の特徴は、第１脈波計測部１１と第２脈波計測部１２とを同時に使用し、両者のうち計測精度の良い方を動的に選んで生体情報を計測し、データ蓄積していく機能を備えた点にある。本実施の形態の生体情報計測装置１０の機能構成は、図１に示した第１の実施の形態のものと共通であり、またハードウェアの外観も図２に示した第１の実施の形態のものと共通である。そして、本実施の形態では、脈波切替部１３が第１脈波計測部１１と第２脈波計測部１２とのうち計測精度の良い方を動的に選び、計測精度の良い方の計測部の計測信号をアンプ・フィルタ部１４に出力する働きをする。

【0053】

基本的に手首部よりも手掌部の方が脈波計測の精度が良いとされているが、ユーザの状況（冷え、姿勢等）によっては、その逆の場合も発生することがあるため、このような方法でさらに計測精度の向上を図る。

【0054】

計測開始時には、図１２のフローチャートに基づき、脈波切替部１３は第２脈波計測部１２を選択し（ステップＳ２１）、少なくとも複数個の脈波をカウントするに十分な一定時間、例えば１０秒間の脈波を計測する（ステップＳ２２）。そして第１の実施の形態と同様の判断により、オフセット電圧の上下両方、あるいは片方に設定した閾値を超える脈波変動があるかどうかを調べ（ステップＳ２３）、その変動がない場合は第２脈波計測部１２が接続されていない（あるいは接続されていても正しく計測できていない）と判断し、第１脈波計測部１１を優先使用すると判断する（ステップＳ２６）。

【0055】

他方、ステップＳ２３で、閾値を超える脈波変動があった場合は、閾値を超えるピークの間隔が脈波と思われる間隔で（例えば０．５秒以上１．５秒以内）周期的に一定回数以上、例えば１０秒間で５回以上出現しているかどうかを調べ（ステップＳ２４）、一定回数以上検出していれば第２脈波計測部１２を優先使用すると判断し（ステップＳ２５）、そうでなければ第１脈波計測部１１を優先使用すると判断する（ステップＳ２６）。

【0056】

この計測開始時の優先使用計測部の選択判断の後、図１５のフローチャートの処理に移

行する。そこではまず、第１脈波計測部１１と第２の脈波計測部１２との間で優先使用すると判断された方の脈波計測部を優先的に使用する（ステップＳ３１）。解析部１８は計測した脈波波形からピーク検出、あるいは生波形あるいは微分波形の閾値クロス等から脈波間隔を検出し（ステップＳ３２）、現在から過去一定時間遡った時間内の脈波検出回数が一定値以上（例えば１分間に３０回以上）であるかどうかを判断する。そうであれば正しく計測できているものとして、優先使用すると判断された方の脈波計測部での計測を継続する。そうでなければ正しく計測できていないものとして、脈波切替部１３は他方の脈波計測部に切り替える（ステップＳ３４）。

【0057】

そして、上記と同様にして解析部１８は脈波間隔を検出し（ステップＳ３５）、現在から過去一定時間遡った時間内の脈波検出回数が一定値以上であるかどうかを判断する（ステップＳ３６）。ここで一定時間内の脈波検出数が一定値以上であれば正しく計測できているものとして、この他方の脈波計測部での計測を継続する。そうでなければ正しく計測できていないものとして、脈波切替部１３は最初に優先使用するとされた方の脈波計測部に再び切り替えて脈波計測を行う（ステップＳ３４）。以降、この一連の処理を継続することで、常に精度の良い方で脈波の計測を行う。尚、脈波計測部で計測した脈波信号に対する処理は第１の実施の形態と同様である。

【0058】

以上により、本実施の形態の生体情報計測装置によれば、ユーザの手首部の脈波計測と手掌部の脈波計測との間で常に精度の良い方に切替ながら脈波計測を行い、その脈波信号に基づいて生体情報の解析を行うので、精度の良い生体情報解析が可能である。

【図面の簡単な説明】

【0059】

【図1】本発明の第１の実施の形態の生体情報計測装置の機能構成を示すブロック図。

【図2】上記実施の形態の生体情報計測装置の外観を示す平面図及び側面図。

【図3】上記実施の形態の生体情報計測装置において、円柱状凹面を下面形状とする筐体を示す下面図及び側面図。

【図4】上記実施の形態の生体情報計測装置において、円錐状凹面を下面形状とする筐体を示す下面図及び側面図。

【図5】上記実施の形態の生体情報計測装置において、楕円球状凹面を下面形状とする筐体を示す下面図及び側面図。

【図6】上記実施の形態の生体情報計測装置において、筐体下面の形状とそこに形成された第１脈波計測部との関係を示す下面図及び側面図。

【図7】上記実施の形態の生体情報計測装置の使用状態を示す下面図。

【図8】上記実施の形態の生体情報計測装置における第２脈波計測部の使用状態を示す断面図。

【図9】上記実施の形態の生体情報計測装置における第２脈波計測部の信号ケーブルを接続するコネクタの設置場所を示す平面図。

【図10】上記実施の形態の生体情報計測装置における第２脈波計測部の信号ケーブル側のコネクタと筐体側のコネクタとのピンアサインの説明図。

【図11】上記実施の形態の生体情報計測装置における第１脈波計測部と第２脈波計測部との選択判断処理の一例のフローチャート。

【図12】上記実施の形態の生体情報計測装置における第１脈波計測部と第２脈波計測部との選択判断処理の別例のフローチャート。

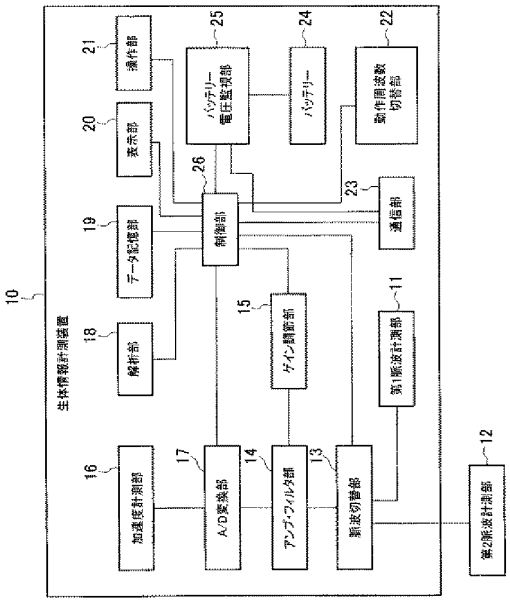
【図13】上記実施の形態の生体情報計測装置において第２脈波計測部から入力される正規の脈波計測信号のグラフ。

【図14】上記実施の形態の生体情報計測装置において第２脈波計測部が接続されていない状態で第２脈波計測部接続用のコネクタから入力される脈波計測信号のグラフ。

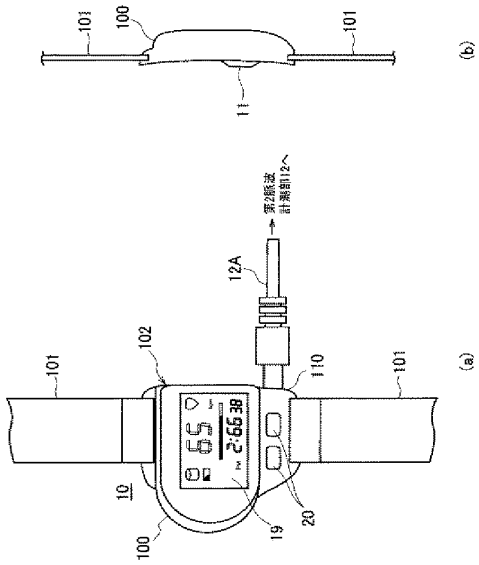
【図15】本発明の第２の実施の形態の生体情報計測装置における第１脈波計測部と第２脈波計測部との選択判断処理のフローチャート。

【符号の説明】
【0060】
１０　生体情報計測装置
１１　第１脈波計測部
１２　第２脈波計測部
１２Ａ　信号ケーブル
１３　脈波切替部
１４　アンプ・フィルタ部
１５　ゲイン調節部
１６　加速度計測部
１７　Ａ／Ｄ変換部
１８　解析部
１９　データ記憶部
２０　表示部
２１　操作部
２２　動作周波数切替部
２３　通信部
２４　バッテリー
２５　バッテリー電圧監視部
２６　制御部
１００　筐体
１０１　ベルト
１０２　手掌側側面
１１０　コネクタ
１２０　下面周縁部の張る平面
１３０　手掌
１３１　小指

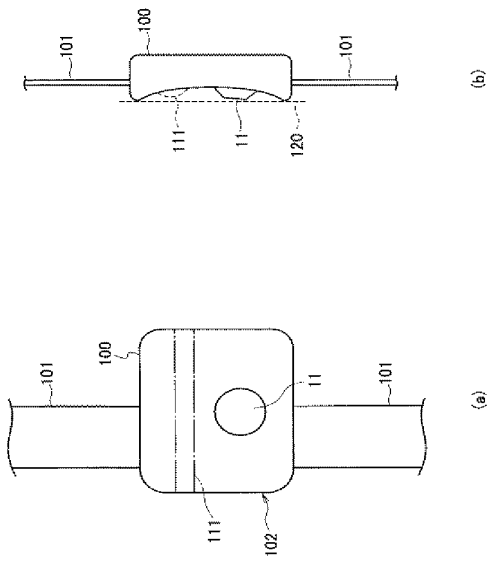
【図1】


生体情報計測装置
10
操作部
21
表示部
20
データ記憶部
19
解析部
18
加速度計測部
16
A-D変換部
17
アンプ・フィルタ部
14
断続切替部
13
ゲイン調整部
15
第1振動計測部
11
制御部
26
バッテリー電圧監視部
25
バッテリー
24
動作周波数切替部
22
通信部
23
第2振動計測部
12

【図2】


101
100
11
(b)
第2振動計測部12へ
12A
102
110
10
19
20
(a)

【図3】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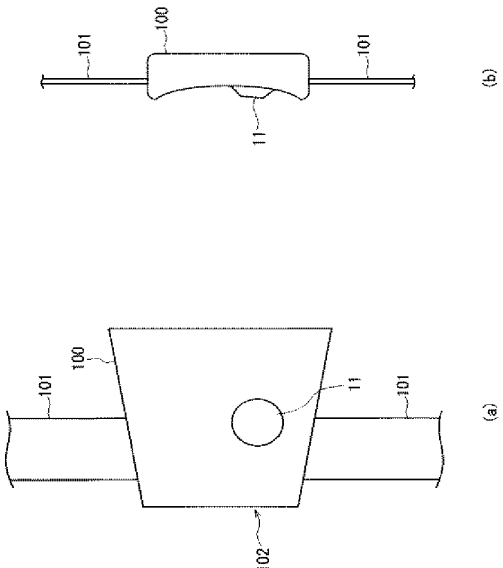
111
11
120
(b)
102
(a)

【図4】


101
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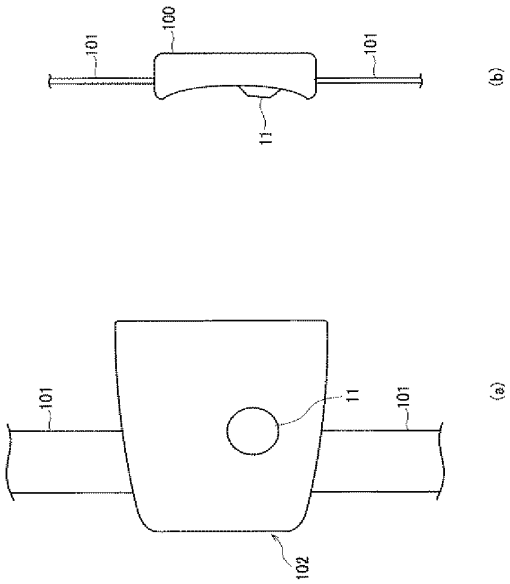
11
(b)
102
(a)

【図5】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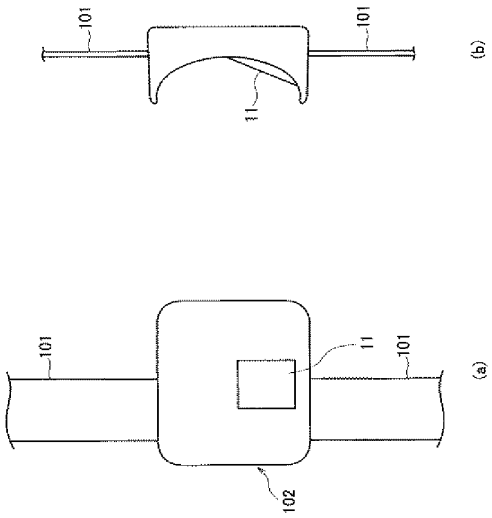
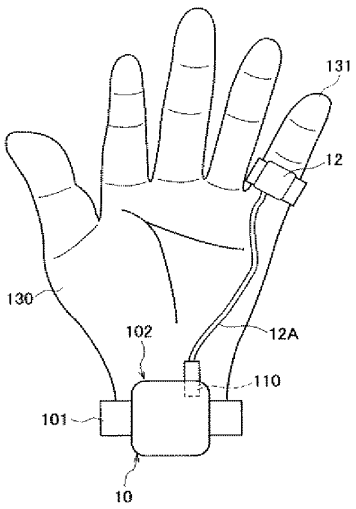
101
11
(b)
101
11
101
(a)
102

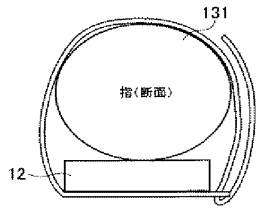
【図6】


101
101
11
(b)
101
11
101
(a)
102

【図7】


131
12
130
102
12A
110
101
10

【図8】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指(断面)
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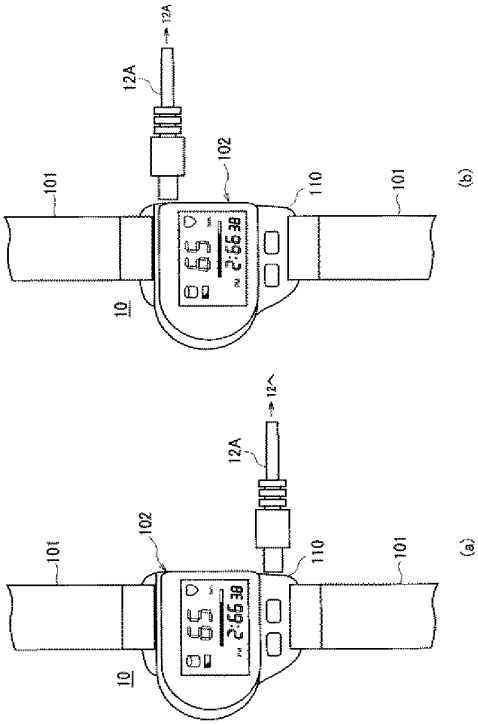
【図9】



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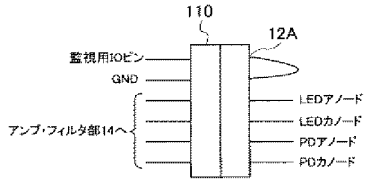

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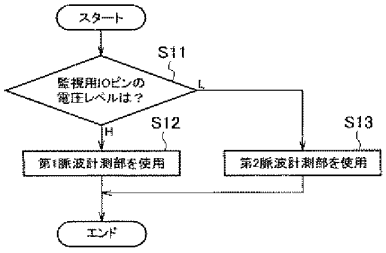

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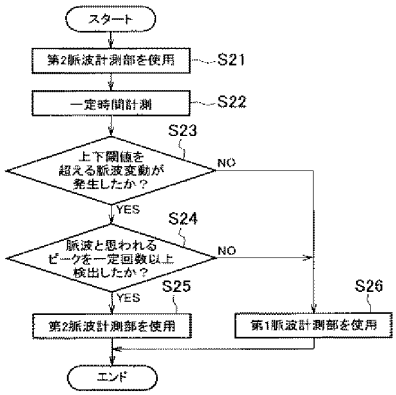
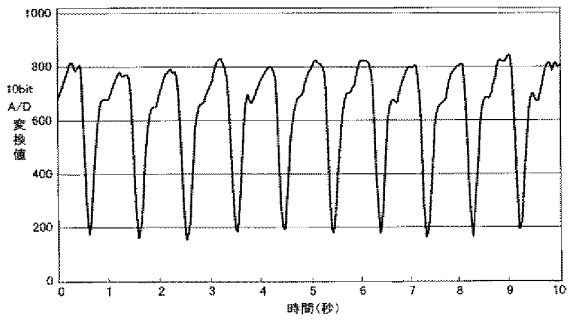
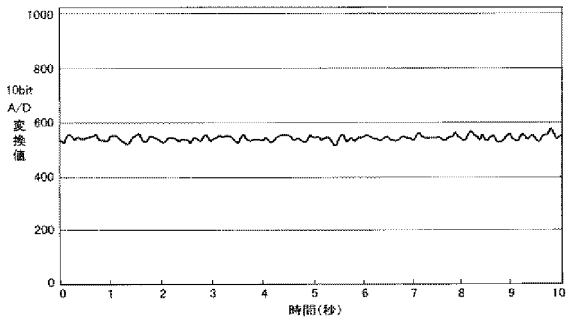


【図13】



【図14】



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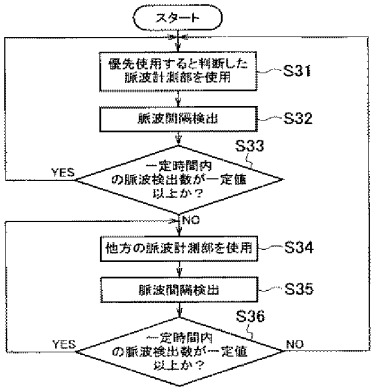
スタート
優先使用すると判断した脈波計測部を使用
S31
脈波間隔検出
S32
S33
一定時間内の脈波検出数が一定値以上か？
YES
NO
他方の脈波計測部を使用
S34
脈波間隔検出
S35
S36
一定時間内の脈波検出数が一定値以上か？
YES
NO

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Ｆターム(参考) 4C017 AA09　AB02　AC28　EE06　FF05　FF15

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 January 2007 (11.01.2007)

PCT

(10) International Publication Number
WO 2007/004083 A1

(51) International Patent Classification:
A61B 5/02 (2006.01)

(21) International Application Number:
PCT/IB2006/051892

(22) International Filing Date: 13 June 2006 (13.06.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/695,725 30 June 2005 (30.06.2005) US

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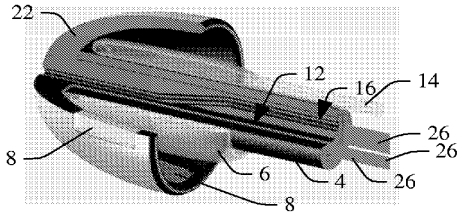
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** SIZING AND POSITIONING TECHNOLOGY FOR AN IN-THE-EAR MULTI-MEASUREMENT SENSOR TO ENABLE NIBP CALCULATION



(57) **Abstract:** An in-the-ear (ITE) physiological measurement device (2) includes a structure (4) formed for easy insertion into multiple shaped and sized ear canals. An inflatable balloon (6) surrounds an end portion of the structure (4) to be positioned in the ear. Optionally, a mushroom shaped tip (22) is connected with an end of the structure (4) and carries a plurality of sensors (8). Inflation of the balloon (6) expands the tip (22) radially to position the sensors (8) proximate to vascular tissue within the ear canal. Once suitably positioned, the one or more sensors (8) sense physiological signals from the vascular tissue and bone structure.

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SIZING AND POSITIONING TECHNOLOGY FOR AN IN-THE-EAR MULTI-MEASUREMENT SENSOR TO ENABLE NIBP CALCULATION

BACKGROUND

The following relates to monitoring physiology. It finds particular application to an in-the-ear structure that is inserted in the ear canal to suitably position one or more physiological sensors within the inner ear to capture information indicative of physiological phenomena including blood pressure, respiration, perfusion index, blood oxygen, pulse rate, and body temperature, for example.

Physiological signals have been measured from within the ear. However, there are no multi-parameter physiological measurement devices that non-invasively measure blood pressure from within the ear. Examples of barriers that frustrate such development include the varying size and shape of the human ear canal from person to person, an inability to strategically position sensors within the ear canal to optimally receive physiological signals, and an inability to protect sensing devices from contamination through contact with inner ear tissue while measuring physiological signals.

In one aspect, an in-the-ear physiological measurement device includes a structure formed for insertion into an ear canal. One or more sensors are operatively coupled to a portion of the structure that is positioned in the ear. An inflatable balloon is operatively coupled to the portion of the structure positioned in the ear and inflates to position the one or more sensors proximate to tissue within the ear canal. Once suitably positioned, the one or more sensors sense physiological signals from the surrounding tissue and bone structure.

One advantage includes measuring physiological signals from within the ear.

Another advantage resides in non-invasively measuring blood pressure from within the ear.

Another advantage is continuously measuring non-invasive blood pressure from with the ear.

Another advantage resides in an in-the-ear device that forms to different shaped and sized ear canals.

Another advantage is positioning the sensor within the ear canal to optimally receive physiological signals therefrom.

Another advantage is positioning the sensor within the ear canal with ideal force and pressure to ensure close coupling of sensors with tissue without causing blanching of the tissue.

Another advantage is positioning the sensor within a well perfused physiological site even if the body is experiencing peripheral shutdown due to shock or other conditions.

Another advantage is the prevention of over insertion into the ear.

Another advantage is measuring physiological signals through a sheath that mitigates contamination of the physiological sensors.

Another advantage resides in an in-the-ear physiological signal measuring device that equalizes ear pressure with ambient pressure, especially during balloon inflation and deflation.

Still further advantages will become apparent to those of ordinary skill in the art upon reading and understanding the detailed description of the preferred embodiments.

FIGURE 1 illustrates an in-the-ear physiological measurement apparatus for measuring physiological signals from within an ear.

FIGURE 2 illustrates an in-the-ear physiological measurement apparatus with a single channel for housing sensor wiring and inflating/deflating an inflatable balloon to position sensors proximate to inner ear tissue.

FIGURE 3 illustrates an in-the-ear physiological measurement apparatus with separate channels for housing sensor wiring and inflating/deflating an inflatable balloon.

FIGURE 4 illustrates an in-the-ear physiological measurement apparatus with an air passage channel for equalizing air pressure between the ear and the environment when inflating and deflating the balloon.

FIGURE 5 illustrates an in-the-ear physiological measurement apparatus positioned within an ear.

FIGURE 6 illustrates a connection point between an in-the-ear physiological measurement apparatus, a supporting behind-the-ear device, and a protective sheath that mitigates contamination of the physiological sensors.

FIGURE 7 illustrates an in-the-ear physiological measurement apparatus connected to a behind-the-ear supporting device.

FIGURES 8-12 illustrate various views of a suitable tip for holding sensors associated with an in-the-ear physiological measurement apparatus.

FIGURE 13 is a perspective view in partial section illustrating an uninflated balloon for insertion into the ear canal.

FIGURE 14 is a perspective view in partial section illustrating an inflated balloon.

FIGURE 1 illustrates an in-the-ear (ITE) physiological measurement apparatus 2 (hereafter "the ITE apparatus 2") for measuring one or more physiological signals (e.g., blood pressure, pulse, blood oxygen, perfusion, temperature, respiration...) from within an ear canal. The ITE apparatus 2 includes a structure 4 that inserts into the ear canal. The structure 4 is dimensioned to enter the ear canal to a suitable depth and adapts to various shaped ear canals (e.g., different curvatures). That is, the structure 4 is small in diameter compared to the diameter of the ear canal. In a preferred embodiment, the structure 4 projects into the ear canal such that an end portion is positioned proximate to a bony region of the ear or other relatively quiet zone of the ear canal.

The end portion of the structure 4 residing in the ear canal includes an annular inflatable balloon 6. The inflatable balloon 6 surrounds the end portion of the structure 4 (as illustrated) or suitable portions thereof. The inflatable balloon 6 ideally supports one or more sensors 8 that are operatively coupled to a surface of the balloon 6 and that measure physiological signals. Suitable sensors include light emitting diodes (LEDs), an infrared (IR) source, light detectors, a pressure transducer, a microphone, and a thermistor, for example. The sensors 8 are strategically positioned on the balloon 6. For example, a light detecting sensor typically is positioned to minimize or prevent absorption of light not indicative of the physiological process under measurement (e.g., light from outside the ear, light emitted from another sensor located on the balloon 6...). Although depicted as circular in FIGURE 1, the one or more sensors 8 can be any shape. Alternatively, the sensors could be mounted within the end portion of the structure 4 and could be moved into contact with the tissue once inserted into the ear.

The inflatable balloon 6 is inflated to position the one or more sensors 8 proximate to appropriate tissue within the ear canal with ideal force and pressure to ensure close coupling of sensors with tissue but without causing decreased perfusion or blanching of the

tissue. For adult humans, this includes inflating the balloon 6 to conform to the widely varying ear canal diameters from about 6 mm to about 13 mm. For neonates and small pediatrics, where the ear canal diameter various from about 4 mm in diameter to about 7 mm in diameter, smaller and shorter ITE devices are used. Typically, sensors for measuring blood oxygen are positioned proximate to ear canal tissue that is perfused with arterial blood supplied by branches of the External as well as the Internal Carotid Arteries, thus serving as a well perfused physiological site even if the body is experiencing peripheral shutdown due to shock or other conditions. Such sensors include an energy emitting means (e.g., an LED, an IR source...) and an energy detecting means that detects energy transmission through the vascular tissue. In another example, a temperature sensor (e.g., a thermistor) is also positioned proximate to vascular tissue. In yet another example, sensors for sensing audio signals (e.g., a microphone) indicative of pulse pressure sounds, and/or respirations are suitably positioned in relatively quite regions of the ear canal to mitigate sensing extraneous audio signals (noise).

The inflatable balloon 6 is also used to facilitate non-invasively measuring blood pressure. For a non-invasive blood pressure measurement, the inflatable balloon 6 is inflated until it occludes blood flow in a portion of the ear proximate a blood pressure sensor(s) (e.g., a pressure transducer) operatively connected to the inflatable balloon 6. The pressure in the inflatable balloon 6 is then suitably released to deflate the inflatable balloon 6. A systolic and a diastolic blood pressure are obtained during inflation and/or deflation using an auscultatory approach (e.g., via a microphone operatively connected to the balloon 6) and/or an oscillometric approach (e.g., via optical sensing components attached to the balloon).

A continuous non-invasive blood pressure is measured by obtaining an initial blood pressure measure as describe above and then re-inflating the balloon 6 to a mean pressure. A servo mechanism periodically adjusts balloon pressure to locate a maximum pulse waveform amplitude indicative of mean blood pressure. As long as the derived mean pressure is relatively close to the initial pressure and/or the pulse waveform amplitudes are relatively close, the derived continuous systolic, diastolic, and mean blood pressure are calculated with high accuracy.

The structure 4 includes one or more passageways (as illustrated in FIGURES 2-4 infra) that extend through the structure 4. Such passageways house sensor data, power,

and control wires, provide a hermetically sealed channel for inflating/deflating the balloon 6, and/or allow pressure inside the ear to equalize with the environment during balloon inflation/deflation. FIGURE 2 depicts an aspect in which the structure 4 includes a channel 10 for both housing sensor wiring and inflating/deflating the balloon 6. The channel 10 isolates the wires from the inner ear environment, mitigating contamination of both the ear and the sensor wiring and provides a pressurized air conduit to the balloon 6. FIGURE 3 depicts an aspect in which the structure 4 includes separate channels for sensor wiring and inflating/deflating the balloon 6; one or more first channels 12 house sensor wiring and a second channel 14 provides the pressurized air conduit for inflating/deflating the balloon 6. FIGURE 4 depicts an aspect in which an optional channel 16 provides an ear pressure stabilizing mechanism that allows ear pressure to equalize with the environment during balloon inflation and/or deflation. The channel 16 mitigates pressure build-up in the ear during balloon inflation and/or deflation and potential pain therefrom. The examples in FIGURE 2-4 depict the structure 4 and the passageways 10-16 with circular shaped cross-sections. These particular shapes are not limitative and are provided for explanatory purposes. It is to be understood that the structure 4 and/or the passageways 10-16 can be essentially any shape (e.g., oval, rectangular, irregular...) conducive to the ear canal.

FIGURE 5 illustrates the ITE apparatus 2 inserted into an ear canal. The structure 4 is inserted such that the end portion with the balloon 6 residing in the ear canal is in a bony region of the ear. The balloon 6 is inflated to position the sensors 8 proximate to inner ear tissue to sense signals indicative of physiological states, including blood pressure, temperature, pulse, respiration, and blood oxygen, for example.

FIGURE 6 illustrates the ITE apparatus 2 with an optional sheath 9 placed over the structure 4 and balloon 6 to protect the ear and the structure/balloon/sensor assembly from contamination. In one aspect, the sheath can be semi-permeable to allow air flow, but prevent fluid from moving from one side of the sheath to the other side. In another aspect, the sheath prevents substantially all matter from moving from one side of the sheath to the other side. The structure/balloon/sensor assembly can be disposable, washable, and/or sterilizeable.

The structure 4 is shown supported in the ear by a (BTE) ear piece 18. The structure 4 can be operatively attached to the ear piece 18. Such attachment can be through

a fastening means including a threaded connector, a snap, a set screw, an adhesive, a rivet, etc. FIGURE 6 shows an exemplary connection region 20 between the structure 4 and the optional ear piece 18. A protective sheath 9 may be used to mitigate contamination of the physiological sensors if desired. In another aspect, the structure 4 and the ear piece 18 can be formed as a single unit.

FIGURE 7 shows the BTE device 18 connected to the ITE device 2. The ITE device 2 includes a battery 21 which powers both devices. With this embodiment, the ITE device 2 and battery 21 are low cost and disposable.

FIGURES 5-7 above illustrate the optional ear piece 18 as a behind-the-ear supporting device. In a preferred embodiment, the ITE apparatus is connected to a behind-the-ear (BTE) device (18) by means of a semi-rigid connector tube that is formed to fit over and/or around the ear to prevent over insertion and to hold in position the ITE device with optimised orientation and positioning. It is to be understood that other types of supporting devices are contemplated. For example, the structure 4 can be mounted to supporting devices that attach to a region of the head, neck, shoulders, etc.

The BTE device 18 can house various electronics that receive physiological signals from the sensors 8 (e.g., via sensor wire extending through the passageways 10 and 12 briefly described above) and transmit the physiological signals to another transceiver (not shown) worn by the subject (e.g., a transceiver worn around the neck or waist) or to a remote device (not shown) such as a monitoring device, a database, a computer, and a graphical display. The BTE device 18 can optionally include a processor (not shown), memory (not shown), and a battery (not shown). The processor is used to control the sensors and electronics, process raw data, and read data from the sensors; the memory is used to store data and/or configuration; and the battery powers the processor, active sensors, and the transceiver.

In the embodiment of FIGURES 8-11, the one or more sensors 8 are located on a soft, pliable tip 22 (rather than directly on the inflatable balloon 6, or on the ITE device tip on a side opposite the inflatable balloon 6) that is operatively connected to the end of the structure 4 inserted into the ear. The balloon 6 is shown in FIGURE 8, but has been removed from the FIGURES 9-11 for clarity of illustration. Upon inserting the structure 4 in the ear, the sensors 8 are still positioned by inflating the balloon 6; however, inflating

the balloon 6 expands sensor carrying leaves 24 of the tip 22, which positions the sensors 8 proximate to inner ear tissue.

FIGURE 12-14 depict the tip 22 as an expandable mushroom shaped element. In this embodiment, inflating the balloon 6 from the insertion level of FIGURE 13 expands the soft, pliable tip 22, which positions the sensors 8 proximate to inner ear tissue (See FIGURE 14). The tip 22 and/or balloon 6 also serve as an optical reflector, helping to reflect light from a light emitter through the tissue, from the bone, through the tissue, reflectively and transmissively, to the reflector, from the reflector back through the tissue and so forth, until it finally reaches the light detector. The back side of the tip 22 is opaque which blocks unwanted ambient light coming from within the ear canal. The tip (22) and/or the balloon (6) also serves as buffer between external ambient airflow and thermistor (8) that is measuring a surrogate of core body temperature. Flex-circuit connectors 26 each extend through the structure 4, bend around the balloon 6, and flexibly interconnect with an associated sensor 8.

The invention has been described with reference to the preferred embodiments. Modifications and alterations may occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be constructed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

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CLAIMS

1. An in-the-ear (ITE) physiological measurement device (2), comprising:

a structure (4) formed for easy insertion into an ear canal;

one or more sensors (8) operatively coupled to a portion of the structure that is inserted in the ear; and

an inflatable balloon (6) operatively coupled to the portion of the structure inserted in the ear, the inflatable balloon (6) inflates to position the one or more sensors (8) proximate to tissue within the ear canal such that the one or more sensors (8) can sense physiological signals from the surrounding tissue and bone structure.

2. The ITE physiological measurement device (2) according to claim 1, wherein the one or more sensors (8) non-invasively sense signals indicative of blood pressure, continuous blood pressure, a pulse, a blood oxygen level, perfusion, body temperature, and respiration.

3. The ITE physiological measurement device (2) according to claim 1, wherein the structure (4) is inserted to position the one or more sensors (8) proximate to at least one of a bony region and a quite zone of the ear canal.

4. The ITE physiological measurement device (2) according to claim 1, wherein the structure (4) is inserted to position the one or more sensors (8) proximate to surrounding deep ear canal tissue which is perfused with arterial blood supplied by branches of at least one of External and Internal Carotid Arteries and serves as a well perfused physiological site even if the body is experiencing peripheral shutdown due to shock or other conditions.

5. The ITE physiological measurement device (2) according to claim 1, wherein the inflated balloon (6) positions the one or more sensors (8) located thereon proximate to the vascular tissue with ideal force and pressure to ensure close coupling of sensors with tissue without causing decreased perfusion or blanching of the tissue.

6. The ITE physiological measurement device (2) according to claim 1, wherein the one or more sensors (8) are operatively attached to the inflatable balloon (6).

7. The ITE physiological measurement device (2) according to claim 1, further including a tip (22) operatively connected to a region of the structure (4) inserted in the ear, the one or more sensors (8) being operatively connected to the tip (22).

8. The ITE physiological measurement device (2) according to claim 7, the tip (22) and/or the balloon (6) serves as a reflector to reflect and direct sensor sourced light through the tissue of the ear, reflectively and transmissively, into a light detector while blocking ambient light.

9. The ITE physiological measurement device (2) according to claim 7, the tip (22) and/or the balloon (6) serves as buffer between external ambient airflow and thermistor (8) that is measuring a surrogate of core body temperature.

10. The ITE physiological measurement device (2) according to claim 7, wherein the balloon (6) is disposed between the structure (4) and the tip (22) to inflate and expand the tip (22) in order to position the one or more sensors (8) located thereon proximate to the vascular tissue.

11. The ITE physiological measurement device (2) according to claim 1, wherein the one or more sensors (8) include one or more of: a light emitting diode, an IR source, a light detector, a thermistor, a pressure transducer, and a microphone.

12. The ITE physiological measurement device (2) according to claim 1, wherein the inflatable balloon (6) expands to position the one or more sensors (8) within an adult ear canal from about 6 mm in diameter to about 13 mm in diameter, and within a pediatric ear canal from about 4 mm in diameter to about 7 mm in diameter.

13. The ITE physiological measurement device (2) according to claim 1, the structure (4) including:

a passageway (10, 14) that extends through the structure (4) to the balloon (6) for inflating and deflating the balloon (6).

14. The ITE physiological measurement device (2) according to claim 1, the structure (4) including:

a passageway (10, 12) that extends through the structure (4) to the one or more sensors (8) for housing sensor wires (26) for carrying power or control signals to the sensors (8) and data from the sensors (8).

15. The ITE physiological measurement device (2) according to claim 1, the structure (4) including:

a passageway (16) that extends through the structure (4) for equalizing ear pressure within the ear canal with ambient air pressure.

16. The ITE physiological measurement device (2) according to claim 1, further including a sheath (9) that protects the structure (4), the balloon 6, the one or more sensors (8), and the ear canal from cross contamination.

17. The ITE physiological measurement device (2) according to claim 1, further including a battery (21) that powers one or more components (2, 18).

18. The ITE physiological measurement device (2) according to claim 1, wherein the ITE physiological measurement device (2) is operatively connected to the BTE device (18) by means of a semi-rigid connector tube that is formed to fit over and/or around the ear to prevent over insertion and to hold in position the ITE device (2) with optimised orientation and positioning.

19. A method for measuring physiological signals within the ear canal, comprising:

inserting an in-the-ear structure (4) into an ear canal to a desired depth;

inflating an inflatable balloon (6) operatively connected to an end portion of the in-the-ear structure (4) to position one or more sensors (8) proximate to vascular tissue of the ear canal; and

using the one or more sensors (8) to sense physiological signals from the surrounding tissue and bone structure.

20. The method according to claim 19, further including measuring blood pressure through the following:

inflating the inflatable balloon (6) to occlude blood flow in the ear tissue proximate to the inflatable balloon (6); and

obtaining a systolic and a diastolic blood pressure while inflating and/or deflating the inflatable balloon (6).

21. The method according to claim 19, further including measuring blood pressure through one or more of an auscultatory approach and an oscillometric approach.

22. The method according to claim 19, further including continuously measuring blood pressure through the following:

obtaining at least one of an initial systolic and diastolic blood pressure measure reading;

determining a mean blood pressure measurement from the reading;

inflating the balloon (6) within the ear canal to the mean blood pressure;

periodically adjusting balloon pressure; and

capturing a maximum pulse waveform amplitude indicative of the mean blood pressure.

23. The method according to claim 22, further including deriving at least one of a systolic and a diastolic blood pressure from at least one of the mean blood pressure and one or more pulse waveform amplitudes.

24. A physiological measurement device (2) for measuring physiological signals from within the ear canal, comprising:

a first structure (4) formed for easy insertion into multiple shaped and sized ear canals;

a second structure (18) that supports the first structure (4) to facilitate maintaining the position of the first structure (4) within the ear canal;

an inflatable balloon (6) disposed around a portion of the first structure to be positioned in the ear, the inflatable balloon (6) expands radially with inflation;

a radially expanding tip (22) connect with the first structure (4) and extending at least partially around the inflatable balloon (6) such that inflation of the balloon (6) radially expands the tip (22); and

a sensor (8) carried by the tip (22) to the pressed into sensing interaction within an ear canal.

25. The physiological measurement device (2) according to claim 24, the sensor (8) senses one or more of blood pressure, continuous blood pressure, pulse, blood oxygen level, perfusion, body temperature, and respiration.

26. The physiological measurement device (2) according to claim 24, wherein the one or more sensors (8) include one or more of the following: a light emitting diode, an IR source, a light detector, a thermistor, a pressure transducer, and a microphone.

27. The physiological measurement device (2) according to claim 24, wherein the physiological measurement device (2) is operatively connected to the secondary device (18) by a semi-rigid connector tube that is formed to fit over and/or around the ear to prevent over insertion and to hold the physiological measurement device (2) in position with optimised orientation and positioning.

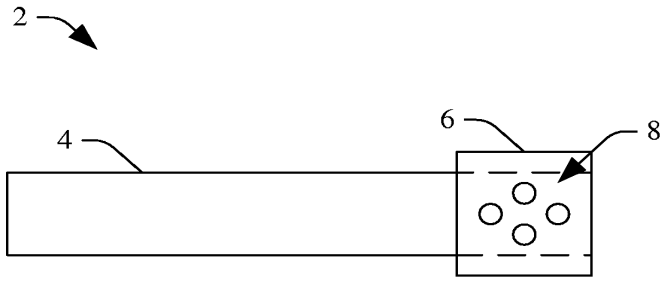

FIGURE 1

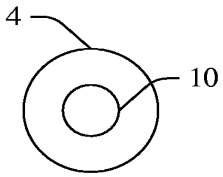

FIGURE 2

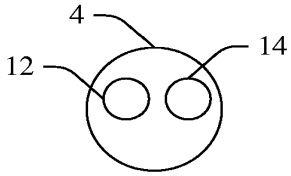

FIGURE 3

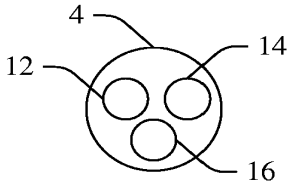

FIGURE 4

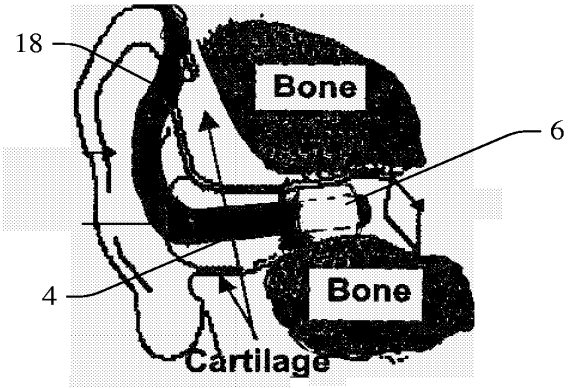

FIGURE 5

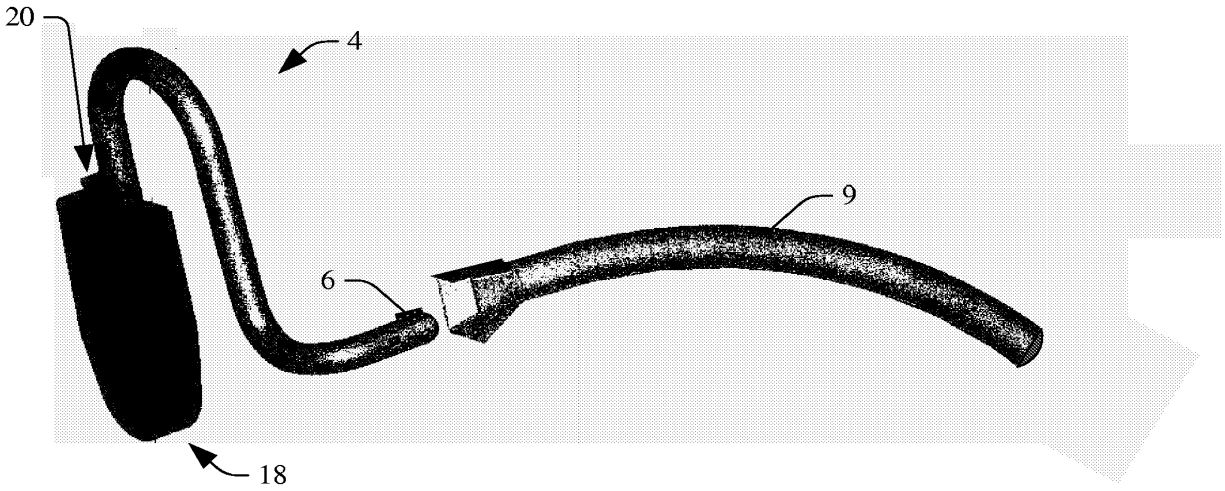

FIGURE 6

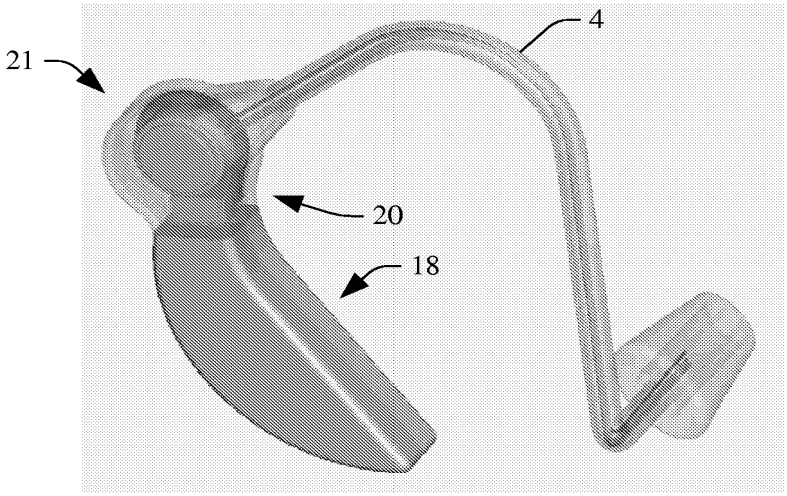

FIGURE 7

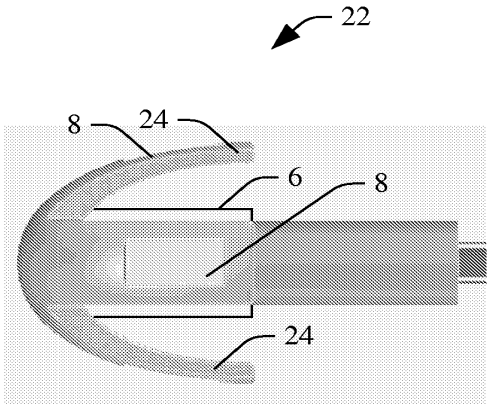

FIGURE 8

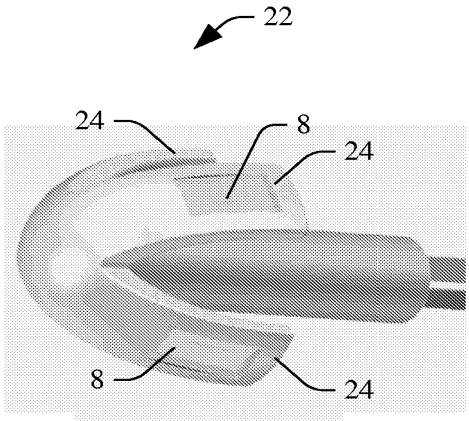

FIGURE 9

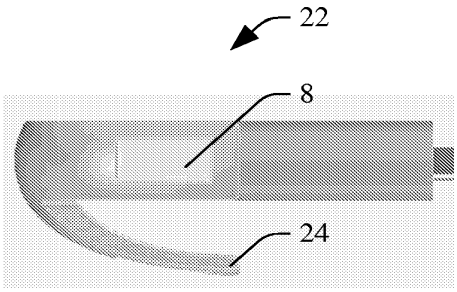

FIGURE 10

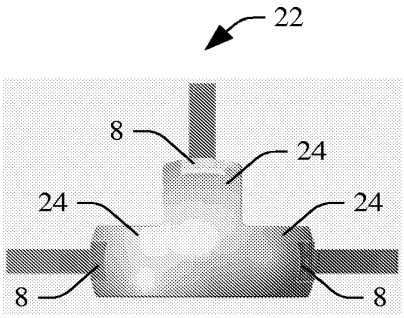

FIGURE 11

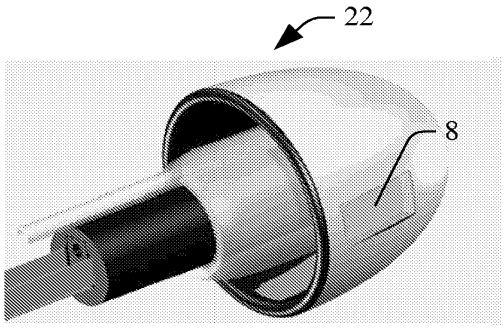

FIGURE 12

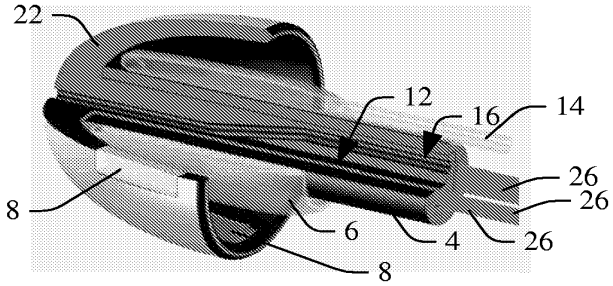

FIGURE 13

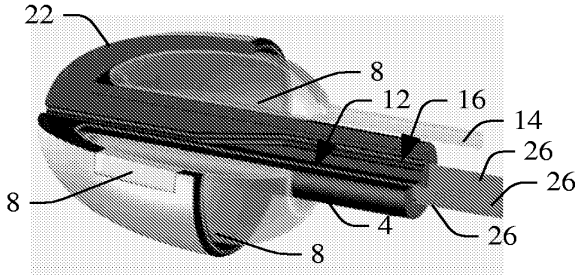

FIGURE 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/051892

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/034742 A (NIPPON TELEGRAPH & TELEPHONE [JP]; UENISHI YUJI [JP]; HIGURASHI EIJI [) 21 April 2005 (2005-04-21) paragraph [0082] - paragraph [0089]; figure 18 paragraph [0587]	1-9, 11-23
E	-& EP 1 671 578 A (NIPPON TELEGRAPH & TELEPHONE [JP]) 21 June 2006 (2006-06-21) paragraph [0082] - paragraph [0089]; figure 18 paragraph [0587]	1-9, 11-23
X	US 5 743 261 A (MAINIERO LOUIS M [US] ET AL) 28 April 1998 (1998-04-28) column 8, line 18 - line 25 column 9, line 46 - column 10, line 14	1-9, 11-14, 16-23

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 October 2006	31/10/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Trachterna, Morten

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/051892

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 601 294 A (DANBY HAL C [US] ET AL) 22 July 1986 (1986-07-22) column 5, line 58 - column 6, line 34; figure 4	1-8, 10-19, 24-27
Y	US 2004/258263 A1 (SAXTON GARY M [US] ET AL) 23 December 2004 (2004-12-23) paragraph [0093]	1-8, 10-19, 24-27
X	US 6 454 718 B1 (CLIFT VAUGHAN L [US]) 24 September 2002 (2002-09-24) column 3, line 15 - line 27 column 4, line 60 - column 5, line 55	1-4,7-9, 11-23
X	US 5 853 005 A (SCANLON MICHAEL V [US]) 29 December 1998 (1998-12-29) column 21, line 21 - line 48; figures 33-35	1-7, 9-12, 16-19

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2006/051892

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2005034742 A	21-04-2005	EP 1671578 A1	21-06-2006
EP 1671578 A	21-06-2006	WO 2005034742 A1	21-04-2005
US 5743261 A	28-04-1998	US 5417207 A	23-05-1995
US 4601294 A	22-07-1986	AU 1072383 A	04-08-1983
		CA 1213351 A1	28-10-1986
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US 5853005 A	29-12-1998	AU 2924797 A	19-11-1997
		CA 2253591 A1	06-11-1997
		EP 0925023 A1	30-06-1999
		WO 9740748 A1	06-11-1997

Form PCT/ISA/210 (patent family annex) (April 2005)

Doc Code: PET.AUTO Document Description: Petition automatically granted by EFS-Web	PTO/SB/140 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**PETITION TO WITHDRAW AN APPLICATION FROM ISSUE AFTER PAYMENT OF THE ISSUE FEE UNDER 37 CFR 1.313(c)**
Application Number	16544713
Filing Date	19-Aug-2019
First Named Inventor	Jeroen Poeze
Art Unit	3791
Examiner Name	CHU CHUAN LIU
Attorney Docket Number	MASCER.002C13
Title	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

An application may be withdrawn from issue for further action upon petition by the applicant. To request that the Office withdraw an application from issue, applicant must file a petition under this section including the fee set forth in § 1.17(h) and a showing of good and sufficient reasons why withdrawal of the application from issue is necessary.

APPLICANT HEREBY PETITIONS TO WITHDRAW THIS APPLICATION FROM ISSUE UNDER 37 CFR 1.313(c).

A grantable petition requires the following items:
(1) Petition fee; and
(2) One of the following reasons:
(a) Unpatentability of one or more claims, which must be accompanied by an unequivocal statement that one or more claims are unpatentable, an amendment to such claim or claims, and an explanation as to how the amendment causes such claim or claims to be patentable;
(b) Consideration of a request for continued examination in compliance with § 1.114 (for a utility or plant application only); or
(c) Express abandonment of the application. Such express abandonment may be in favor of a continuing application, but not a CPA under 37 CFR 1.53(d).

Petition Fee

- ○ Small Entity
- ○ Micro Entity
- ◉ Regular Undiscounted

Reason for withdrawal from issue

◯ One or more claims are unpatentable ◉ Consideration of a request for continued examination (RCE) (List of Required Documents and Fees) ◯ Applicant hereby expressly abandons the instant application (any attorney/agent signing for this reason must have power of attorney pursuant to 37 CFR 1.32(b)).
RCE request,submission, and fee. ☐ I certify, in accordance with 37 CFR 1.4(d)(4) that : The RCE request ,submission, and fee have already been filed in the above-identified application on ☒ Are attached.
THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES I certify, in accordance with 37 CFR 1.4(d)(4) that I am: ◉ An attorney or agent registered to practice before the Patent and Trademark Office who has been given power of attorney in this application. ◯ An attorney or agent registered to practice before the Patent and Trademark Office, acting in a representative capacity. ◯ A sole inventor ◯ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application ◯ A joint inventor; all of whom are signing this e-petition

Signature	/Scott Cromar/
Name	Scott Cromar
Registration Number	65066

Electronic Patent Application Fee Transmittal

Application Number:	16544713
Filing Date:	19-Aug-2019
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Filer:	Scott Cromar/Kealani Aguon
Attorney Docket Number:	MASCER.002C13

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
PETITION FEE- 37 CFR 1.17(H) (GROUP III)	1464	1	140	140
RCE- 1ST REQUEST	1801	1	1300	1300
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1440**

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Decision Date : December 11, 2019

In re Application of :

Jeroen Poeze

DECISION ON PETITION
UNDER CFR 1.313(c)(2)

Application No : 16544713

Filed : 19-Aug-2019

Attorney Docket No : MASCER.002C13

This is an electronic decision on the petition under 37 CFR 1.313(c)(2), filed December 11, 2019 to withdraw the above-identified application from issue after payment of the issue fee.

The petition is **GRANTED.**

The above-identified application is withdrawn from issue for consideration of a submission under 37 CFR 1.114 (request for continued examination). See 37 CFR 1.313(c)(2).

Petitioner is advised that the issue fee paid in this application cannot be refunded. If, however, this application is again allowed, petitioner may request that it be applied towards the issue fee required by the new Notice of Allowance.

Telephone inquiries concerning this decision should be directed to the Patent Electronic Business Center (EBC) at 866-217-9197.

This application file is being referred to Technology Center AU 3791 for processing of the request for continuing examination under 37 CFR 1.114 .

Office of Petitions

Electronic Acknowledgement Receipt	
EFS ID:	37997586
Application Number:	16544713
International Application Number:	
Confirmation Number:	9381
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Customer Number:	64735
Filer:	Scott Cromar/Kealani Aguon
Filer Authorized By:	Scott Cromar
Attorney Docket Number:	MASCER.002C13
Receipt Date:	11-DEC-2019
Filing Date:	19-AUG-2019
Time Stamp:	15:17:38
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1440
RAM confirmation Number	E2019BAF17342634
Deposit Account	111410
Authorized User	Kealani Aguon
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Continued Examination (RCE)	RCE_002C13.PDF	1349947 af554a9631dbe08a14375b1b7d6bd36b18a40fe1	no	3
Warnings:					
Information:					
2		IDS_002C13.PDF	215916 5831674c855eb0bf137e095aa1c938b76d07bccb	yes	3
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Information Disclosure Statement (IDS) Form (SB08)		3	3	
	Transmittal Letter		1	2	
Warnings:					
Information:					
3	Foreign Reference	JP2005160641A_MT.PDF	822792 c371a253442013a45b30ca620d079553b98cdda4	no	28
Warnings:					
Information:					
4	Foreign Reference	JP3741147B2_MT.pdf	7027908 113ae2bddcaa91d11e3f02c65eb53f922b88422d	no	12
Warnings:					
Information:					
5	Foreign Reference	JP3803351B2_MT.PDF	6523907 e853cf77bbdba6c6bf0c5a0efedd0995b89beeb6	no	51
Warnings:					
Information:					

6	Foreign Reference	JP2007319232A_MT.pdf	19014760 29052c7801cb4f0352daece3580e464d2a330b05	no	31
Warnings:					
Information:					
7	Foreign Reference	WO2007004083A1.PDF	1421871 38649d13898d9c6edff7f90a83cb9421bb421ed8	no	20
Warnings:					
Information:					
8	Non Patent Literature	Zheng_A_Ring-type_Device_for_the_Noninvasive_Measurement.pdf	2901968 2985753512a8f24c1f1e1967bdeeae12547ac666	no	4
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Information:					
9	Petition automatically granted by EFS	petition-request.pdf	31456 9c93b03d899d16ba9d9d081b01566a7582b61eee	no	2
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Warnings:					
Information:					
		Total Files Size (in bytes):	39342844		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	3791
(Multiple sheets used when necessary)	Examiner	Liu, Chu Chuan
SHEET 1 OF 4	Attorney Docket No.	MASCER.002C13

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Examiner Signature	Date Considered

***Examiner:** Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

T[1] - Place a check mark in this area when an English language Translation is attached.

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	3791
(Multiple sheets used when necessary)	Examiner	Liu, Chu Chuan
SHEET 2 OF 4	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
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Examiner Signature	Date Considered
***Examiner:** Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	3791
(Multiple sheets used when necessary)	Examiner	Liu, Chu Chuan
SHEET 3 OF 4	Attorney Docket No.	MASCER.002C13

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
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Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
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Examiner Signature	Date Considered
***Examiner:** Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

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PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	3791
(Multiple sheets used when necessary)	Examiner	Liu, Chu Chuan
SHEET 4 OF 4	Attorney Docket No.	MASCER.002C13

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
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Examiner Signature	Date Considered
***Examiner:** Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

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INFORMATION DISCLOSURE STATEMENT

First Inventor	:	Jeroen Poeze
App. No.	:	16/544713
Filed	:	August 19, 2019
For	:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
Examiner	:	Liu, Chu Chuan
Art Unit	:	3791
Conf. No.	:	9381

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

References and Listing

Pursuant to 37 CFR 1.56, an Information Disclosure Statement listing references is provided herewith. Copies of any listed foreign and non-patent literature references are being submitted.

For certain cited non-English patent and/or non-patent references, machine translations of the references (and/or Abstracts) are included, and inclusion is indicated in the last column. Applicant makes no representation as to the accuracy of the English machine translations. If the Examiner would like additional information regarding these references or if anything is unclear, the Examiner is invited to request such information, and Applicant will attempt to comply with any such request.

Pursuant to 37 CFR 1.97(g) and (h), Applicant makes no representation that the information is considered to be material to patentability. Additionally, inclusion on this list is not an admission that any of the cited documents are prior art in this application. Further, Applicant makes no representation regarding the completeness of this list, or that better art does not exist.

No Disclaimers

To the extent that anything in the Information Disclosure Statement or the listed references could be construed as a disclaimer of any subject matter supported by the present application, Applicant hereby rescinds and retracts such disclaimer.

Timing of Disclosure

This Information Disclosure Statement is being filed with an RCE or before receipt of a First Office Action after an RCE, and no fee is believed to be required.

The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment, to Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: December 12, 2019

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Scott A. Cromar
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31848888

Electronic Acknowledgement Receipt

EFS ID:	38006899
Application Number:	16544713
International Application Number:	
Confirmation Number:	9381
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Customer Number:	64735
Filer:	Scott Cromar/Frances Tsai
Filer Authorized By:	Scott Cromar
Attorney Docket Number:	MASCER.002C13
Receipt Date:	12-DEC-2019
Filing Date:	19-AUG-2019
Time Stamp:	12:26:37
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	CN1270793A_MT.pdf	14781659 615bdabb5acf42a041d1928d3bd6ea01bb230e4b	no	34

Warnings:

Information:					
2	Foreign Reference	EP0922432A1.pdf	2468884 d73566523d5cf50171b1e31f535267a8b6bf65a9	no	58
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Warnings:					
Information:					
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	Multipart Description/PDF files in .zip description		
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	Transmittal Letter	1	2
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Espacenet

Bibliographic data: CN1270793 (A) — 2000-10-25

Wound-less continuous blood pressure measuring method and device

Inventor(s): LU WEIMING [CN] ± (WEIMING LU, ; 陆渭明)

Applicant(s): LU WEIMING [CN] ± (LU WEIMING, ; 陆渭明)

Classification: **- international:** ***A61B5/022; A61B5/0225;*** (IPC1-7): A61B5/022
- cooperative:

Application number: CN19991005671 19990421

Priority number(s): CN19991005671 19990421

Also published as: CN1163191 (C)

Abstract of CN1270793 (A)

A non-trauma continuous measuring blood-pressure method is as follows: the volume pulse wave is first detected and a pressurizing device is controlled to pressurize tested artery externally to make the average volume reach no-load state. In the subsequent closed-loop operation state, the volume pulse wave is amplified, and it is used to control the pressure of the pressurizing device. When the volume of the tested artery is limited to the volume of no-load state, a pressure sensor is used to measure the pressure of pressurizing bag repressenting the artery blood pressure continuously. The present invention features that the volume detection is for the artery and the external pressurized position is on the proper part of wrist, and only one wrist radial artery and one of ulnar arteries aredetected and pressurized.

Notice

CLAIMS CN1270793

1、
A non-invasive continuous blood pressure measurement method, which uses a blood vessel volume detection device to detect the volume pulse of the measured artery, and first controls a pressure device to perform external pressure on the measured artery in an open-loop working state, so that Measure the average volume of arterial blood to an unloaded state without any circumferential tension, and then enter a closed-loop working state. Connect a servo amplifier circuit to amplify the volume pulse and use it to further control the pressure of the pressure device. When the amplitude of the volume pulse of the measured artery tends to zero and its volume is completely embedded in its unloaded state, a pressure sensor is used to continuously measure the pressure value of the pressurized capsule to continuously represent the inside of the measured artery. The blood pressure value is characterized in that the volume measurement of the arterial blood vessels and the external pressure are located on the appropriate part of the wrist, and only one artery of the wrist arteries and ulnar arteries is detected and compressed: the operation process of this method is as follows:

A. The fixing device is used to press the above-mentioned pressurizing device against the skin surface of the measurement artery of the wrist, and the fixing device determines that the position of the blood vessel volume detection device relative to the measured artery remains unchanged;

B. Turn on feedback-control the system to the working state, so as to enter the closed loop control of the above open loop.

2、
A non-invasive method for continuous blood pressure measurement according to claim 1, characterized in that

the compression center of the arterial compression device should be aligned with the superficial flexor artery or ulnar artery at the wrist.

3、
The non-invasive continuous blood pressure measurement method according to claim 1, characterized in that the diameter of the compression area to compress the arteries to be measured should be 1 / 2-1 / 3 of the diameter of the wrist to be measured to ensure that The pressure can be fully transmitted to the depth of the measured artery, while avoiding compressing to another artery and causing the volume of the capsule to be too large, so that the pressure in the capsule cannot be quickly controlled.

4、
A non-invasive continuous blood pressure measurement method according to claim 1, characterized in that said arterial compression device should be fixed on said wrist position by a fixing device having a certain hardness and a certain elasticity.

5、
The non-invasive continuous blood pressure measurement method according to claim 4, characterized in that the effective contact area of the fixation device and the wrist should be more than three times the compression area of the compression device.

6、
The non-invasive continuous blood pressure measurement method according to claim 1, characterized in that the center of the detection range of the blood vessel volume detection device is also unsuccessfully aligned with the most superficial surface that is compressed by the back pressure device. Arteries.

7、
A non-invasive continuous blood pressure measurement method according to claim 1, characterized in that the angle of the palm relative to the wrist and the angle of the wrist closer to the elbow joint relative to the forearm should be fixed.

8、
A non-invasive continuous blood pressure measurement method according to claim 1, characterized in that the volume detection and external compression of the arterial blood vessels can be performed alternately on the two arteries of the arterial artery and the ulnar artery.

9.

An apparatus based on the method for continuously measuring blood pressure according to claim 1, comprising a device for volume measurement and external compression of the measured artery, and a measurement-feedback control system, characterized in that The device for measuring the volume of the measured artery is a photoelectric probe for volume detection of the arteries of the wrist and the ulnar artery, and the device for externally pressing the measured artery is the wrist of the opponent. The same artery detected by the above-mentioned photoelectric volume probe is a locally pressurized capsule with external compression.

The photoelectric volume probe and the pressurized capsule are arranged on a fixed device.

10.

The non-invasive continuous blood pressure measuring device according to claim 9, characterized in that the compression capsule is flat and its diameter can be selected from 1/2 to 1/3 of the wrist diameter, and the compression capsule The inner wall of the body facing the wrist is made of a thin, soft, translucent material with a certain elasticity, and has a shape that projects inward. The wall of the capsule and a wall around the circumference are made of Made of a certain hardness material.

11.

The non-invasive continuous blood pressure measuring device according to claim 9, characterized in that the fixing device of the pressurized capsule body is a fixing strap with a certain hardness and a certain elasticity. Fixation shall use non-stretchable devices.

12.

The non-invasive continuous blood pressure measuring device according to claim 9 or 11, characterized in that the width of the strap should be greater than 50 mm for an average adult, and the surface facing the wrist should have a concave-convex shape that fits the wrist. .

13.

The non-invasive continuous blood pressure measuring device according to claim 9 or 11, characterized in that the pressurized bladder can be integrated with a strap, that is, on the side of the strap facing the wrist, corresponding to A flat recess having the same diameter as the diameter of the capsule is processed at the position of the pressurized capsule, and the edge of the inner wall of the capsule body made of the translucent material is sealed with the edge of the recess of the strap.

14.

The non-invasive continuous blood pressure measurement device according to claim 9, wherein the photoelectric volume probe is a reflective photoelectric sensor composed of a light emitting device and a photoelectric device, and the light emitting device and the photoelectric device The inner surface of the inner wall of the pressurized capsule body is fixed along the length direction of the bag fixing strap at an interval of 5-10 mm, and the midpoint of the line connecting the two devices is aligned with the center of the inner sidewall.

15.

The non-invasive continuous blood pressure measuring device according to claim 9, wherein the fixing device further comprises a wrist fixing bracket.

The wrist fixed support is a support plate made of a hard material with a certain strength. Its length and width should ensure that it covers the entire back of the hand from the base of the finger to the elbow joint, the back of the wrist, and the back half of the forearm. Its shape should ensure that its inner side matches the shape of the back of the hand, the back of the wrist, and the back of the forearm.

16.

The non-invasive continuous blood pressure measuring device according to claim 9 or 15, characterized in that several small straps are fixed on the wrist fixing bracket, and a layer of soft material is adhered to the inner side of the fixing bracket. pad.

17.

The non-invasive continuous blood pressure measuring device according to claim 9 or 15, characterized in that the wrist fixing bracket can be formed by using multiple brackets, and the brackets are connected to each other by an adjustable connection mechanism. .

18.

The non-invasive continuous blood pressure measurement device according to claim 9, wherein the measurement-feedback control system is a measurement-feedback control system that continuously measures blood pressure based on the vascular no-load method.

19.

The non-invasive continuous blood pressure measuring device according to claim 9 or 14, characterized in that the pressurized capsules embedded in the photoelectric volume probe can be respectively fixed on the flexural artery and the ulnar artery of the wrist respectively. One and use a switching device to make them alternately perform volume detection and external compression on the arterioles and ulnar arteries.

20.

A non-invasive continuous blood pressure measurement device according to claim 9, characterized in that the measurement-feedback control system or a part thereof is integrated with the fixing device of the compression capsule.

Notice

DESCRIPTION CN1270793

Method and device for non-invasive continuous blood pressure measurement

The invention relates to a method and a device for detecting blood pressure or blood flow, in particular to a method and a device for continuously and non-invasively measuring the arterial blood pressure of a human body based on the principle of the vascular no-load method.

In order to continuously measure the arterial blood pressure of the human body at all times, in order to continuously monitor and track the instantaneous changes of human blood pressure, for many years, it has been traditionally used clinically to insert a catheter into a superficial arterial blood vessel (mostly the flexor artery of the wrist). A method of directing arterial blood into a pressure sensor for direct pressure measurement. Because this traditional method is traumatic, there are always complicated operations and pain to patients (so this method of pressure measurement can only be performed under anesthesia), especially after use, it is easy to cause bleeding, infection, thrombosis, Complications such as embolism and nerve damage or sequelae.

For this reason, in recent years, a variety of non-invasive continuous blood pressure measurement methods have been studied, the most notable of which is the so-called "vascular no-load method" (or "volume embedding method", "volume compensation method") Methods. Based on this method, several blood pressure measurement devices have been developed abroad (Cs133205, 1969; US4510940; US4524777, 1985; US4869261, 1989, etc.), some of which have also been commercialized (such as Finapres TM2300, Ohmeda). When using this method to continuously measure blood pressure without trauma, a photoelectric probe is generally used to detect the volume pulse of the measured artery (that is, the change in the arterial volume caused by the arterial wall following the blood pressure wave pulse), and at the same time control a fixed Measure the pressure in the airbag (or water sac) on the surface of the skin above the artery, so that the blood vessel wall of the artery under test is not only affected by the original blood pressure wave on the inside, but also by the external pressure on the

outside, which makes the measured The arterial volume pulse changes. When this feedback control makes the volume pulse of the measured artery change to a certain characteristic (for example, its amplitude or the amplitude of the small vibration wave artificially superimposed on the volume pulse reaches the maximum, or the descending section of its curve shows a downward depression When its baseline height (average value) drops to 1/3 of the baseline height when the artery begins to empty, etc.), it means that the vessel wall of the measured artery is at its softest, that is, without any circumferential direction. Pulsing in the so-called "unloaded state" of tension. At this time, a servo amplifier circuit is connected to amplify the volumetric pulse wave and use it to further control the pressure of the balloon (or water balloon), so that the pressure applied to the outside of the vessel wall of the measured artery is not only in the shape of the waveform, but also in The size of the waveform is exactly the same as the blood pressure wave in the artery, that is, when the forces on the inner and outer sides of the blood vessel wall of the measured artery reach dynamic equilibrium, the blood vessel wall of the measured artery will no longer pulsate with the blood pressure wave in the blood vessel. Its vascular volume will be embedded in its volume when unloaded. At this time, as long as the pressure value of the airbag (water bladder) is continuously measured with a pressure sensor, continuous blood pressure measurement can be achieved.

Because this method is easy to operate, does not require calibration, and the measurement results are not easily affected by the patient's body motion interference, it is relatively a non-invasive continuous blood pressure measurement method suitable for clinical applications. However, this method also has the following problems: ① This method is generally used on fingers to measure finger arterial pressure. This is mainly because it is convenient to realize photoelectric blood vessel volume wave detection on the finger, and it is also convenient to fix, and at the same time, it has less impact on limb compression. However, the finger arteries are peripheral small arteries that have high resistance to blood flow, so the blood pressure in the finger area is compared with the so-called "systemic blood pressure" (that is, the blood pressure of the large arteries close to the heart) that is generally used to determine whether the patient's blood pressure is normal. Under normal circumstances, it should be about 10mmHg lower. If arteriosclerosis occurs, the difference can reach tens of mmHg. What's more important is that the smooth muscle components in the walls of small arteries are larger than those in the walls of large arteries, and these vascular smooth muscle components are easily affected by various factors (such as cold, anesthesia, etc.) to cause contraction or relaxation, resulting in small arteries. The blood pressure varies so much that the blood pressure measured with finger arteries on many occasions cannot be used to reflect the patient's general blood pressure. Especially when the patient's circulatory function is poor, the arteries of the fingers sometimes have extreme contraction of the vascular smooth muscles, causing blood loss in the arteries, so that blood pressure cannot be measured on the fingers. ② When this method is used to compress the finger arteries, a round tube-shaped balloon (water sac) is generally used to press the entire middle or base of the finger. During continuous blood pressure measurement, the pressure in the balloon (water sac) is always maintained between the systolic and diastolic blood pressure of the finger artery, although this pressure will only cause a certain decrease in blood flow to the arteries in the compressed part. It will not cause the blood flow to be blocked, but it will completely block the blood flow of all the venous and capillary blood vessels in the compressed part, causing congestion of the finger downstream of the measured part, so it is not suitable for continuous use for a long time. In response to the above problem ①, there have been attempts to apply this vascular no-load principle to the upper arm to measure the blood pressure of the brachial artery. The results show that although this can measure

the systemic blood pressure close to the aorta, because the position of the brachial artery in the upper arm is very deep, to fully compress the brachial artery, the upper arm must be pressurized at or near the entire circumference. In a short period of time, the blood circulation of the entire forearm and hand downstream will be seriously affected; in addition, in response to the above problem ②, some people have also used this vascular no-load principle to measure the temporality of the head An attempt at arterial blood pressure. The basic starting point is that the head has a rich network of arteries and veins. If a small airbag (water sac) is used to compress the temporal artery only, continuous blood pressure measurement will not affect the blood circulation in the head. However, in practice, it is difficult to fix the airbag at the temporal artery, especially the fixed bandage will compress the occipital artery and occipital vein at the back of the head. Long-term continuous use will also cause headache, dizziness and other symptoms. Moreover, the temporal arteries are also peripheral arterioles, and the blood pressure measured on the temporal arteries cannot be used to reflect the systemic blood pressure of the patient.

An object of the present invention is to provide a method and a device for continuously and non-invasively measuring blood pressure, which can accurately measure the whole-body blood pressure of a human body, and has substantially no influence on the blood circulation downstream of the measured part.

In order to achieve the above object, the solution adopted by the present invention is to change the measurement site of the existing vascular no-load method, that is, the site for volume detection and external compression of arterial blood vessels to an appropriate part of the wrist, and use a local The compression device only compresses one of the two arteries of the wrist (the flexor artery and the ulnar artery).

The present invention is based on: ① Although the diameter of the flexor artery or ulnar artery is slightly smaller than the diameter of the brachial artery at the upper arm, it is much larger than the small arteries such as the finger artery and the temporal artery, and the smooth muscle component in the vessel wall of the flexure artery or ulnar artery is small. Because of the finger arteries and temporal arteries, the blood pressure of the flexor arteries or ulnar arteries is closer to the body's blood pressure than the finger arteries and temporal arteries, which are much less affected by various factors. And even when the patient's circulatory function is poor, the blood vessel volume wave can always be measured on the flexor artery or ulnar artery without the situation that blood pressure measurement cannot be performed. In particular, due to the aforementioned characteristics of the wrist arteries and ease of operation on the wrist, invasive direct pressure measurement of the flexor arteries on the wrist has been used as the most commonly used blood pressure measurement method in surgery and critical care in countries around the world for many years. As for the blood pressure value of the wrist artery, it has always been used by clinical medical personnel as the most reliable and accurate criterion for the whole-body blood pressure of the human body. Therefore, continuous measurement of blood pressure using the blood vessel no-load method without trauma at the wrist has a high clinical value. ② In normal people, there are more than two arteries and veins on the wrist. Two of them (the arterioles and ulnar arteries) are connected to each other through two arterial arches inside the palm. Several veins are also on the back of the hand. Connected through

the dorsal vein network. The interconnectedness of these blood vessels ensures that even if one artery or / and part of the veins of the wrist are blocked for a long time, the blood of the hand is still flowing when the other artery and most of the veins can still flow. The circulation is also largely unaffected. Therefore, long-term non-invasive continuous blood pressure measurement can be achieved by using the vascular no-load method on one of the arteries of the wrist torsion and the ulnar artery. In fact, because the radial and ulnar arteries are superficial when passing through the wrist, and they are far apart, the distribution of several veins in the wrist is also scattered. It is necessary to fully compress only one artery in the wrist. At the same time, it can ensure the smooth flow of blood in another artery and most other veins. In addition, if such a non-invasive continuous blood pressure measurement is performed on the wrist, it is obvious that there are also advantages such as convenient operation and easy fixing of the pressure device.

Drawing description:

FIG. 1 is a general block diagram of an embodiment of the present invention.

FIG. 2 is a schematic diagram of a wrist device in the embodiment shown in FIG. 1.

Fig. 3 is a cross-sectional view of the wrist device of Fig. 2 taken in the direction perpendicular to the wrist through the center of an externally pressurized airbag in the wrist device.

Fig. 4 is a working principle diagram of the third embodiment of the present invention.

FIG. 5 is a schematic structural diagram of a fourth embodiment of the present invention

The present invention will be further described in detail by the following examples.

FIG. 1 is a general block diagram of an embodiment of the present invention. It shows that this embodiment includes two parts, of which the first part is a wrist device 1, which is mainly a device for volume detection and external compression of the wrist arteries; the second part is a measurement-feedback control system 2. In order to highlight how the present invention achieves continuous blood pressure measurement using the vascular no-load method without trauma on the wrist, the second part of the measurement-feedback control system 2 in this embodiment directly uses the measurement in the existing early product Finapres TM 2300. -Feedback control system.

First, the first part of the embodiment-the wrist device 1 will be described. As shown in FIG. 2 and FIG. 3, in this embodiment, volume measurement and external pressure are performed on the flexural artery 11 and the ulnar artery 12 of the wrist, so as to realize continuous blood pressure measurement of the flexural artery. This wrist device 1 includes four parts: a flexor artery compression balloon 3, a balloon fixation band 4, a flexure volume probe 5 and a wrist fixation support 6.

The arterial compression balloon 3 is a flat, circular balloon. In order to ensure that the pressure of this airbag can be fully transmitted to the depth of the radial artery 11, on the one hand, the position of the airbag should be fixed so that its center can be aligned with the superficial radial artery of the wrist; on the other hand, The diameter of this balloon should be sufficiently large, but too large pressure on the other ulnar artery 12 and other venous vessels simultaneously will increase the volume of the balloon, making it difficult to quickly control the pressure in the balloon, so this diameter can be selected as Half the diameter of the wrist (for example, 30-40mm for the average adult). In addition, in order to ensure that this airbag 3 does not generate circumferential tension in its wall due to inflation and affect the effective compression of the flexural artery, the inner wall (wrist) of this airbag 3 is thin, soft, and has A certain elastic translucent material is made to have a shape protruding inward, and the wall of the airbag with one circumference and the wall facing outward are made of a material having a certain hardness.

The airbag fixing strap 4 is used to fix the pressurized airbag 3 at the above-mentioned wrist position. In fact, in order to simplify the structure, the present embodiment integrates the airbag 3 and the strap 4, that is, a diameter with a certain thickness and hardness is used, and a diameter is processed on the surface of the wrist facing the position corresponding to the airbag. A flat round pit having the same diameter as the airbag 3, and then the edge of the above-mentioned airbag inner wall 7 made of the film is bonded to the edge of the recess of the strap 4 so that the airbag inner wall 7 made of the film and the The cavity with a certain rigidity on the strap 4 constitutes the airbag 3 described above. When the blood pressure is continuously measured by the non-invasive method of blood pressure, the internal pressure of the balloon 3 will be pulsated according to the blood pressure of the arterial artery 11, in order to ensure that the position of the balloon does not occur in any direction under the action of this large pulsed internal pressure. The self-excited oscillation of the feedback control system is caused by the beating of the belt. The strap 4 as a whole should have a certain degree of rigidity, and its two ends should be fixed with non-scalable devices. In this embodiment, both ends of this strap 4 are fixed to the wrist fixing bracket 6 by Velcro 8. In addition, the material of this strap 4 should also have a certain elasticity, so that when the wrist is slightly thinned after being continuously pressed for a long time, its resilience can also enable it to fasten the airbag on the wrist without happening Loose. On the other hand, in order to ensure that the measured arterial artery is fully compressed by the airbag 3 only, the pressure of the bandage 4 on the other part of the wrist is reduced as much as possible, so as not to block the other ulnar artery and most of the veins and affect it. For the blood circulation of the downstream hand, the effective contact area of the strap with the wrist should be greater than 3 times the compression area of the airbag 3. For this reason, the width of the strap should be as large as

possible (greater than 50mm for ordinary adults) and the strap should be tied. The skin-facing surface has a concave-convex shape that fits the wrist.

The arterial volume probe 5 is a reflective photoelectric sensor. In order to facilitate the use of the strap 4 to fix the probe to the wrist together with the airbag 3, and not to prevent the airbag from clinging to the wrist watch face, this probe is built into the inside of the airbag. This probe is composed of a light emitting device 9 and a photoelectric device 10. These two devices 9 and 10 are attached to the inner surface of the inner side wall 7 of the airbag 3 made of a translucent film at intervals of 5-10 mm. When pasting, the light-emitting surface of the light-emitting device 9 and the light-receiving surface of the optoelectronic device 10 should face the inner surface of the inner wall 7 of the film, and the line between the two devices 9 and 10 should be perpendicular to the direction of the tortuous artery, that is, Along the length of the strap; at the same time, align the midpoint of the line with the center of the inner wall 7 of the film to ensure that when the center of the airbag 3 is aligned with the superficial flexure 11 of the wrist, the two devices 9 and 10 It can be located on both sides of the radial artery on the skin surface of the wrist, so that the center of the detection range of the volume probe is exactly aligned with the radial artery. When the volume probe 5 is used to detect changes in the blood vessel volume of the arteries 11, the light emitted by the light emitting device 9 therein passes through the inner wall 7 of the airbag 3 made of a translucent film and enters the inside of the wrist. The surrounding soft tissue is reflected into the optoelectronic device 10. The change in the volume of the arterial artery 11 will cause the light intensity reflected to the optoelectronic device 10 to change, so that the output current of the optoelectronic device 10 will change. Thus, the volume probe 5 will convert the volume of the arterial artery with the change of the blood pressure wave into The arterial volume pulse wave signal is output.

The wrist fixing support 6 is used to fix the angle of the palm relative to the wrist and the angle of the wrist close to the elbow joint relative to the forearm, so as to ensure that the subject pressurizes the airbag 3 when any physical movement occurs during the continuous measurement of blood pressure for a long time. The position of the sum volume probe 5 relative to the arterial artery 11 remains unchanged. At the same time, the use of this fixing bracket can also distribute the pressure on the back of the wrist of the strap 4 for fixing the airbag. This wrist fixing bracket 6 is a pallet made of a hard material with a certain strength. Its length and width should ensure that it covers the entire back of the hand from the base of the finger to the elbow joint, the back of the wrist, and the back half of the forearm. Its shape should ensure that its inner side can match the shape of the back of the hand, the back of the wrist, and the back of the forearm (thus, in order to adapt to the forearm of different lengths and thicknesses, several fixed supports need to be made separately). The wrist fixing bracket 6 is fixed with several small straps 15 with velcro stitches at the ends for binding the forearm, wrist and hand of the subject to the wrist fixing bracket 6. In order to avoid the uncomfortable subject caused by the rigid support, a pad 16 of soft material can be glued on the inner side of the support, but this pad should not be too thick and too soft, otherwise it will affect the wrist fixing effect. At the same time, when the internal pressure of the balloon changes greatly with the blood pressure, the wrist beats under the pulsating internal pressure of the balloon, so that the feedback control system generates self-excited oscillation.

The following describes how the above-mentioned wrist device 1 is used in this embodiment to perform continuous blood pressure measurement of the arterial artery without trauma. As shown in FIG. 1, when the above-mentioned wrist device 1 is used to measure the arterial blood pressure, the wrist device must be connected to a measurement-feedback control system 2 for the purpose of controlling vascular no-load. In this embodiment, this measurement-feedback control system 2 uses an early measurement-feedback control system in the Finafres product for continuous and non-invasive measurement of finger blood pressure based on the principle of the vascular no-load method. The method of combining is very simple, that is, the leads of the light-emitting device 9 and the photoelectric device 10 in the arterial volume probe 5 in the wrist device 1 are respectively used with the finger-arterial volume probe in the measurement-feedback control system of Finapres. The output end of the light-emitting device power supply (the output end is omitted in FIG. 1) is connected to the volume signal input end 17 of the photoelectric device, and the airway of the flexor arterial compression balloon 3 in the wrist device 1 is measured with Finapres -A voltage-pressure conversion device in a feedback control system is connected to an air tube 18 that was originally used to supply air to the finger arterial compression balloon.

When the embodiment consisting of the above-mentioned wrist device 1 and the measurement-feedback control system 2 in Finapres is used for non-invasive continuous measurement of the arterial blood pressure, the subject's back, wrist and forearm are first fixed on the wrist In the wrist fixing bracket 6 in the device 1, and then align the center of the airbag 3 in the wrist device with the shallowest part of the wrist arterial artery 11, the airbag fixing strap 4 is wound around the wrist, and The two ends of the fixing strap are fixed together with the wrist fixing bracket 6 by a Velcro 8. After the above fixation and connection are completed, the measurement-reversing control system 2 enters an automatic working state. Among them, at the beginning of continuous blood pressure measurement, in order to find and record the volume of the subject's arterial flexure in the unloaded state, the measurement-feedback control system 2 first connects the operating state switch 19 to the "open loop" position. In this open-loop working state, the volume probe 5 in the wrist device 1 converts the blood vessel volume of the flexor artery with the change in blood pressure wave into the flexure artery volume wave, and at the same time, the airbag pressure setting circuit 20 in the system starts to automatically adjust the supply The voltage of the voltage-to-pressure converter 21 causes the airbag 3 in the wrist device 1 to begin to pressurize the outside of the arterial artery 11. As the external pressure of the arterial artery increases, the amplitude and shape of the arterial volume wave will change. When the amplitude of the arterial volume wave reaches a maximum, it means that the volume of the arterial artery's blood volume with the blood pressure wave has changed up and down in the volume of the unloaded state of the vessel. At this time, the system will cause the airbag pressure setting circuit 20 to stop the pressure adjustment of the airbag 3, and cause an unloaded volume memory circuit 22 to record the mean value (DC component) of the flexural artery volume wave at this time as the subject's flexural artery. No-load state volume V0. After finding and memorizing the unloaded state volume V0 of the subject ' s arterial artery, the measurement-feedback control system 2 automatically connects the working state switch 19 to the "closed loop" position, and gradually increases the gain of the servo amplifier circuit 23, The difference between the volume wave detected by the volume probe 5 and the volume wave near the unloaded state volume and the unloaded volume V0 recorded by the unloaded volume memory circuit 22 is subtracted by a comparison circuit

24 (i.e., the arterial blood vessel volume) The AC component of the wave is amplified, and the voltage-to-pressure converter 21 is driven to control the airbag 3 to further apply the same pressure to the flexural artery 11 from the outside as the internal blood pressure waveform, so that the amplitude of the volume wave generated by the flexural artery with the internal blood pressure wave Began to get smaller. Since the gain of the servo amplifier circuit 23 is adjusted so that the pressure applied by the balloon 3 to the outside of the flexible artery 11 is not only in the shape of the waveform, but also the waveform size is completely the same as the blood pressure waveform inside the flexible artery, that is, the flexible artery blood vessel When the forces on the inner and outer sides of the wall reach dynamic equilibrium, the vessel wall of the flexural artery will no longer pulsate with the blood pressure wave in the vessel, and the volume of the flexural artery will be completely embedded in its unloaded volume V0. Therefore, in the closed-loop working state, as long as the system gradually increases the gain of the servo amplifier circuit 23 and finds the time point when the amplitude of the volume wave of the radial artery 11 eventually reaches zero, it can be sure that the pressure in the airbag 3 starts to increase. At any time, the blood pressure in the arterial artery 11 is equal. At this time, the pressure sensor 25 connected to the pressurized balloon 3 is used to continuously measure the internal pressure of the pressurized balloon 3 to achieve a non-invasive continuous measurement of the arterial blood pressure.

The above list is only one embodiment of the present invention. In fact, the present invention can be implemented and improved in various ways.

For example, selecting one of the two arteries of the wrist for continuous measurement of blood pressure does not necessarily require selection of the flexural artery. As a second embodiment of the present invention, the ulnar artery of the wrist can also be selected as the measured artery, and its measurement method It is the same as Embodiment 1, and is not repeated here.

A third embodiment of the present invention is to place a pressurized balloon with a vascular volume probe in it at a position corresponding to the flexor artery and ulnar artery of the wrist, and a switching device so that they are arranged at intervals Alternate the volume and external compression of the flexural and ulnar arteries. The wrist device is shown in Figure 4. This method is more conducive to continuous blood pressure measurement over a long period of time, because the use of two arteries alternately can avoid the pain and numbness caused by prolonged compression on one place.

A fourth embodiment of the present invention is shown in FIG. 5. In this embodiment, the wrist fixing bracket is formed by using multiple brackets. These pallets are connected to each other by an adjustable connection mechanism (such as a universal joint), so that the wrist fixed pallets assembled by these pallets can be adjusted into various shapes for subjects with different fat, thin, long and short forearms. Share without having to make them separately.

On the other hand, in the above-mentioned embodiment, we have used a measurement-feedback control system in Finapres, a device for continuously measuring blood pressure based on the vascular no-load method that is originally used for fingers, in which the measured arterial volume pulse wave is used Whether the amplitude reaches the maximum is used as a criterion for judging whether the arterial vessel under test is in an unloaded state, and a control air pressure is used to control the external pressure applied to the arterial being tested. In fact, the measurement-feedback control system in the present invention can be other measurement-feedback control systems that continuously measure blood pressure based on the no-load method of blood vessels. For example, it can use other criteria (such as the shape of arterial volume waves) to determine The unloaded state of the measured artery can also be controlled hydraulic pressure to control the external pressure applied to the measured artery.

In the above-mentioned embodiment, the wrist device including the externally pressurized balloon of the measured artery and the volume detecting probe is a separate device. In fact, because the wrist has a large load-bearing capacity, the pressure sensor, voltage-pressure converter, and even the entire control system in the measurement-feedback control system can be integrated with the above-mentioned wrist device, which can greatly increase the pressure. The speed of feedback control can further improve the accuracy of blood pressure measurement, and can reduce the connection and pipeline during use, which is more convenient for clinical application.

[19]中华人民共和国国家知识产权局

[51]Int.Cl[7]
A61B 5/022

[12]发明专利申请公开说明书

[21]申请号 99105671.X

[43]公开日 2000年10月25日

[11]公开号 CN 1270793A

[22]申请日 1999.4.21 [21]申请号 99105671.X

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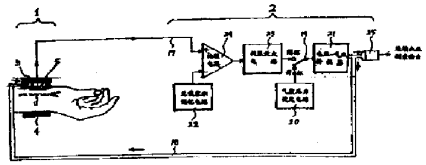
权利要求书4页 说明书9页 附图页数5页

[54]发明名称 无创伤连续测量血压的方法和装置

[57]摘要

一种无创伤连续测量血压的方法，先检测出被测动脉的容积脉波，并控制一个 加压装置对被测动脉进行外部加压，使其平均容积达到无载状态，然后进入闭 环工作状态将这个容积脉波加以放大，并用它去进一步控制加压装置的压力，当这个控制使得被测动脉的容积被嵌定在其无载状态时的容积时，利用压力传 感器连续测出加压囊体的压力值来连续表示被测动脉内血压值，其特征在于对 动脉血管进行容积检测和外部加压的部位位于手腕的适当部位上，并且仅仅检 测和压迫手腕挠动脉和尺动脉之中的一根动脉。



ISSN1008-4274

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权 利 要 求 书

1、一种无创伤连续测量血压的方法，其采用一个血管容积检测装置检测出被测动脉的容积脉波，先在开环工作状态下控制一个加压装置对被测动脉进行外部加压，使得被测动脉血平均容积达到不存在任何周向张力的无载状态，然后进入闭环工作状态接通一个伺服放大电路将这个容积脉波加以放大，并用它去进一步控制加压装置的压力，当这个控制使得被测动脉的容积脉波的振幅趋于零而其容积完全被嵌定在其无载状态时的容积时，利用压力传感器连续测出加压囊体的压力值来连续表示被测动脉内血压值，其特征在于对动脉血管进行容积检测和外部加压的部位位于手腕的适当部位上，并且仅仅检测和压迫手腕挠动脉和尺动脉之中的一根动脉：本方法的操作过程如下：

A、利用一固定装置将上述加压装置压于手腕部测动脉的皮肤表面，由该固定装置确定血管容积检测装置相对于被测动脉的位置保持不变；

B、接通反馈--控制系统至工作状态，使进入上述开环的闭环的控制。

2、根据权利要求 1 所述的一种无创伤连续测量血压的方法，其特征在于所述的动脉加压装置的加压中心应对准手腕部的处于最表浅处的挠动脉或尺动脉。

3、根据权利要求 1 所述的一种无创伤连续测量血压的方法，其特征在于对被测动脉加压的加压面积的直径应为被测手腕直径的 1/2--1/3，以保证其压力能充分地传到被测动脉所在的深度，同时又要避免压迫到另一根动脉和造成囊体容积过大以至于使囊体中的压力不能得到快速控制。

4、根据权利要求 1 所述的一种无创伤连续测量血压的方法，其特征在于所述的动脉加压装置应被用一个具有一定的硬度和一定的弹性的固定装置稳固在上述的手腕位置上。

5、根据权利要求 4 所述的一种无创伤连续测量血压的方法，其特征在于所述的固定装置与手腕的有效接触面积应为加压装置的加压面积的 3 倍以上。

6、根据权利要求 1 所述的一种无创伤连续测量血压的方法，其特征在于

所述的血管容积检测装置的检测范围的中心也方兴未应对准被回压装置所压迫的最表浅表处的动脉。

7、根据权利要求 1 所述的一种无创伤连续测量血压的方法，其特征在于应固定手掌相对于手腕的角度，以及手腕相对于前臂靠近肘关节部分角度。

8、根据权利要求 1 所述的一种无创伤连续测量血压的方法，其特征在于对动脉血管进行的容积检测和外部加压可以在挠动脉和尺动脉两根动脉上交替地进行。

9. 一种基于权利要求 1 所述的无创伤连续测量血压的方法的装置，包括有一个对被测动脉进行容积检测和外部加压的装置，以及一个测量－反馈控制系统，其特征在于所述的对被测动脉进行容积检测的装置是一个对手腕部的挠动脉和尺动脉之中的一根动脉进行容积检测的光电探头，而对被测动脉进行外部加压的装置是一个对手腕部被上述的光电容积探头所检测的同一根动脉进行外部加压的局部加压囊体。所述的光电容积探头和加压囊体被设置在一固定装置上。

10. 根据权利要求 9 所述的一种无创伤连续测量血压的装置，其特征在于所述的加压囊体呈扁平状，其直径可选为手腕直径的 1/2～1/3，加压囊体的朝向手腕的内侧壁采用薄而柔软、具有一定弹性的半透明材料作成，并使其具有向内侧凸出的形状，而这个囊体的沿圆周一圈的壁和朝向外侧的壁采用具有一定硬度的材料做成。

11. 根据权利要求 9 所述的一种无创伤连续测量血压的装置，其特征在于所述的加压囊体的固定装置可为一个具有一定的硬度和一定的弹性的固定绑带，它的两端的固定应采用具有不可伸缩性的装置。

12. 根据权利要求 9 或 11 所述的一种无创伤连续测量血压的装置，其特征在于所述的绑带的宽度对于一般成人应大于 50 mm，其朝向手腕的面应具有于手腕相吻合的凹凸形状。

13. 根据权利要求 9 或 11 所述的一种无创伤连续测量血压的装置，其特

征在于所述的加压囊体可与绑带做成一体，即在绑带的朝向手腕的面的、对应于加压囊体的位置上加工出一个直径与囊体直径相同的扁平凹坑，将所述的用半透明材料作成的囊体内侧壁的边缘与绑带的凹坑的边缘密封接合。

14. 根据权利要求 9 所述的一种无创伤连续测量血压的装置，其特征在于所述的光电容积探头可以是一个由发光器件和光电器件构成的反射式光电传感器，所述的发光器件和光电器件被以 5－10 mm 的间隔沿囊体固定绑带的长度方向固定加压囊体内侧壁的内表面，且两器件连线的中点对准所述的内侧壁的中心。

15. 根据权利要求 9 所述的一种无创伤连续测量血压的装置，其特征在于所述的固定装置还包括有一手腕固定托。所述的手腕固定托是由具有一定强度的硬质材料做成的托板，它的长度和宽度应保证覆盖从手指基节至接近肘关节的整个手背、手腕以及前臂的背侧半面，而它的形状应保证它的内侧面能与手背、手腕背侧以及前臂背侧的形状相吻和。

16. 根据权利要求 9 或 15 所述的一种无创伤连续测量血压的装置，其特征在于所述的手腕固定托上固定有几根小绑带，且固定托的内侧面粘有一层软质材料的衬垫。

17. 根据权利要求 9 或 15 所述的一种无创伤连续测量血压的装置，其特征在于所述的手腕固定托可以采用多块托板拼成，这些托板之间采用可调节的连接机构相互连接。

18. 根据权利要求 9 所述的一种无创伤连续测量血压的装置，其特征在于所述的测量－反馈控制系统是采用一种基于血管无载法连续测量血压的测量－反馈控制系统。

19. 根据权利要求 9 或 14 所述的一种无创伤连续测量血压的装置，其特征在于所述的光电容积探头内藏的加压囊体可以被在手腕部的挠动脉和尺动脉上分别各固定一个，并利用一个切换装置使它们交替地对挠动脉和尺动脉进行容积检测和外部加压。

20. 根据权利要求 9 所述的一种无创伤连续测量血压的装置，其特征在于所述的测量－反馈控制系统或其中的一部分可以与于所述的加压囊体的固定装置做成一体。

说　明　书

无创伤连续测量血压的方法和装置

本发明有关一种探测血压或血流的方法和装置，具体地是一种基于血管无载法原理的无创伤连续测量人体动脉血压的方法和装置。

为了连续测量人体每时每刻的动脉血压，以便不间断地监视和追踪人体血压的瞬间变化，多年来，临床上传统采用在浅表动脉血管（最多的是手腕的挠动脉）中插入导管，把动脉血液引入压力传感器进行直接测压的方法。由于这种传统的方法是有创伤的，始终存在着操作复杂，给病人造成痛苦（故这种测压方法只能在麻醉状态下进行），特别是使用后易引起出血、感染、血栓形成、栓塞以及神经损伤等并发症或后遗症等问题。

为此，近些年来人们研究了多种无创伤连续血压测量方法，其中最引人瞩目的是一种被称作“血管无载法”（或“容积嵌定法”、“容积补偿法”）的方法。基于这种方法，国外曾开发出了数种血压测量装置(Cs133205,1969; US4510940; US4524777,1985; US4869261,1989 等），其中有的还被商品化（如 Finapres TM2300, Ohmeda）。按照这种方法无创伤连续测量血压时，一般采用一个光电探头检测出被测动脉的容积脉波（即由于动脉血管壁随其中血压波搏动产生的动脉容积的变化），同时控制一个固定在被测动脉上方的皮肤表面上的气囊（或水囊）中的压力，使得被测动脉的血管壁除了在内侧受到本来的血压波作用外，同时在外侧还受到外来的压力作用，进而使得被测动脉的容积脉波发生变化。当这个反馈控制使得被测动脉的容积脉波变化至某一特征（例如它的振幅或容积脉波上人为叠加上去的小振动波的振幅达到最大，或者它的曲线的下降段表现出向下凹、它的基线高度（平均值）下降至该动脉开始排空时的基线高度的1/3 等）出现时，说明这时被测动脉的血管壁已是在其最柔软、即无任何周向张力的所谓“无载状态”下搏动。这时接通一个伺服放大电路将这个容积脉波加以放大，并用它去进一步控制气囊（或水囊）的压力，使得加在被测动脉血管壁外侧的压力不仅在波形的形状上、而且在波形的大小上都与该动脉内的血

压波完全相同，即被测动脉血管壁的内外两侧的受力达到动态平衡时，被测动脉的血管壁将不再随血管内的血压波搏动，其血管容积将被嵌定在其无载状态时的容积上。这时只要用压力传感器连续测出气囊（水囊）的压力值，即可实现连续血压测量。

由于使用这种方法操作简便，无需校准，且测量结果不易受病人体动干扰的影响，因而相对来说是一种宜于临床应用的无创伤连续血压测量方法。但是这种方法也存在下列问题：①这种方法一般被用在手指上来测量手指动脉压。这主要是由于在手指上便于实现光电血管容积波检测，也便于固定，同时对肢体压迫的影响也较小。但手指动脉属于对血流阻力大的末梢小动脉，因而手指部位的血压与一般临床上判断病人血压是否正常时所用的所谓“全身血压”（即靠近心脏的大动脉的血压）相比，即使在正常情况下也要低 10 mmHg 左右，若在动脉硬化情况下这个差可达数十 mmHg。更重要的是由于小动脉血管壁中的平滑肌成份比大动脉血管壁中的大，而这些血管平滑肌成份极易受各种因素（比如寒冷、麻醉等）的影响产生收缩或舒张，造成小动脉中血压大幅度变化，以至于在许多场合用手指动脉测得的血压值根本不能被用来反映病人全身血压。尤其当遇到病人的循环功能很差的场合，手指动脉有时会出现血管平滑肌极度收缩造成动脉内失血，以至于在手指上无法测量血压。②该方法对手指动脉加压时一般采用圆管形气囊（水囊）对手指的中节或基节进行全周加压。由于连续测量血压过程中，气囊（水囊）中的压力总是保持在手指动脉的收缩压与舒张压之间变动，虽然这种压力对于被压部分的动脉只会引起血流一定程度的下降而不会造成血流阻断，但是会使被压部分的所有静脉血管和毛细血管血流完全阻断，引起被测部下游手指淤血，因而不适于长时间连续使用。针对上述问题①，曾有人进行过将这种血管无载原理用于上臂部位来测量肱动脉血压的尝试。其结果表明，这样做虽然能够测得接近大动脉的全身血压，但由于在上臂处肱动脉的位置很深，要充分地压迫肱动脉必须对上臂进行全周或接近全周的加压，因而在很短的时间内就会使得其下游的整个前臂和手部的血液循环受到

严重的影响；另外，针对上述问题②，也曾有人进行过将这种血管无载原理用于头部来测量颞动脉血压的尝试。其基本出发点是头部具有丰富的动脉、静脉网，如果采用一个小的气囊（水囊）仅压迫颞动脉，即使长时间连续测量血压也不会使头部血液循环受到影响。但实际上在颞动脉处气囊固定困难，特别是固定用的绑带会压迫头部后侧的枕骨动脉和枕骨静脉，长时间连续使用也会引起病人的头痛，眩晕等症状。而且颞动脉也属于末梢小动脉，在颞动脉上测得的血压值也不能被很好地用来反映病人的全身血压。

本发明的目的是提供一种无创伤连续测量血压的方法和装置，它能正确地测量人体的全身血压，而且对被测部位下游的血流循环基本上没有影响。

为达到上述目的，本发明采用的解决方案是：把现有的血管无载法的测量部位，即对动脉血管进行容积检测和外部加压的部位改到手腕的适当部位上，并且采用一个局部加压装置仅仅压迫手腕两根动脉（挠动脉和尺动脉）中的一根动脉。

本发明基于：①挠动脉或尺动脉的直径虽然较上臂处肱动脉的直径略小，但远大于手指动脉和颞动脉等小动脉的，而且挠动脉或尺动脉的血管壁中的平滑肌成份少于手指动脉和颞动脉中的，故挠动脉或尺动脉的血压比手指动脉和颞动脉的更接近人体全身血压，受各种因素的影响也要小的多。并且即使是在病人的循环功能很差的场合，在挠动脉或尺动脉上一般也总能测出血管容积波，而不会出现血压测量无法进行的情况。特别是，由于手腕动脉的上述特点以及在手腕部便于操作等原因，手腕部位的挠动脉有创直接测压多年来一直被世界各国作为最常用的血压测量方法应用于手术和危重病监护，以至于手腕动脉的血压值历来被临床医务人员习惯作为最可靠、最准确的人体全身血压的判据，因而在手腕部位利用血管无载法无创伤连续测量血压具有极高的临床使用价值。②正常人在手腕处较大的动脉和静脉都在两根以上，其中两根动脉（挠动脉和尺动脉）在手掌内部被通过两个动脉弓相互连通，数根静脉在手的背部也被通过手背静脉网相互连通。这些血管之间的相互连通保证了即便使手腕部

的某根动脉或／和部分静脉被长时间阻断，但另一根动脉和其他大部分的静脉仍能血流畅通时，手部的血液循环也基本上不会受到影响。因而，在手腕挠动脉和尺动脉中的一根动脉上利用血管无载法能够实现长时间的无创伤连续血压测量。事实上，由于挠动脉和尺动脉在穿过手腕部位时位置表浅，且相距较远，数根静脉在手腕部位的分布也很分散，要在手腕部做到仅仅对一根动脉进行充分压迫的同时还能保证另一根动脉和其他大部分的静脉血流畅通是不难实现的。另外，在手腕部实施这种无创伤连续血压测量的话，显然还有操作方便、加压装置易于固定等优点。

附图图面说明：

图 1 是本发明的一个实施例的总框图。

图 2 是图 1 所示的实施例中腕部装置的示意图。

图 3 是图 2 的腕部装置在与手腕垂直的方向上、过腕部装置中的外部加压气囊的正中所做的横断面图。

图 4 是本发明的第三种实施例的工作原理图.

图 5 是本发明的第四种实施例的结构示意图

下面用实施例对本发明作进一步的详细说明。

图 1 是本发明的一个实施例的总框图。它表明本实施例包括两大部分，其中第一部分是一个腕部装置 1，主要是对腕部动脉进行容积检测和外部加压的装置；第二部分是一个测量－反馈控制系统 2。为了重点说明本发明是如何在手腕部实现利用血管无载法无创伤连续血压测量的，本实施例中的第二部分测量－反馈控制系统 2 直接采用了现有的早期产品 Finapres TM2300 中的测量－反馈控制系统。

首先对该实施例中的第一部分——腕部装置 1 进行说明。如图 2 和图 3 所示，在本实施例是对手腕部的挠动脉 11 和尺动脉 12 中的挠动脉进行容积检测和外部加压，从而实现挠动脉的连续血压测量的。这个腕部装置 1 包括挠动脉加压气囊 3，气囊固定绑带 4，挠动脉容积探头 5 以及手腕固定托 6 共四个部分。

挠动脉加压气囊 3 是一个扁平的圆形气囊。为了保证这个气囊的压力能充分地传到挠动脉 11 所在的深度，一方面，这个气囊的固定位置应使得它的中心能够对准手腕部的处于最表浅处的挠动脉；另一方面，这个气囊的直径应充分地大，但过大会同时压迫到另一根尺动脉 12 和其他静脉血管，同时会增加气囊的容积，从而使得气囊中的压力难以得到快速控制，故这个直径可选为手腕直径的一半（例如对于一般成人可选在 30-40 mm）。另外，为了保证这个气囊 3 在充气后不至于因膨胀而在它的壁中产生周向张力而影响对挠动脉的有效压迫，这个气囊的朝向内侧（手腕）的壁 7 采用薄而柔软、具有一定弹性的半透明材料作成，并使其具有向内侧凸出的形状，而这个气囊的沿圆周一圈的壁和朝向外侧的壁采用具有一定硬度的材料做成。

气囊固定绑带 4 被用来把加压气囊 3 固定在上述的手腕位置上。实际上，为了简化结构，本实施例把气囊 3 与绑带 4 做成了一体，即采用有一定厚度和硬度的绑带，在其朝向手腕的面的对应于气囊的位置上加工出一个直径与气囊 3 直径相同的扁平圆坑，然后把上述用薄膜做成的气囊内侧壁 7 的边缘粘合在绑带 4 的凹坑的边缘上，从而利用这个用薄膜做成的气囊内侧壁 7 和绑带 4 上这个具有一定硬度的空腔构成上述的气囊 3。由于在利用血管无创法连续测量血压时上述气囊 3 的内压将按照挠动脉 11 的血压做脉动变化，为了保证这个气囊的位置在这种大的脉冲内压的作用下也不至于发生任何方向的跳动而造成反馈控制系统自激振荡，这个绑带 4 在整体上都应具有一定的硬度，且它的两端的固定应采用具有不可伸缩性的装置。在本实施例中，这个绑带 4 的两端被利用尼龙搭扣 8 固定在手腕固定托 6 上。另外，这个绑带 4 的材料还应具有一定的弹性，以便当手腕在受到长时间连续压迫后略微变细时，其回弹性能还能使得它能把气囊紧固在手腕上而不会发生松动。另一方面，为了保证仅由气囊 3 充分压迫被测的挠动脉，而尽可能地减小绑带 4 对手腕其他部分的压强，以免阻断另一根尺动脉和大部分的静脉从而影响其下游手部的血液循环，这个绑带与手腕的有效接触面积应大于气囊 3 的加压面积的 3 倍，为此应采用尽可能大

的绑带宽度（对于一般成人应大于 50 mm）并使得绑带朝向皮肤的面具有于手腕相吻合的凹凸形状。

挠动脉容积探头 5 是一个反射式光电传感器。为了便于利用绑带 4 将该探头与上述气囊 3 一起固定到手腕上，并且不妨碍气囊贴紧手腕表面，这个探头被内藏在上述气囊的内部。这个探头由一个发光器件 9 和一个光电器件 10 构成。这两个器件 9 和 10 被以 5－10 mm 的间隔粘贴在上述气囊 3 的用半透明薄膜作成的内侧壁 7 的内表面。粘贴时，应使得发光器件 9 的发光面和光电器件 10 的受光面朝向薄膜内侧壁 7 的内表面，并使得这两个器件 9 和 10 之间的连线与挠动脉走行方向相垂直，即沿着绑带的长度方向；同时使连线的中点对准薄膜内侧壁 7 的中心，以保正当气囊 3 的中心对准手腕最表浅处的挠动脉 11 时，这两个器件 9 和 10 能够在手腕皮面上位于挠动脉的两侧，便使该容积探头的检测范围的中心正好对准挠动脉。当容积探头 5 被用于检测挠动脉 11 的血管容积变化时，其中的发光器件 9 发出的光透过气囊 3 的用半透明薄膜作成的内侧壁 7 射入手腕内部，经其中挠动脉 11 和周围软组织反射到光电器件 10 中。由于挠动脉 11 的血管容积变化会造成反射到光电器件 10 中的光强度变化进而使光电器件 10 的输出电流产生变化，由此容积探头 5 便会将挠动脉的容积随血压波的变化转换成挠动脉容积脉波信号输出。

手腕固定托 6 被用来固定手掌相对于手腕的角度，以及手腕相对于前臂靠近肘关节部分角度，以保证在长时间连续测量血压的过程中被测者出现任何体动时，加压气囊 3 和容积探头 5 相对于挠动脉 11 的位置始终保持不变。同时，这个固定托的使用还可以起到分散固定气囊用的绑带 4 对手腕背侧的压力的作用。这个手腕固定托 6 是一块用有一定强度的硬质材料做成的托板，它的长度和宽度应保证覆盖从手指基节至接近肘关节的整个手背、手腕以及前臂的背侧半面，而它的形状应保证它的内侧面能于手背、手腕背侧以及前臂背侧的形状相吻和（因此，为了适应不同长短、粗细的前臂，需分别做几种固定托备用）。这个手腕固定托 6 上固定有几根末端缝有尼龙搭扣的小绑带 15 用于将被测者

的前臂、手腕和手绑在这个手腕固定托 6 中。为避免固定托过硬造成被测者不舒适，可在固定托的内侧面粘一层软质材料的衬垫 16，但这一衬垫不宜过厚、过软，否则会影响手腕的固定效果，同时还会在当气囊内压随血压作大幅度脉动变化时，出现手腕在气囊的脉动内压作用下产生跳动以至于反馈控制系统产生自激振荡。

下面说明上述的腕部装置 1 在本实施例中是如何被用来进行挠动脉无创伤连续血压测量的。如图 1 所示，在利用上述的腕部装置 1 进行挠动脉血压测量时，须将该腕部装置与一个以血管无载为控制目的的测量－反馈控制系统 2 相接合。在本实施例中，这个测量－反馈控制系统 2 采用早期的一种基于血管无载法原理无创伤连续测量手指血压产品 Finapres 中的测量－反馈控制系统。结合的方法非常简单，即把该腕部装置 1 中挠动脉容积探头 5 中的发光器件 9 和光电器件 10 的引线分别与 Finapres 的测量－反馈控制系统中本来用于给手指动脉容积探头中的发光器件供电的输出端（该输出端在图 1 中被省略）和光电器件的容积信号输入端 17 相连接，同时把该腕部装置 1 中挠动脉加压气囊 3 的导气管与 Finapres 的测量－反馈控制系统中的电压－气压转换装置中本来用于给手指动脉加压气囊供气的导气管 18 相连接。

使用由上述的腕部装置 1 和 Finapres 中的测量－反馈控制系统 2 两部分组成的实施例对挠动脉血压进行无创伤连续测量时，首先将被测者的手背、手腕以及前臂固定在腕部装置 1 中的手腕固定托 6 中，然后再把腕部装置中的气囊 3 的中心对准被测手腕挠动脉 11 的最表浅处后，将气囊固定绑带 4 缠绕在手腕部，并将固定绑带的两端利用尼龙搭扣 8 与手腕固定托 6 固定在一起。在完成上述固定和连接后启动测量—反馈控制系统 2 进入自动工作状态。其中血压连续测量开始时，为了找到并记下被测者的挠动脉在无载状态时的容积，测量－反馈控制系统 2 首先把工作状态开关 19 接到“开环”位置。在这个开环工作状态下，腕部装置 1 中的容积探头 5 将挠动脉的血管容积随血压波的变化转换成挠动脉容积波，同时系统中的气囊压力设定电路 20 开始自动地调节供

给电压－气压转换器 21 的电压，使腕部装置 1 中的气囊 3 开始对挠动脉 11 外部加压。随着挠动脉外部压力的增加，挠动脉容积波的振幅和形状都将发生变化。当挠动脉容积波的振幅达到最大时，说明挠动脉血管容积随血压波的变化已是在该血管无载状态容积的上下变化了。这时系统会使气囊压力设定电路 20 停止对气囊 3 的压力调节，并使得一个无载容积记忆电路 22 记下这时挠动脉容积波的平均值（直流成份）作为被测者挠动脉的无载状态容积 Vo。在找到并记忆下作为被测者挠动脉的无载状态容积 Vo 后，测量－反馈控制系统 2 自动地把工作状态开关 19 接到“闭环”位置，并逐渐增加其中伺服放大电路 23 的增益，把容积探头 5 检测到的挠动脉在这个无载状态容积附近的容积波与被无载容积记忆电路 22 记下来的无载容积 Vo 通过一个比较电路 24 相减得到的差（即挠动脉血管容积波的交流成份）加以放大，并驱动电压－气压转换器 21 去控制气囊 3 进一步从外部对挠动脉 11 施加波形与其内部血压波形一样的压力，使得挠动脉随内部血压波产生的容积波的幅度开始变小。由于当伺服放大电路 23 的增益被调节到使气囊 3 加在挠动脉 11 外部的压力不仅在波形的形状上，而且在波形的大小上也完全与挠动脉内部的血压波形相同，即挠动脉血管壁的内外两侧的受力达到动态平衡时，挠动脉的血管壁将不再随血管内的血压波搏动，挠动脉的血管容积将被完全嵌定在其无载状态容积 Vo 上。所以在闭环工作状态下，只要令系统在逐渐增加伺服放大电路 23 的增益同时找到挠动脉 11 的容积波振幅最终趋于零的时间点，就可以肯定由此开始加压气囊 3 内的气压在任何时刻都与挠动脉 11 内的血压相等，这时用与加压气囊 3 相连的压力传感器 25 连续测量加压气囊 3 的内压即可实现挠动脉血压的无创伤连续测量。

以上所列举的只是本发明的一个实施例。事实上本发明可以有多种实施和改进方案。

例如，在手腕部两根动脉中选择一根连续测量血压不一定非要选择挠动脉不可，作为本发明的第二种实施例，也可选择手腕部的尺动脉作为被测动脉，

其测量方法与实施例 1 相同，在此不再赘述。

本发明的第三种实施例是把内藏有血管容积探头的加压气囊在对应于手腕部的挠动脉和尺动脉的位置上分别各设置一个，并设置一个切换装置，使它们每隔一段时间交替地对挠动脉和尺动脉进行容积检测和外部加压。其腕部装置如图 4 所示。此种方法更有利于长时间连续测量血压，因为交替使用两根动脉可以避免长时间压迫一处所造成的疼痛和麻木。

本发明的第四种实施例如图 5 所示。在本实施例中手腕固定托采用多块托板拼成。这些托板之间采用可调节的连接机构（如万向节）相互连接，以使这些托板拼成的手腕固定托可以调节成多种形状以供具有不同胖瘦、长短前臂的被测者共用而不必为他们分别制作。

另一方面，在上述的实施例中，我们利用了一种本来用于手指的基于血管无载法连续测量血压的装置 Finapres 中的测量－反馈控制系统，其中采用了被测动脉容积脉波的振幅是否达到最大作为判断被测动脉血管是否处于无载状态的判据，并采用了控制气压来控制对被测动脉施加的外部压力。实际上，本发明中的测量－反馈控制系统可以是其它的基于血管无载法连续测量血压的测量－反馈控制系统，例如它可以采用其它判据（比如根据动脉容积波的形状等）来判定被测动脉的无载状态，也可以采用控制液压来控制对被测动脉施加的外部压力。

在上述实施例中，包括被测动脉外部加压气囊和容积检测探头在内的腕部装置是一个单独的装置。实际上，由于手腕有较大的承重能力，因而可以把测量－反馈控制系统中的压力传感器、电压－气压转换器甚至整个控制系统与上述的腕部装置做成一体，这样还可以大大提高压力反馈控制的速度，从而进一步提高血压测量精度，而且可以减少使用时的连线和管道，更便于临床应用。

说 明 书 附 图

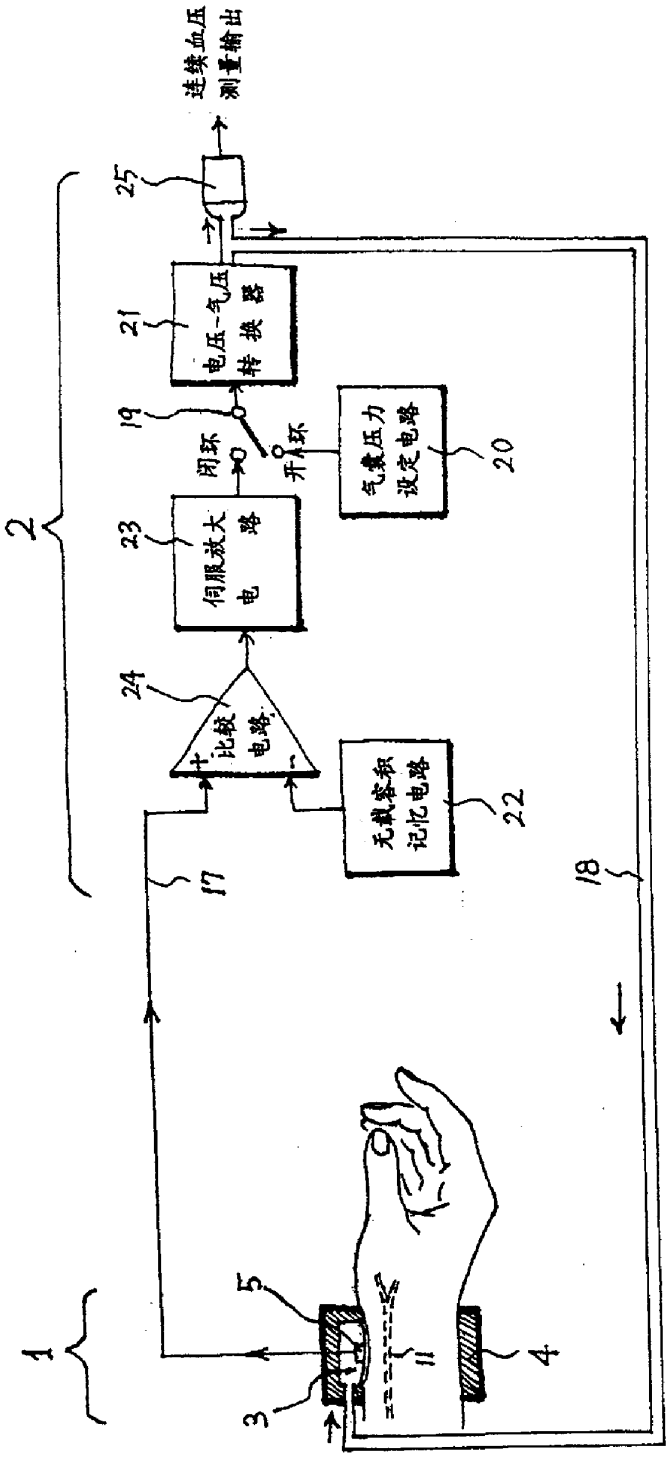
连续血压测量输出
25
21
电压-气压转换器
19
闭环
开环
气囊压力设定电路
20
23
伺服放大电路
24
比较电路
无载容积记忆电路
22
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图 1

99.04.21

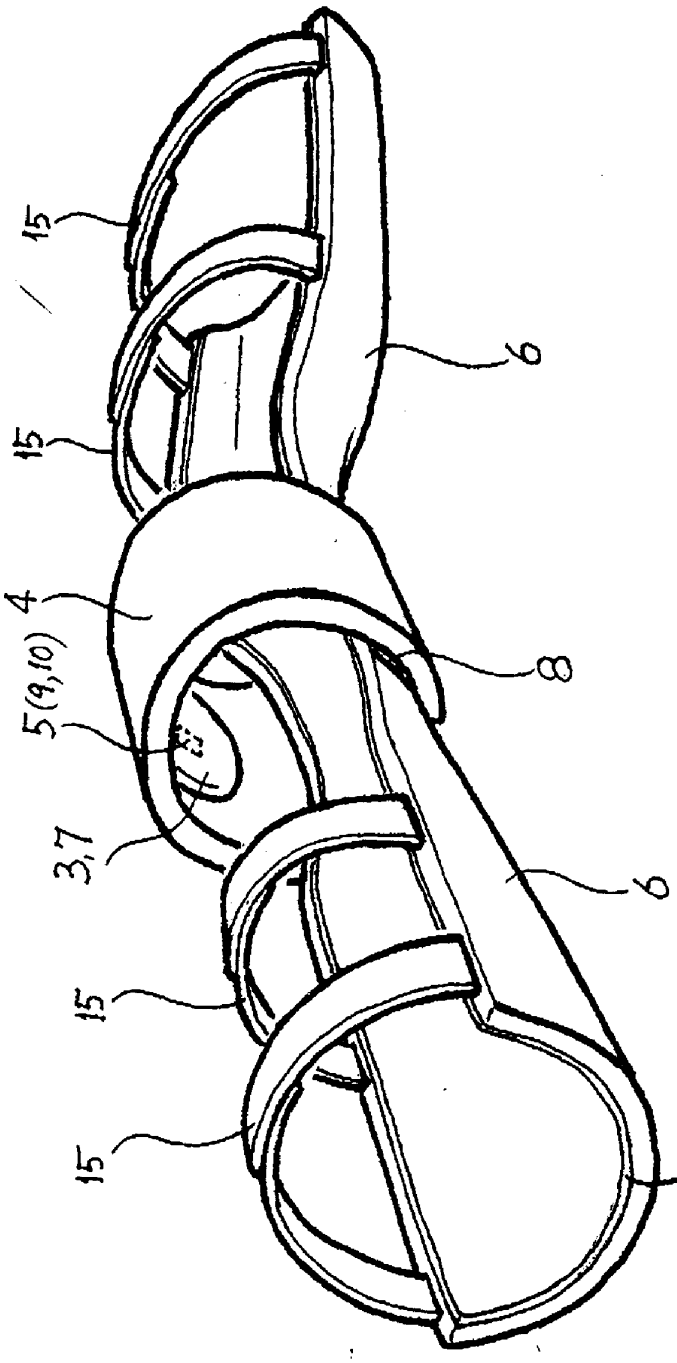

图 2

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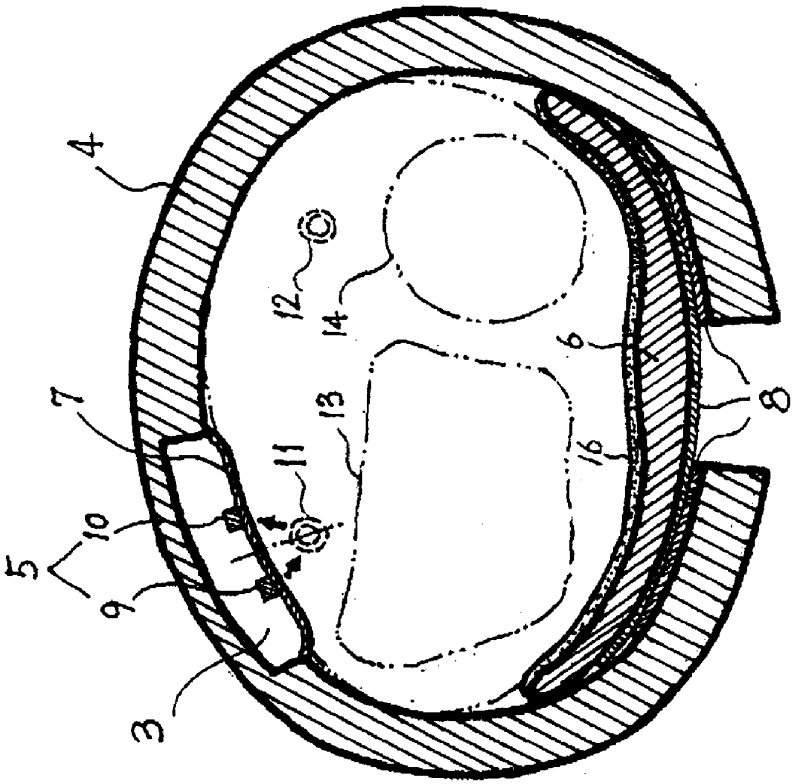

図 3

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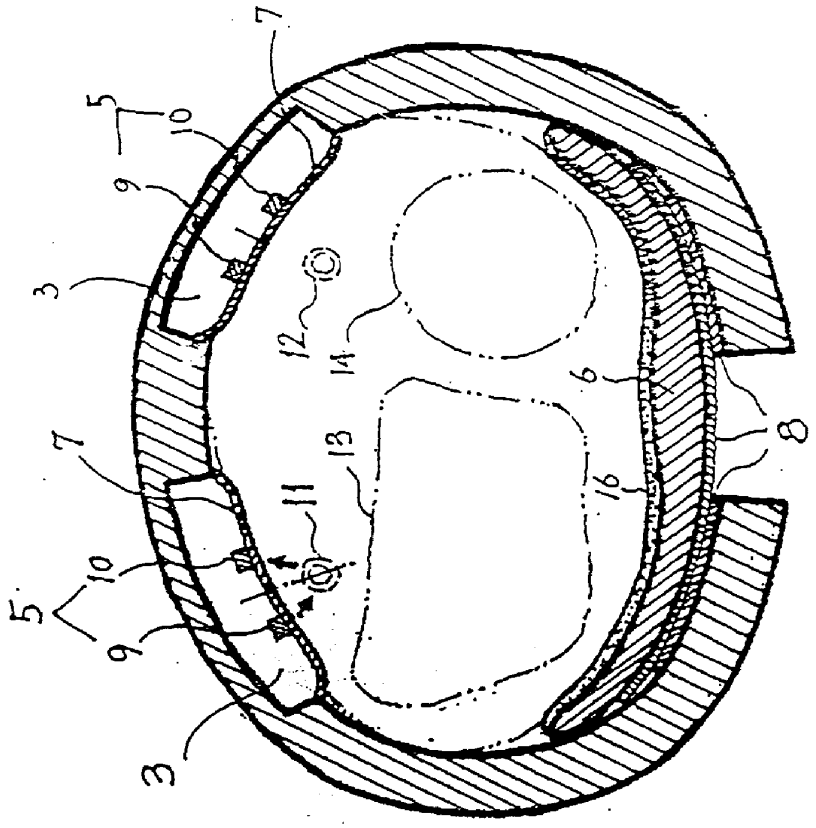

図 4

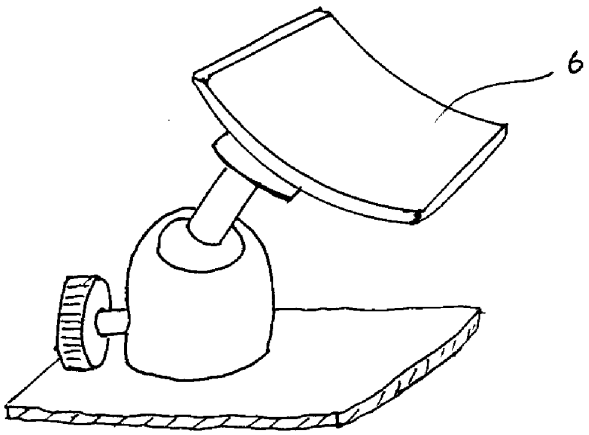

图 5

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 922 432 A1

(12) EUROPEAN PATENT APPLICATION

published in accordance with Art. 158(3) EPC

(43) Date of publication:
16.06.1999 Bulletin 1999/24

(21) Application number: **98909844.7**

(22) Date of filing: **24.03.1998**

(51) Int. Cl.[6]: **A61B 5/024**

(86) International application number:
PCT/JP98/01276

(87) International publication number:
WO 98/42254 (01.10.1998 Gazette 1998/39)

(84) Designated Contracting States:
CH DE GB LI

(30) Priority: **25.03.1997 JP 9023797**
30.04.1997 JP 12631697
31.10.1997 JP 30133197

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(54) PULSE WAVE DETECTOR, PULSATION DETECTOR AND PRESSURE DETECTOR

(57) A pulse wave measuring device is provided with a plurality of pulse wave measuring units. Each pulse wave measuring unit has a supporting member to which a beam of a pressure measuring device is attached. Contact portions at the distal end of the beam is in contact with the patient's arm, so that piezoelectric elements mounted on the beam measures the stress variation according to pulsation of the patient's radial artery. The supporting meter has two pressing legs between which the contact portions of the beam are situated. The distal ends of the pressing legs are also pressed against the patient's arm. The pressing legs are harder than the radial artery. The interval between the pressing legs can be altered by handling a micrometer head. The contact portions are situated back from the distal ends of the pressing legs.

FIG. 2A

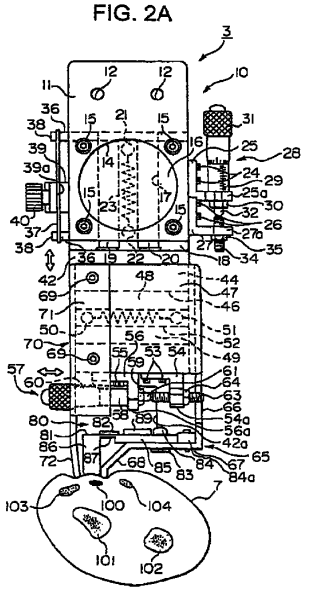

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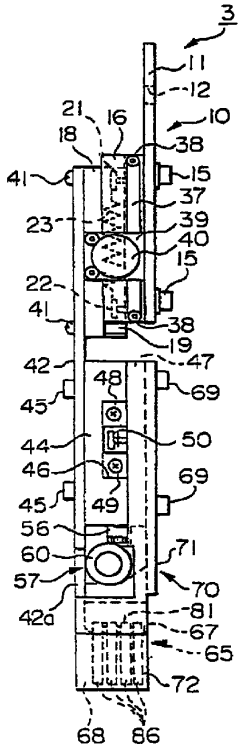
FIG. 2B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Description

TECHNICAL FIELD

[0001] The present invention relates to a device for measuring blood pulse wave, a device for measuring pulsation, and a pressure measuring device.

TECHNICAL BACKGROUND

[0002] A "*blood pulse wave*" is the blood pressure wave, which is pumped out from the heart and propagates through a blood vessel, or the vibration of the blood vessel wall generated by the blood pressure wave. Since various medical information, for example, the vital condition of the heart, can be obtained by detecting and analyzing blood pulse waves, it has been carried out to diagnose blood pulse wave by the diagnostician's sense of touch traditionally in Oriental medicine.

[0003] More specifically, the diagnostician presses the patient's wrist by his fingers and measures blood pulse wave of the radial artery by the finger's sense of touch in Oriental medicine. Due to the finger pressure, the amplitude of the sensed pulse wave changes, so that the changing characteristic of the amplitude of pulse wave can be a diagnostic parameter in the field of Oriental medicine.

[0004] Figs. 22A to 22C respectively show curves indicating amplitude variations of the sensed pulse wave due to pressure change. These curves are called "*tendency curves*" in Oriental medicine.

[0005] The *tendency curve* in Fig. 22A has a peak at the center thereof. That is, when a medium pressure is applied to the artery, pulse wave can be detected clearly. This kind of curve is categorized into a "*normal curve*", and this is a characteristic of normal pulse wave ("*Ping-mai*") obtained from a healthy human body.

[0006] The *tendency curve* in Fig. 22B has a peak at the left thereof. This kind of curve is categorized into a "*gradual decrease curve*". In this case, pulse wave can be detected clearly when a weak pressure is applied, but pulse wave weakens when the applied pressure rises. This phenomenon is called "*Hua*" and this kind of pulse wave is called "*Hua-mai*".

[0007] The *tendency curve* in Fig. 22C has a peak at the right thereof. This kind of curve is categorized into an "*gradual increase curve*". In this case, pulse wave can not be detected clearly when a weak pressure is applied, but it can be detected when the pressure applied by the diagnostician's finger rises. This phenomenon is called "*Xuan*" and this kind of pulse wave is called "*Xuan-mai*".

[0008] The *Hua-mai* is caused by an abnormality in the flow of blood in which the movement of the blood through the vessel becomes extremely smooth due to some kinds of illness. The *Xuan-mai* is on the other hand caused by an increase in the tension in the walls of the blood vessels because of other kinds of illness. Thus, the correlation between the given initial pressure and the wave amplitude is an important factor for evaluating patient's condition in the pulse wave diagnosis.

[0009] However, there are individual differences among patients. Namely, there are fat patients and thin patients. In addition, each patient has his or her own muscular and fat distribution and elasticity in the flesh. Therefore, although the same pressure is given, the displacement of the organism tissues is dependent on the individuality. The amplitude of pulse wave relates to the distance between the skin surface and the blood vessel when the pressure is applied, and to the configuration of the pressed blood vessel. In manual diagnosis by a skilled diagnostician, he controls the pressure by himself, thereby judging that the patient's pulse wave belongs to *Ping-mai*, *Hua-mai* or, *Xuan-mai*. Therefore, it is also preferable to optionally adjust the initial pressure given to the measured blood vessel for mechanical diagnosis.

[0010] Conventionally, devices for measuring blood pulse wave comprise pressure measuring devices including pressure sensors, such as piezoelectric elements or strain gauges, which can be into contact with the organism's skin, e.g., the, skin portion over the radial artery. The pressure sensor is strained due to the stress varying by the pulsation of the blood vessel, and outputs pulsation signals corresponding to the stress fluctuations.

[0011] In order to measure pulse wave under stable condition, these pressure measuring devices should be pressed against the organism's skin at a pressure. As disclosed in JP-A-4-102438, JP-A-4-108424, JP-A-4-67839, and JP-A-4-67840, pressure measuring devices are usually mounted on cuffs which are elastic bags wound around the patients' arms, and are pressed on the organisms' surfaces by compulsorily introducing air into the cuffs.

[0012] However, it is difficult to adjust the initial pressure on the blood vessel using with such cuffs for pressing the pressure measuring devices on the organisms' surfaces since the flat surfaces of the cuffs transform the tissues in the vicinity of the blood vessels as well as the blood vessels. Even If the same pressure is applied to the cuff, the pressure in the blood vessel is not solely determined. Furthermore, the pressure measuring device mounted on the cuff is difficult to be accurately positioned above the blood vessel, e.g., the radial artery.

[0013] Another type of blood pulse wave measuring device comprises a pen-like holder and a pressure sensor mounted on the end of the holder. The pressure sensor is into contact with the patient's skin, e.g., the vicinity of the radial artery, and measures pulse wave according to the pulsation of the blood vessel.

[0014] Another type of blood pulse wave measuring device comprises a rubber glove and a strain gauge mounted on the finger sheath of the glove. The diagnos-

tician wears the rubber glove and presses the strain gauge against the skin over the radial artery of the patient using with his finger, whereby the strain gauge detects blood pulse wave.

[0015] It is necessary for the diagnostician to hold the sensor above the radial artery of the patient when using such a blood vessel measuring device with the pen-like holder or rubber glove. However, since it is difficult for the diagnostician to continuously hold the sensor, mounted on the finger sheath or the pen end, above the radial artery, the sensor may move from the desirable position above the radial artery and may not measure accurately. If physiological status of organism is analyzed on the basis of inaccurate results obtained by such a measuring device, the analysis may contain some errors.

[0016] Accordingly, a pulse wave measuring device with an automatic positioner is proposed in JP-A-1-155828. In the device, while the sensor is moved across the line along the blood vessel, pulse wave is measured at a plurality of positions. The amplitude and other characteristics are analyzed over these positions, so that the best position directly above the blood vessel is detected. Then, the sensor is fixed at the best position to measure blood pulse wave.

[0017] However, the technique disclosed in JP-A-1-155828 needs a driver for moving the sensor, and devices for automatically determining the best measuring position. Therefore, the entire device should be enlarged.

[0018] It is therefore an object of the present invention to provide blood pulse wave measuring device and a pulsation measuring device, in which a pressure sensor or pulsation sensor can be positioned accurately on the measured subject, and the initial pressure given to the measured subject can be readily and desirably adjusted.

[0019] Another object of the present invention is to provide a pressure measuring device in which the energy loss can be reduced.

DISCLOSURE OF INVENTION

[0020] According to the present invention, a pulse wave measuring device for measuring pulse wave at a blood vessel of an organism, comprises: a vessel pressing portion being pressed against a skin over the blood vessel of the organism; a pulsation measuring sensor for measuring pulsation of the blood vessel pressed by the vessel pressing portion; two vessel-vicinity pressing portions being harder than the blood vessel of the organism and having distal ends, respectively, the distal ends being pressed against the skin of the organism at both sides of the vessel pressing portion; and adjusting means for adjusting an interval between the vessel-vicinity pressing portions.

[0021] In accordance with this pulse wave measuring device, since the interval between two vessel-vicinity pressing portions is adjusted by the adjusting means, the vessel-vicinity pressing portions can be positioned on softer skin parts at both sides of the measured blood vessel and press down the softer parts, whereby the pulsation measuring sensor can be readily positioned in relation to the blood vessel. In addition, since two vessel-vicinity pressing portions, which are harder than the blood vessel, press down the softer skin parts at both sides of the blood vessel, the initial pressure on the blood vessel given by the vessel pressing portion may be altered desirably. Since the interval between the vessel-vicinity pressing portions is adjusted, effect by skin tension can be constant, whereby the initial pressure may be altered more precisely.

[0022] In another aspect of the present invention, a pulse wave measuring device for measuring pulse wave at a blood vessel of an organism, comprises: a vessel pressing portion being pressed against a skin over the blood vessel of the organism; a pulsation measuring sensor for measuring pulsation of the blood vessel pressed by the vessel pressing portion; and two vessel-vicinity pressing portions being harder than the blood vessel of the organism and having distal ends, respectively, the distal ends being pressed against the skin of the organism at both sides of the vessel pressing portion, the vessel pressing portion being situated back from the distal ends of the vessel-vicinity pressing portions.

[0023] In accordance with this pulse wave measuring device, since the vessel pressing portion is situated back from the distal ends of the vessel-vicinity pressing portions, the blood vessel, which is harder than circumferential tissues, can be positioned between the vessel-vicinity pressing portions, whereby the vessel pressing portion can be readily positioned directly above the measured vessel. In addition, since two vessel-vicinity pressing portions, which are harder than the blood vessel, press down the softer skin parts at both sides of the blood vessel, the initial pressure on the blood vessel given by the vessel pressing portion may be altered desirably.

[0024] In another aspect of the present invention, a pulse wave measuring device for measuring pulse wave at a blood vessel of an organism, comprises: a beam supported by a support; a plurality of vessel pressing portions provided at the beam and arranged at intervals along a direction of the blood vessel of the organism, each of the vessel pressing portion being pressed against a skin over the blood vessel of the organism; a plurality of pressure sensors respectively corresponding to the vessel pressing portions, each of the pressure sensors outputting a pulse wave signal according to varying stress transmitted from the corresponding vessel pressing portion because of pulse wave of the blood vessel; and two vessel-vicinity pressing portions being harder than the blood vessel of the organism and having distal ends, respectively, the distal ends being pressed against the skin of the organism at both sides of the ves-

sel pressing portions.

[0025] In accordance with this pulse wave measuring device, since two vessel-vicinity pressing portions, which are harder than the blood vessel, press down the softer skin parts at both sides of the blood vessel, the pulsation measuring sensor can be readily positioned in relation to the blood vessel and the initial pressure on the blood vessel given by the vessel pressing portion may be altered desirably. Furthermore, by means of the multiple number of pressure sensors, pulse waves transmitted respectively through the multiple number of vessel pressing portions can be measured, whereby the patient may be diagnosed in detail.

[0026] In another embodiment of the present invention, a pulse wave measuring device may comprise: a supporting member; a perpendicular sliding member which is supported by the supporting member and slidable perpendicularly in relation to the supporting member; measuring means situated at the perpendicular sliding member for measuring pulse wave at a blood vessel of an organism; and first and second toothed portions formed at mutual sliding faces of the supporting member and the perpendicular sliding member, respectively and meshed with each other.

[0027] In accordance with this pulse wave measuring device, the diagnostician manually handles the perpendicular sliding member, so that the measuring means is positioned in relation to the measured subject. Accordingly, although the entire device is of a simple construction without driving device and so on, accurate measurement may be achieved. In addition, after starting the measurement, the measuring means is prevented from being moved, so that accurate measurement may be achieved.

[0028] In another embodiment of the present invention, a pulse wave measuring device may comprise: a supporting member; a transverse sliding member which is supported by the supporting member and slidable transversely in relation to the supporting member; a perpendicular sliding member which is supported by the transverse sliding member and slidable perpendicularly in relation to the transverse sliding member; measuring means situated at the perpendicular sliding member for measuring pulse wave at a blood vessel of an organism; third and fourth toothed portions formed at mutual sliding faces of the supporting member and the transverse sliding member, respectively and meshed with each other; and fifth and sixth toothed portions formed at mutual sliding faces of the transverse sliding member and the perpendicular sliding member, respectively and meshed with each other.

[0029] In another embodiment of the present invention, a pulse wave measuring device may comprise; a supporting member; a perpendicular sliding member which is supported by the supporting member and slidable perpendicularly in relation to the supporting member; a transverse sliding member which is supported by the perpendicular sliding member and slidable transversely in relation to the perpendicular sliding member; measuring means situated at the transverse sliding member for measuring a pulse wave at a blood vessel of an organism; seventh and eighth toothed portions formed at mutual sliding faces of the supporting member and the perpendicular sliding member, respectively and meshed with each other; and ninth and tenth toothed portions formed at mutual sliding faces of the perpendicular sliding member and the transverse sliding member, respectively and meshed with each other.

[0030] In another embodiment of the present invention, a pulse wave measuring device may comprise: a supporting member; a transverse sliding member which is supported by the supporting member and slidable transversely in relation to the supporting member, a screw hole being formed perpendicularly at the transverse sliding member; eleventh and twelfth toothed portions formed at mutual sliding faces of the supporting member and the transverse sliding member, respectively and meshed with each other; a perpendicular sliding member which is screwed in the screw hole of the transverse sliding member and movable perpendicularly to the transverse sliding member by rotation; and measuring means situated at the perpendicular sliding member for measuring pulse wave at a blood vessel of an organism.

[0031] According to the present invention, a pulsation measuring device for measuring pulsation at a measured subject of a measured thing, comprises: a subject pressing portion being pressed against a covering over the measured subject of the measured thing; a pulsation measuring sensor for measuring pulsation of the measured subject pressed by the subject pressing portion; two subject-vicinity pressing portions being harder than the measured subject of the measured thing and having distal ends, respectively, the distal ends being pressed against the covering of the measured thing at both sides of the subject pressing portion; and adjusting means for adjusting an interval between the subject-vicinity pressing portions.

[0032] In another aspect of the present invention, a pulsation measuring device for measuring pulsation at a measured subject of a measured thing, comprises: a subject pressing portion being pressed against a covering over the measured subject of the measured thing; a pulsation measuring sensor for measuring pulsation of the measured subject pressed by the subject pressing portion; and too subject-vicinity pressing portions being harder than the measured subject of the measured thing and having distal ends, respectively, the distal ends being pressed against the covering of the measured thing at both sides of the subject pressing portion, the subject pressing portion being situated back from the distal ends of the subject-vicinity pressing portions.

[0033] In another aspect of the present invention, a pulsation measuring device for measuring pulsation at a measured subject of a measured thing, comprises: a beam supported by a support; a plurality of subject

pressing portions provided at the beam and arranged at intervals along a direction of the measured subject of the measured thing, each of the subject pressing portion being pressed against a covering over the measured subject of the measured thing; a plurality of pressure sensors respectively corresponding to the subject pressing portions, each of the pressure sensors outputting a pulsation signal according to varying stress transmitted from the corresponding subject pressing portion because of the pulsation of the measured subject; and two subject-vicinity pressing portions being harder than the measured subject of the measured thing and having distal ends, respectively, the distal ends being pressed against the covering of the measured thing at both sides of the subject pressing portions.

[0034] In another embodiment of the present invention, a pulsation measuring device may comprise: a supporting member; a perpendicular sliding member which is supported by the supporting member and slidable perpendicularly in relation to the supporting member; measuring means situated at the perpendicular sliding member for measuring pulsation at a measured subject of a measured thing; and first and second toothed portions formed at mutual sliding faces of the supporting member and the perpendicular sliding member, respectively and meshed with each other.

[0035] In another embodiment of the present invention, pulsation measuring device may comprise: a supporting member; a transverse sliding member which is supported by the supporting member and slidable transversely in relation to the supporting member; a perpendicular sliding member which is supported by the transverse sliding member and slidable perpendicularly in relation to the transverse sliding member; measuring means situated at the perpendicular sliding member for measuring pulsation at a measured subject of a measured thing; third and fourth toothed portions formed at mutual sliding faces of the supporting member and the transverse sliding member, respectively and meshed with each other; and fifth and sixth toothed portions formed at mutual sliding faces of the transverse sliding member and the perpendicular sliding member, respectively and meshed with each other.

[0036] In another embodiment of the present invention, a pulsation measuring device may comprise: a supporting member; a perpendicular sliding member which is supported by the supporting member and slidable perpendicularly in relation to the supporting member; a transverse sliding meter which is supported by the perpendicular sliding member and slidible transversely in relation to the perpendicular sliding member; measuring means situated at the transverse sliding member for measuring pulsation at a measured subject of a measured thing; seventh and eighth toothed portions formed at mutual sliding faces of the supporting member and the perpendicular sliding member, respectively and meshed with each other; and ninth and tenth toothed portions formed at mutual sliding faces of the perpendicular sliding member and the transverse sliding member, respectively and meshed with each other.

[0037] In another embodiment of the present invention, a pulsation measuring device may comprise: a supporting member; a transverse sliding member which is supported by the supporting member and slidable transversely in relation to the supporting member, a screw hole being formed perpendicularly at the transverse sliding member; eleventh and twelfth toothed portions formed at mutual sliding faces of the supporting member and the transverse sliding member, respectively and meshed with each other; a perpendicular sliding member which is screwed in the screw hole of the transverse sliding member and movable perpendicularly to the transverse sliding member by rotation; and measuring means situated at the perpendicular sliding member for measuring pulsation at a measured subject of a measured thing.

[0038] According to another aspect of the present invention, a pressure measuring device comprises: a beam having at least one proximel portion supported by a support; a subject pressing portion provided at the beam and pressed against a measured subject; and a piezoelectric element mounted on the beam for outputting an electric signal according to varying stress transmitted from the subject pressing portion, the beam including a thinner portion formed between the proximal portion and the subject pressing portion, the thinner portion being thinner than other portions of the beam, the piezoelectric element being longer than the thinner portion and mounted on the thinner portion entirely and on another portion partially, which is closer to the proximal portion or subject pressing portion than the thinner portion.

[0039] In this pressure measuring device, since the piezoelectric element is longer than the thinner portion to be mounted on another portion in addition to the thinner portion, strain energy accumulated in the piezoelectric element can be enhanced. Therefore, the current generated by the piezoelectric element can be increased in comparison with prior art.

[0040] In another aspect of the present invention, a pressure measuring device comprises: a beam having at least one proximal portion supported by a support; a subject pressing portion provided at the beam and pressed against a measured subject; and a piezoelectric element mounted on the beam for outputting an electric signal according to varying stress transmitted from the subject pressing portion, an area of cross section of the thinner portion of the beam, on which the piezoelectric element is mounted, being equal to or less than 60% of an area of total cross section of the thinner portion and the piezoelectric element mounted thereon.

[0041] In accordance with this pressure measuring device, since the area of cross section of the beam is not large in relation to that of the piezoelectric element mounted thereon, strain energy accumulated in the beam is diminished and strain energy in the piezoelec-

tric element is relatively enhanced. Therefore, electric energy converted from the strain energy by the piezoelectric element can be relatively increased, whereby amplitude of the output signal from the piezoelectric element can be enlarged.

BRIEF DESCRIPTION OF DRAWINGS

[0042] Various embodiments will be described below with reference to the accompanying drawings. In the accompanying drawings:

Fig, 1 is a perspective view showing a pulse wave measuring device according to a first embodiment of the present invention;
Fig. 2A is a front view showing one of pulse wave measuring units of the pulse wave measuring device in Fig. 1;
Fig. 2B is a left side view of Fig. 2A;
Fig. 3 is a rear view showing the pulse wave measuring unit in Fig. 2A;
Fig. 4 is a perspective view showing the pulse wave measuring unit in Fig. 2A;
Fig. 5 is a bottom view showing the pulse wave measuring unit in Fig. 2A;
Fig. 6A is a front view showing a pressure measuring device of the pulse wave measuring unit in Fig. 2A;
Fig. 6B is a left side view of Fig. 6A;
Fig. 6C is a bottom view of Fig. 6A;
Fig. 7 is a front view showing the pulse wave measuring unit in Fig. 2A when pressing legs (vessel vicinity pressing portions) thereof are in contact with the patient's arm at a sill pressure;
Fig. 8 is a front view showing balance of forces exerted in the contact portion (vessel pressing portion) of the pulse wave measuring unit in Fig. 2A and in the patient's arm;
Fig. 9 is a graph showing mutual relationship between the displacement of the pressing legs of the pulse wave measuring unit in Fig. 2A and the skin tension exerted in the patient's arm;
Fig. 10 is a front view showing important parts of a pulse wave measuring device according to a second embodiment of the present invention;
Fig. 11A is a conceptual diagram for describing the correlation between entering light intensity and exiting light intensity according to Lambert-Beer law when the material distance through which light passes is ΔL;
Fig. 11B is a conceptual diagram for describing the correlation between entering light intensity and exiting light intensity according to Lambert-Beer law when the material distance through which light passes is $5\Delta L$;
Fig. 12 is a graph showing an example of variation of light absorption while time passes when outside light is entered to a part of a human body including blood vessels;
Fig. 13 is a graph showing an example of distribution of blood pressure in various parts of a human body;
Fig. 14 is a front view showing important parts of a pulse wave measuring device according to a variant of the second embodiment of the present invention;
Fig. 15 is a side view shoving a pulse wave measuring device according to a third embodiment of the present invention;
Fig. 16 is a front view showing a pulse wave measuring device according to a fourth embodiment of the present invention;
Fig. 17 is a diagram showing the blood circulation system of a human body, especially showing arteries and veins;
Fig. 18 is a diagram showing an output circuit, in which the output signals from the pressure sensors of the pulse wave measuring unit are amplified, of the first embodiment;
Fig. 19 is a graph showing a pulse waveform amplified by the output circuit shown in Fig. 18;
Fig. 20 is a cross sectional view showing the pressure measuring device taken along line XX-XX in Fig. 6A;
Fig. 21 is a graph showing variation of the electromechanical coupling factor of the pressure measuring device in relation to the relative thickness of the thinner portions of the beam in the pressure measuring device shown in Fig. 6A;
Fig. 22A is a graph showing a *tendency curve* of *Ping-mai* indicating amplitude variations of human pulse wave due to pressure change given to human skin;
Fig. 22B is a graph showing a *tendency curve* of *Hua-mai*;
Fig. 22C is a graph showing a tendency curve of *Xuan-mai*;
Fig. 23 is a perspective view showing a pulse wave measuring device according to a fifth embodiment of the present invention;
Fig. 24 is a side view showing the pulse wave measuring device in Fig. 23;
Fig. 25 is a front view taken along line XXV-XXV in Fig. 24;
Fig. 26 is a perspective view showing a variant of the pulse wave measuring device according to the fifth embodiment, in which an arm holder is altered;
Fig. 27 is a perspective view showing another variant of the pulse wave measuring device according to the fifth embodiment, in which an arm holder is altered;
Fig. 28 is an enlarged side view showing the connection of the supporting member and the transverse sliding member of the pulse wave measuring device according to the fifth embodiment;
Fig. 29 is a block diagram showing structural elements for showing pulse waveform in a monitor dis-

play according to the signals from the pulse wave measuring device of the fifth embodiment;

Fig. 30 is an illustration showing usage of the pulse wave measuring device;

Fig. 31 is a side view showing a variant of the pulse wave measuring device according to the fifth embodiment;

Fig. 32 is a side view showing another variant of the pulse wave measuring device according to the fifth embodiment;

Fig. 33 is a side view showing another variant of the pulse wave measuring device according to the fifth embodiment;

Fig. 34 is a side view shoving the pulse wave measuring device according to the sixth embodiment of the present invention;

Fig. 35 is a front view taken along line XXXV-XXXV in Fig. 34;

Fig. 36 is a bottom view taken along line XXXVI-XXXVI in Fig. 34;

Fig. 37 is a side view showing the pulse wave measuring device in Fig. 34 in which the diagnostician is adjusting the position of the sensor;

Fig. 38 is a side view showing the pulse wave measuring device according to the seventh embodiment of the present invention;

Fig. 39 is a front view taken along line XXXIX-XXXIX in Fig. 39;

Fig. 40 is a bottom view showing a variant of a finger-insertion member, which may be used in any of the sixth and seventh embodiments;

Fig. 41 is a bottom view showing another variant of a finger-insertion member, which may be used in any of the sixth and seventh embodiments;

Fig. 42 is a bottom view showing another variant of a finger-insertion member, which may be used in any of the sixth and seventh embodiments;

Fig. 43 is a bottom view showing another variant of a finger-insertion member, which may be used in any of the sixth and seventh embodiments;

Fig. 44 is a front view showing the pulse wave measuring device according to the sixth embodiment, in which the finger-insertion member is replaced by that shown in Fig. 43, whereby the diagnostician directly touches the patient's arm and searches the measured position;

Fig. 45 is a front view showing a variant of the pulse wave measuring device according to any of the fifth through seventh embodiments, in which supporting members are modified; and

Fig. 46 is a front view showing another variant of the pulse wave measuring device according to any of the fifth through seventh embodiments, in which supporting members are modified.

BEST MODE FOR CARRYING OUT INVENTION

1. FIRST EMBODIMENT

1-1. STRUCTURE OF PULSE WAVE MEASURING DEVICE OF FIRST EMBODIMENT

[0043] As shown in Fig. 1, a pulse wave measuring device 1 according to a first embodiment of the present invention comprises a stand 2 placed on a flat plane and three pulse wave measuring units 3, which are of the same type as one another, supported by the stand 2. The stand 2 includes a vertically standing shaft 2a, and an arm 2b connected to the shaft 2a. A bracket 4 is arranged at the distal end of the arm 2b.

[0044] The height of the proximal end of the arm 2b can be adjusted in relation to the shaft 2a. The arm 2b is rotatable about the shaft 2a, so that the direction of the arm 2b in a horizontal plane can be adjusted. In addition, the arm 2b can be swiveled in a vertical plane, and the direction of the arm 2b in the vertical plane can be adjusted. These adjusting mechanisms are known, so that the description thereof is omitted. By the above-mentioned adjustment of the stand 2, the position of the bracket 4 may be adjusted. However, other mounting means may be adapted instead of the stand 2 as long as the position of the bracket 4 can be adjusted.

[0045] An arm support 5 is utilized for the pulse wave measuring device 1. The arm support 5 is of a substantially rectangular block shape having a planar upper surface 5a. An upwardly opening hollow 5b is formed at the arm support 5 while an upwardly projecting wall 5c is formed in the vicinity of the hollow 5b. A cylindrical rod 6 is mounted on the projecting wall 5c, so as to extending over the hollow 5b and parallel to the upper surface 5a.

[0046] A human patient's arm (measured thing) 7 is placed on the upper surface 5a of the arm support 5 in such a manner that the patient's hand 8 is situated below the rod 6 and the palm is oriented upward. In this condition, the hand 8 may be inclined slightly downward from the wrist so as to be positioned within the hollow 5b. Accordingly, as long as the patient does not move the arm 7 intentionally, the arm 7 is stabled at the illustrated position. Above the arm 7 placed on the upper surface 5a, three pulse wave measuring units (pulsation detecting devices) 3 are arranged by adjusting the stand 2. The pulse wave measuring units 3 measures the pulse waves at three portions called "*Sunn*", "*kann*", and "*Syaku*" in Oriental medicine, respectively.

[0047] Figs. 2A, 2B, 3, and 4 show one of the pulse wave measuring unit 3. The single pulse wave measuring unit 3 comprises a supporting member 10 and a pressure measuring device 80 supported in a cantilever manner by the supporting member 10. As will be described later, two pressing legs (vessel-vicinity pressing portions or subject-vicinity pressing portions) 68 and 72 are formed at the supporting member 10. The pressing legs 68 and 72 are oriented toward and are pressed

against the patient's arm 7.

[0048] The supporting member 10 comprises a mounting plate 11 which is a substantially rectangular planar plate. As shown in Fig. 1, the mounting plate 11 is secured to the bracket 4 by screws 13, and the supporting member 10 is arranged in a vertical plane. The mounting plates 11 of three pulse wave measuring units 3 are parallel to one another. As illustrated In Figs. 2A, 2B, 3, and 4, a pair of through-holes 12, through which the screws 13 are inserted, are formed at the upper portion of the mounting plate 11.

[0049] At the lower portion of the mounting plate 11, a circular penetrating opening 14 is formed. Four screws 15 arranged around the opening 14 secure a first perpendicular sliding plate 16 to the mounting plate 11. The first perpendicular sliding plate 16, which is a substantially rectangular planar plate, is provided with a perpendicular guidance groove 17 at the side which is opposite to the mounting plate 11.

[0050] At the side, which is opposite to the mounting plate 11, of the first perpendicular sliding plate 16, a second perpendicular sliding plate 18 is arranged in a manner that the second sliding plate 18 is slidable in relation to the first slidable plate 16. The second perpendicular sliding plate 18 is also a substantially rectangular planar plate. A pair of parallel rails 19 and 20 are fixed at the side, facing to the first slidable plate 16, of the second sliding plate 18. The rails 19 and 20 are put into the perpendicular guidance groove 17 of the first perpendicular sliding plate 16, so that the second perpendicular sliding plate 18 is slidable along the vertical or perpendicular direction in relation to the first perpendicular slidable plate 16. A mechanism is provided for preventing the first and second sliding plates 16 and 18 from being separated from each other (not shown).

[0051] Pins 21 and 22 are arranged in the space between the rails 19 and 20. The upper pin 21 is fixed to the second slidable plate 18 while the lower pin 22 is fixed to the first slidable plate 16. Hooks formed at both ends of a coil spring 23 are hung on the pins 21 and 22, respectively. Therefore, the second perpendicular slidable plate 18 is always pulled downwardly.

[0052] As shown in Figs. 2A and 3, an L-shaped bracket 25 is secured to the second perpendicular sliding plate 18 by screws 24 while another L-shaped bracket 27 is secured to the first perpendicular sliding place 16 by screws 26. The bent distal end 25a of the L-shaped bracket 25 projects frontward in Fig. 2A while the bent distal end 27a of the bracket 27 projects rearward in Fig. 2A, so that the ends 25a and 27a overlap with each other in a vertical line.

[0053] The sleeve 29 of a micrometer head 28 is fixed to the distal end 25a of the L-shaped bracket 25 by a nut 30. The micrometer head 28 is of a known configuration comprising the sleeve 29, a thimble 31, and a spindle 32.

[0054] On the other hand, a headless screw 34 is screwed in the distal end 27a of the L-shaped bracket 27 and is fixed by a nut 35 temporarily. The spindle 32 of the micrometer head 28 and the headless screw 34 are aligned coaxially. Since the coil spring 23 pulls the first perpendicular sliding plate 18 downward, the end face of the spindle 32 is always in contact with the upper end face of the screw 34.

[0055] With such a structure, when the thimble 31 of the micrometer head 28 is revolved about the axis thereof, the spindle 32 extends or contracts. When the spindle 32 extends, the second sliding plate 18 is raised up overcoming the force of the coil spring 23 since the headless screw 34 is secured to the fixed first sliding plate 16. Conversely, when the spindle 32 contracts, the second sliding plate 18 is lowered in relation to the first sliding plate 16 by the force of the coil spring 23. Fig. 7 shows the second sliding plate 18 raised in comparison with the status shown in Fig. 2A. The displacement of the second sliding plate 18 can be measured using with the dials of the thimble 31 and sleeve 29 of the micrometer head 28 in a known manner.

[0056] Two protruding pins 36 are attached to the side surface, which is opposite to the micrometer bead 28, of the first sliding plate 16. A narrow plate 37 bridging between the pins 36 are fixed to the pins 36 by screws 38. The narrow plate 37 is held in the vertical groove 39a in a holding block 39 of a rectangular block shape that is attached to the second sliding plate 18. A fastening screw 40 is screwed in the holding block 39, and can tightly fasten the arrow plate 37 in the vertical groove 39a when the screw 40 is revolved. In summary, after the height of the second sliding plate 18 is adjusted by handling the micrometer head 28, the height is maintained by fastening the screw 40. Before the height of the second sliding plate 18 is adjusted by handling the micrometer head 28, it is necessary to loosen the screw 40 in order that the arrow plate 37 be freed from the holding block 39.

[0057] As shown in Figs. 2B and 3, a connecting plate 42 is secured by screws 41 to the side, which is opposite to the first sliding plate 16, of the second sliding plate 18. The connecting plate is of a length in the vertical direction greater than the double of the length of the second sliding plate 18. Circular penetrating openings 43 are formed at upper and lower positions of the connecting plate 42.

[0058] A first horizontal or transverse sliding plate 44, which is of a substantially rectangular planar shape, is fixed to the connecting plate 42 by the screws 45. A horizontally extending guidance groove 46 is formed at the side, which is opposite to the connecting plate 42, of the first transverse gliding plate 44.

[0059] At the side, which is opposite to the connecting plate 42, of the first transverse sliding plate 44, a second horizontal or transverse sliding plate 47 is arranged in a manner that the second transverse sliding plate 47 is slidable in relation to the first transverse slidable plate 44. The second transverse sliding plate 47 is also a substantially rectangular planar plate. A pair of parallel rails

48 and 49 are fixed at the side, facing to the first transverse slidable plate 44, of the second transverse sliding plate 47. The rails 48 and 49 are put into the horizontal guidance groove 46 of the first transverse sliding plate 44, so that the second transverse sliding plate 47 is slidable along the transverse direction in relation to the first transverse slidable plate 44. A mechanism is provided for preventing the first and second sliding plate 44 and 47 from being separated from each other (not shown).

[0060] Pins 50 and 51 are arranged in the space between the rails 48 and 49. The pin 50 is fixed to the second slidable plate 47 while the other pin 51 is fixed to the first slidable plate 44. Hooks formed at both ends of a coil spring 52 are hung on the pins 50 and 51, respectively, Therefore, the second transverse slidable plate 47 is always pulled leftwardly in Fig. 2A.

[0061] As shown in Fig. 2A and 3, an L-shaped bracket 54 is secured to the first transverse sliding plate 44 by screws 53 while another L-shaped bracket 56 is secured to the second transverse sliding plate 47 by screws 55. The bent distal end 54a of the L-shaped bracket 54 projects frontward in Fig. 2A while the bent distal end 56a of the bracket 56 projects rearward in Fig. 2A, so that the ends 54a and 56a overlap with each other in a horizontal line.

[0062] The sleeve 58 of a micrometer bead (adjusting means) 57 is fixed to the distal end 56a of the L-shaped bracket 56 by a nut 59. The micrometer head 57 comprises the sleeve 58, a thimble 60, and a spindle 61, as similar to the micrometer head 28.

[0063] On the other hand, a headless screw 63 is screwed in the distal end 54a of the L-shaped bracket 54 and is fixed by a nut 64 temporarily. The spindle 61 of the micrometer head 57 and the headless screw 63 are aligned coaxially. Since the coil spring 52 pulls the second transverse sliding plate 47 leftward in Fig. 2A, the end face of the spindle 61 is always in contact with the end face of the screw 63. To clarify the structure, the pulse wave measuring unit 3 viewed from a lower position is shown in Fig. 5.

[0064] With such a structure, when the thimble 60 of the micrometer head 57 is revolved about the axis thereof, the spindle 61 extends or contracts. When the spindle 61 extends, the second sliding plate 47 is moved rightward in Fig. 2A overcoming the force of the coil spring 52. Conversely, when the spindle 61 contracts, the second sliding plate 47 is moved leftward in Fig. 2A in relation to the first sliding plate 44 by the force of the coil spring 52. Fig. 7 shows the second sliding plate 47 is moved leftward in comparison with the status shown in Fig. 2A. The displacement of the second sliding plate 47 can be measured using with the dials of the thimble 60 and sleeve 58 of the micrometer head 57.

[0065] A rectangular notch 42a is formed at the lower end of the connecting plate 42, so that the dials of the micrometer head 57 can be seen through the notch 42a. As shown in Fig. 2A, a bent first pressing plate 65 is secured to the right side face and the lower end face of the connecting plate 42. The first pressing plate 65 comprises a vertical portion 66 secured to the right side face of the connecting plate 42, a horizontal portion bent perpendicularly from the lower end of the vertical portion 66, and a first pressing leg 68 bent obliquely and downwardly from the horizontal portion 67. As shown in Fig. 3, the horizontal portion 67 is secured to the lower end face of the connecting plate 42 while the lower end portion of the first pressing legs 68 is bent and oriented downwardly.

[0066] In addition, a second pressing plate 70 is secured to the second transverse sliding plate 47 by screws 69. The second pressing plate 70 comprises a planar mounting portion 71 secured to a front surface of the second transverse sliding plate 47 in Fig. 2A, and a planar second pressing leg 72 bent perpendicularly from the mounting portion 71. The lower portion of the second pressing leg 72 is of a width greater than that of the upper portion, and faces to the first pressing leg 68. The lower end portion of the second pressing leg 68 is bent obliquely and downwardly. Since the second transverse sliding plate 47 is moved transverse in relation to the first transverse sliding plate 44 as described above, the interval between the pressing legs 68 and 72 is adjusted.

[0067] As shown in Fig. 2A, the pressing legs 68 and 72 may be into contact with the skin of the patient's arm 7, especially, both side positions of the radial artery (measured subject) 100. In Fig. 2A, a cross section of the arm 7 is shown for clearly indicating the radius 101, ulna 102, brachioradialis tendon 103, and flexor carpi radial is tendon 104. The first leg 68 presses the softer or more elastic part between the radial artery 100 and the flexor carpi radialis tendon 104 while the second leg 72 presses the softer or more elastic part between the radial artery 100 and the brachioradialis tendon 103. In the organism's superficial portion, since the vicinity of blood vessels and tendons has less elasticity and other parts have greater elasticity, the pressing legs 68 and 72 press down the softer parts.

[0068] The structural elements of the supporting member 10, i.e., the mounting plate 11, the first and second perpendicular sliding plates 16 and 18, the connecting plate 42, the first and second transverse sliding plates 44 and 47, and the first and second pressing plates 65 and 70 are manufactured of a metal. However, these elements may be made of another material, such as hard plastics, as long as the material has hardness greater than that of the blood vessel or measured subject (radial artery in this embodiment).

[0069] The horizontal portion 67 of the first pressing plate 65 supports a pressure measuring device 80 comprising a beam 81 supported by the horizontal portion 67 in a cantilever manner, and piezoelectric elements (pulsation measuring sensors or pressure sensors) 82 adhered on the beam 81. The beam 81 is of a substantially L-shaped configuration comprising a planar sup-

ported portion 85, which is a proximal portion secured to the horizontal portion 67; and a contact portion (vessel pressing portion or measured subject pressing portion) 86, which is perpendicularly bent from the supported portion 85. The center of the supported portion of the beam 81 is affixed to the horizontal portion 67 by a bolt 83 and nut 84 while the end of the supported portion is pinched between a jaw plate 84a and the horizontal portion 67, which are secured to each other.

[0070] The contact portion 86 is situated in the space between the first and second legs 68 and 72. In other words, the pressing legs 68 and 72 are arranged at both sides of the contact portion 86. The distal end of the contact portion 86 is oriented downward and may be into contact with the skin over the radial artery 100 of the patient's arm 7. The distal end of the contact portion 86 is upper than the distal ends of the pressing legs 68 and 72. That is, the distal end of the contact portion 86 is situated back from the distal ends of the pressing legs 68 and 72. When the beam 81 is not stressed, the distal end of the contact portion 86 is preferably 0.5 to 2 mm, more preferably 0.9 to 1.1 mm per than the distal ends of the pressing legs 68 and 72.

[0071] As shown in Fig. 6A, the distal end portion of the supported portion 85 of the beam 81 is thinner than the other portions. This portion will be called thinner portion 87. As shown in Figs. 6B and 6C, three parallel separating grooves 88 are formed from the thinner portion 87 and the contact portion 86. Therefore, each of the thinner portion 87 and the contact portion 86 is divided into four parts. Four piezoelectric elements 82 are adhered to the upper surfaces of four thinner portions 87, respectively. More exactly, each piezoelectric element 82 is longer than the thinner portion 87 along the longitudinal direction of the beam 81 and is adhered to the corresponding thinner portion 87 entirely and to the supported portion 85 partially. In addition, a through-hole 90 for inserting the above-mentioned bolt 83 is illustrated in Figs. 6A and 6C.

[0072] With such a structure, the stress on four contact portions 86 varies according to pulsation of the radial artery 100. The varying stress is transmitted to each piezoelectric element 82 via the corresponding thinner portion 87. Each piezoelectric element 82 outputs a pulse wave signal (pulsation signal) which is the voltage varying according to the stress variation. The supported portion 85 of the beam 81 is provided with four amplification units 89. Pulse wave signal from each of the piezoelectric elements 82 is supplied to corresponding amplification unit 89 to be amplified, and the amplified signal is outputted from the unit 89.

[0073] As will be understood, the beam 81 of each pulse wave measuring unit 3 is provided with four contact portions 86, which are aligned in a row at an interval along the radial artery 100. Consequently, each pulse wave measuring unit 2 measures pulse waves at four points of the patient's arm 7. Since the pulse wave measuring device 1 has three pulse wave measuring units 3, the entire pulse wave measuring device 1 measures 12 points.

[0074] Fig. 18 shows an output circuit "*a*" in which the output signals from the piezoelectric elements 82 are amplified. The output circuit *a* is constituted of four operational amplifiers OP1 to OP4, which are respectively contained in the amplification units 89. With respect to each of the op-amps OP1 to OP4, the negative input terminal and the output terminal is connected, so that each op-amp functions as a voltage follower. The piezoelectric elements 82 are connected with the positive input terminals of the op-amps OP1 to OP4 and with the earth. Input impedance of the op-amps OP1 to OP4 is between 10^8 ohms and 10^{12} ohms. Such high input impedance can be realized by the op-amps since they are MOSFETs and the like. If other op-anps with only low input impedance are used, the output signals of the op-amps are not analyzed since the current generated by the piezoelectric element 82 is weak. However, the op-amps OP1 to OP4 have high input impedance, the output signals can be analyzed. In an experiment, the amplitude of voltage at the output terminal of each of the op-amps OP1 to OP4 was about 0.15 volts as shown in Fig. 19.

[0075] The output signals from the op-amps OP1 to OP4 are provided to an outside analog-to-digital converter (not shown), and converted to digital signals. The digital signals are provided to a computer (not shown). The output circuit *a* shown in Fig, 18 is provided in the beam 81 for a single pulse eve measuring unit 3. Therefore, three output circuits *a* are provided for three pulse wave measuring units 3 in the entire device 1. The A/D converter has 12 channels for the op-amps OP1 to OP4 of three measuring units 3 and converts the signals through 12 channels. The computer operates on the basis of a diagnostic program, referring to the signals provided through 12 channels, so as to diagnose the patient's physiological condition.

[0076] In the above-described pressure measuring device 80, since the piezoelectric elements 82 are fixed at the thinner portions 87 of the beam 81, the transformation occurred on the piezoelectric elements 82 according to the stress variation is larger than the transformation when they are fixed at other portions. Therefore, the strain exerted on the piezoelectric elements 82 is large, so that the measurement accuracy can be enhanced. Each of the piezoelectric elements 82 is longer than the thinner portion 87 along the longitudinal direction of the beam 81 and is adhered to the corresponding thinner portion 87 entirely and to the supported portion 85 partially. Since the piezoelectric elements 82 is long and partially adhered on the supported portion 85, the strain energy stored in each piezoelectric element 82 is large when the beam 81 is stressed.

[0077] In a typical conventional pressure measuring device with cantilever, a piezoelectric element is adhered only to the vicinity of the distal end of the can-

tilever (vicinity of the contact portions 86, e.g., thinner portions 87 in the embodiment) since the curvature is the largest at distal end. However, the piezoelectric element in the vicinity of the end should be small in size. Therefore, less strain energy is stood therein, and flown is an extremely weak current. Furthermore, although a piezoelectric element can output a high voltage, it generates less current. Accordingly, the output voltage (signal) is difficult to be detected and analyzed by the prior art.

[0078] In contrast, by virtue of the above-described pressure measuring device 80, since much strain energy can be accumulated in the piezoelectric element 82, the current generated by the piezoelectric element 82 is larger than that of conventional device. Therefore, the amplitude of the output signal may be enlarged. The above-described output circuit with high input impedance can further improve the advantage.

[0079] In the illustrated embodiment, the piezoelectric element 82 is adhered, along the longitudinal direction of the beam 81, to the corresponding thinner portion 87 entirely and to the supported portion 85 partially. However, in a variant, the piezoelectric element 82 may be adhered to the corresponding thinner portion 87 entirely and to the contact portions 86 partially. In another variant, the piezoelectric element 82 may be adhered to the corresponding thinner portion 87 entirely, to the supported portions 85 partially, and to the contact portion 86 partially.

[0080] In order to accumulate much strain energy, it is preferable that the area of the piezoelectric element 82 is large. However, if the area of piezoelectric element 82 is large, the electrostatic capacity will be large, thereby lowering the measurement accuracy. Accordingly, it is preferable that the area of the piezoelectric element 82 is between 130 and 150% of that of the corresponding thinner portion 87. Namely, the extra area of the piezoelectric element 82 protruding outside from the corresponding thinner portion 87 is preferably between 30 and 50% of the area of the corresponding thinner portion 87.

[0081] Fig. 20 is a cross section of the pressure measuring device 80 taken along line XX-XX in Fig. 6A. As shown in Fig. 20, the thickness Ts of the thinner portions 87 of the beam 81 is substantially the same as the thickness Tp of the piezoelectric elements 82. The reason will be explained below.

[0082] Fig. 21 shows a variation of the electromechanical coupling factor of the piezoelectric element 82 in relation to the relative thickness (Ts/(Ts + Tp)) of the thinner portion 87 (supporting layer for the piezoelectric element 82) when the beam 81 was made of phosphor bronze and the piezoelectric element 82 was made of a ceramic material. The electromechanical coupling factor is a factor indicating the electromechanical conversion efficiency in the pressure measuring device 80, and more specifically it is the square root of the ratio of electrically generated energy to given mechanical energy. Although the result illustrated in Fig. 21 was obtained when the beam 81 was made of phosphor bronze, similar results were obtained when other materials are used for the beam 81. Consequently, it is not intended to limit the present invention to manufacture the beam 81 of phosphor bronze.

[0083] As clearly shown in Fig. 21, the electromechanical coupling factor peaked when the relative thickness was approximately 20%, and it decreased gradually when the relative thickness was beyond 20%. In addition, when the relative thickness was approximately 60%, the electromechanical coupling factor was the same as that when the relative thickness or thickness Ts of the thinner portions 87 was zero ("Ts was zero" means that only the piezoelectric element supported the contact portion 86). When the relative thickness was in excess of 60%, the electromechanical coupling factor decreased linearly. From the experimental result, it is understood that the relative thickness of the thinner portion 87 is preferably equal to or less than about 60%. More preferably, the relative thickness of the thinner portion 87 is about 20% in order to enhance the electromechanical coupling factor and conversion efficiency of the piezoelectric element 82. It is supposed that the reason of the result is that when the area of cross section of the thinner portion 87 is large, large strain energy is accumulated therein, so that the electromechanical conversion efficiency is reduced.

[0084] On the other hand, it is possible that the contact portions 86 are supported by only piezoelectric elements without the thinner portions 87 of the beam 81. In this case, since the given strain energy can be accumulated in the piezoelectric elements, it is theoretically supposed that the conversion efficiency is increased. However, because of various factors, for example, the accumulating speed of the strain energy and the vibration damping, it is preferable that the piezoelectric elements 82 are mounted on the beam 81 as in the embodiment.

[0085] Therefore, it is understood that the piezoelectric elements 82 are preferably mounted on the different beam 81 and the ratio of the area of cross section of the beam 81 to the area of total cross section of the beam 81 and piezoelectric elements 82 is preferably equal to or less than 60% in order to enhance the amplitude of the output signals.

1-2. USAGE OF PULSE WAVE MEASURING DEVICE OF FIRST EMBODIMENT

[0086] Usage of the pulse wave measuring device 1 of the embodiment will be next explained below. Before the use, the second perpendicular sliding plate 18 and the elements suspended therefrom are raised by handling the micrometer bead 28, and the interval of the pressing legs 68 and 72 is broadened by handling the micrometer head 57.

[0087] First, the patient's arm 7 is placed as shown in

Fig. 1, and then three pulse wave measuring units 3 are roughly positioned above the *Sunn*, *Kann*, and *Syaku* of the arm 7 by adjusting the stand 2. Simultaneously, four contact portions 86 of each pulse wave measuring unit 3 are aligned along a line directly above the patient's radial artery 100

[0088] Next, the micrometer bead 28 is handled, so that the spindle 32 is retracted to lower the second perpendicular sliding plate 18. Simultaneously, the mounting plate 42 suspended from the second perpendicular sliding plate 18 are lowered, whereby the pressing legs 68 and 72 and the contact portions 86 come into contact with the skin of the patient's arm 7. The micrometer head 28 is revolved until the pressing leg 68 presses down the softer part, between the radial artery 100 and the flexor carpi radialis tendon 104, to a predetermined depth.

[0089] Then, the micrometer head 57 is handled, so that the spindle 61 is retracted to make the second pressing leg 72 approach the first pressing leg 68. When the second pressing leg 72 arrives at the softer part between the radial artery 100 and the brachioradialis tendon 103 and presses this part down, the micrometer head 57 is stopped to be revolved, so that the movement of the second pressing leg 72 is stopped. In Fig. 7, the second pressing leg 72 before the approach is illustrated with solid lines while the leg 72 after the approach is illustrated with imaginary lines. The contact portions 86 are positioned on the skin above the radial artery 100 according to the aforementioned manner, so that the wave pulses on 12 points are evaluated according to the output signals from 12 piezoelectric elements 82.

[0090] As described above, since the second pressing leg 72 can be moved in relation to the first pressing leg 68, both pressing legs 68 and 72 can press down the more elastic or softer parts at the sides of the radial artery 100, whereby four contact portions 86 of each pressure measuring device 80 can be readily positioned on the skin above the radial artery 100. Furthermore, since the distal ends of the contact portions 86 are upper than the distal ends of the pressing legs 68 and 72, the radial artery 100, which is more inflexible or harder than other tissues, is readily positioned between the pressing legs 68 end 72. In other words, twelve contact portions 86 of three pressure measuring devices 80 can be readily positioned on the skin over the radial artery 100 although it is unnecessary for the patient to move his arm 7 and unnecessary for the diagnostician to tend the supporting memoers 10 in accordance with the embodiment.

[0091] If a pressure measuring device is pressed on the organism's surface by a cuff as in the conventional manner, not only the blood vessel but also muscle or tissues around it are pressed flatly, so that it is difficult to adjust the initial pressure on the blood vessel. However, in the embodiment, since two rigid pressing legs 68 and 72 press down the softer parts at the sides of the radial artery 100, it is readily adjust the initial pressure on the radial artery 100 given by the contact portions 86 of the pressure measuring devices 80. Namely, the contact portions 86, which transfer the stress to the piezoelectric elements 82, are used to vary the initial pressure to the radial artery 100 by handling the micrometer head 28.

[0092] After the finish of a diagnosis at a depth where the pressing legs 68 and 72 have been stopped, the pressing legs 68 and 72 and the contact portions 86 are further lowered by handling the micrometer head 28 again, whereby the initial pressure on the radial artery 100 is changed. Since blood pulse wave feature varies depending on the initial pressure on the measured blood vessel as depicted in Figures 22A to 22C, the patient's physiological condition can be diagnosed in detail. While Fig. 7 shows that the pressing legs 68 and 72 and the contact portions 86 are slightly lowered, Fig. 2A shows that they are greatly lowered.

[0093] If the contact portions 86 are lowered, the initial pressure on the artery given by the pressure measuring device 80 is increased. However, if the contact portions 86 are lowered simply, the skins are stretched by the pressing legs 68 and 72 so as to slightly change its tension T depicted in Fig. 8. The pressure measured by the pressure measuring device 80 depends not only on the internal pressure D of the radial artery 100, but also on the skin tension T. Therefore, the initial pressure on the radial artery 100 is not exactly and univocally controlled.

[0094] Fig. 9 is a graph showing the correlation between the skin tension T and the displacement of the pressing legs 68 and 72 in the vertical direction when the interval between the pressing legs 68 and 72 is constant. The abscissa of Fig. 9 designates the absolute value of the downward displacement of the first pressing leg 68, wherein the position at which the first pressing leg 68 first comes into contact with the skin is determined to be zero. As shown in Fig. 9, the skin tension T increases in accordance with increase of the initial pressure by the downward movement of the first pressing leg 68 and contact portions 86.

[0095] Accordingly, in advance, it is preferable to research the correlation between the skin tension T and the displacement of the pressing legs 68 and 72 in the vertical direction when the interval between the pressing legs 68 and 72 is constant. Alternatively, in advance, it is preferable to research the correlation between the skin tension T and the interval between the pressing legs 68 and 72 when the displacement of the pressing legs 68 and 72 in the vertical direction is constant. Consequently, it is possible to adjust the interval between the pressing legs 68 and 72 by handling the micrometer head 57 on the basis of any of the results of the above researches, thereby excluding the affection of the skin tension T, i.e., making the skin tension T constant at every diagnostic points. By virtue of the research and adjustment, the initial pressure given to the radial artery 100 can be altered to desirable values exactly. The

adjustment of the initial pressure is conducted for all of three pulse wave measuring units 3. Under the adjusted pressure, the wave pulses on 12 points are evaluated again according to the output signals from 12 piezoelectric elements 82.

[0096] In accordance with the traditional blood pulse wave diagnosis in Oriental medicine, the physiological status of a patient is determined according to more than ten pulse wave characteristics obtained by quantitative or qualitative analyses. In addition, the diagnostician in this field should consider the patients' individual characteristics for diagnosis. For example, if a patient's radial artery has a special characteristic that a level of pressure is exerted in the radial artery as long as a great amount of pressure is applied to the wrist from outside, the diagnostician must determine the patient's waveform in view of his individuality. Therefore, it has been difficult for skill-less diagnosticians to determine the patients' characteristics in the conventional finger-touch manner.

[0097] However, by virtue of the embodiment, since the initial pressure can be readily adjusted, the diagnostician can obtain the patient's physiological characteristics quantitatively and qualitatively. Although special diagnosticians using with their sense have conventionally supposed such physiological characteristics, the physiological characteristics can be objectively obtained according to the embodiment. Therefore, the embodiment enables to reduce diagnostician's burden and contributes to inherit the technique for pulse wave diagnosis.

1-3. VARIANTS OF FIRST EMBODIMENT

[0098] In the first embodiment, the second transverse sliding plate 47 is moved in relation to the first transverse sliding plate 44 using with the micrometer head 57, so that the second pressing leg 72 is moved in relation to the first pressing leg 68. Conversely, the pressing legs 68 and 72 may be constructed in such a manner that the first pressing leg 68 is movable in relation to the fixed second pressing leg 72 in an alteration. Furthermore, both of the pressing legs 68 and 72 may be constructed so as to be movable in another alteration. These alterations may be also applied to the second through fourth embodiments, which will be described later.

[0099] Other types of pressure sensors, e.g., strain gauges can be used instead of the piezoelectric elements 82.

[0100] In the first embodiment, the beam 81 is supported in a cantilever manner. However, as long as there is a univocal correlation between the load onto each contact portion 86 and the strain in the pressure sensor, other supporting types for beam, e.g., a simple beam manner, can be also adapted.

2. SECOND EMBODIMENT

2-1. STRUCTURE AND OPERATION OF PULSE WAVE MEASURING DEVICE OF SECOND EMBODIMENT

[0101] A second embodiment of the present invention will be described next. Fig. 10 shows important parts of the pulse wave measuring device according to the second embodiment. The pulse wave measuring device also includes three pulse wave measuring units 3, which are almost the same as those in the first embodiment, each of the pulse wave measuring units 3 including the supporting member 10. The second embodiment is different from the first embodiment in the sort of the pulsation measuring sensors provided at the supporting member 10. The structural elements common to the first embodiment are not illustrated in Fig. 10.

[0102] As shown in Fig. 10, a beam 110 is secured to the horizontal portion 67 of the first pressing plate 65 in the supporting member 10 in the same fixing manner as of the beam 81 in the first embodiment. The beam 110 comprises a planar supported portion 111, which is a proximal portion secured to the horizontal portion 67; and a bent portion 112, which is perpendicularly bent from the supported portion 111. In the same manner as the beam 81 of the first embodiment (see Figs. 6B and 6C), the beam 110 is divided into four parts, so that a plurality of (four) bent portions 112 are provided in fact.

[0103] The bent portions 112 of the beam 110 are situated in the space between the first and second legs 68 and 72. In other words, the pressing legs 68 and 72 are arranged at both sides of the bent portions 112. The distal ends of the bent portions 112 are oriented downward. The distal end faces of the bent portions 112 are fixedly provided with optical pulsation measuring sensors 113, respectively. The optical pulsation measuring sensors 113 may be into contact with the skin over the radial artery 100 of the patient's arm 7. The optical pulsation measuring sensors 113 are upper than the distal ends of the pressing legs 68 and 72. That is, optical pulsation measuring sensors 113 are situated back from the distal ends of the pressing legs 68 and 72. When the beam 110 is not stressed, the optical pulsation measuring sensors 113 are preferably 0.5 to 2 mm, more preferably 0.9 to 1.1 mm upper than the distal ends of the pressing legs 68 and 72.

[0104] With such a structure, by handling the micrometer head 27 (see Figs. 2A, etc.) to lower the beam 110, the optical pulsation measuring sensors 113 on the bent portions 112 of the beam 110 may be pressed against the skin over the radial artery 100, so as to give the radial artery 100 an initial pressure. Consequently, the bent portions 112 and the optical pulsation measuring sensors 113 cooperate to constitute vessel pressing portions or subject pressing portions.

[0105] Each of the optical pulsation measuring sensors 113 includes a light-emitting element (emitting

means) 113a and a light-receiving element (receiving means) 113b. The light-emitting element 113a and light-receiving element 113b may be in contact with the skin over the radial artery 100, and while the emitting element emits light rays toward the radial artery 100, the receiving element receives the reflected rays by the radial artery 100.

[0106] Each of the receiving elements outputs a pulse wave signal (pulsation signal) relating to the strength of the received light. The pulse wave signals are amplified by an amplifier (not shown), and converted to digital signals by an outside analog-to-digital converter having 12 channels. The digital signals are provided to a computer (not shown). The computer operates on the basis of a diagnostic program, referring to the signals provided through 12 channels, so as to diagnose the patient's physiological condition.

[0107] The principle of pulse wave measurement by the optical pulsation measuring sensors 113 will be explained below.

[0108] When light rays are entered to a thin material, the luminous intensity of transmitting light decreases in comparison with the intensity of incident light by a value which is proportional to the material density and the material thickness. This phenomenon is well known as Lambert-Beer law.

[0109] With reference to Figs. 11A and 11B, Lambert-Beer law will be explained in more detail. As indicated in Fig. 11A, there is a correlation between intensity I_{in} of entering light and intensity I_{out} of exiting light which can be expressed in the next equation.

$$I_{out}/I_{in} = 1 - kC\Delta L \quad (1)$$

where C is the density of the material M, ΔL is its thickness, and k is its linear absorption coefficient.

[0110] If the material thickness is five times longer (see Fig. 11B), the correlation of equation (1) may be rewritten into the next equation.

$$I_{out}/I_{in} = (1 - kC\Delta L)^5 \quad (2)$$

[0111] According to equation (2), if intensity I_{out} of exiting light is 9 while intensity I_{in} of entering light is 10 in case shown in Fig. 11A, intensity I_{out} of exiting is be 5.9 while intensity I_{in} of entering light is 10 in case shown in Fig. 11B since I_{out}/I_{in} is equal to 0.9^5.

[0112] By integrating equation (1), the correlation between the intensity I_{in} of entering light and intensity I_{out} of light exiting through a distance L can be expressed in the next equation.

$$\log(I_{out}/I_{in}) = -kCL \quad (3)$$

[0113] Equation (3) may be further rewritten into the next equation.

$$I_{out} = I_{in} \times \exp(-kCL) \quad (4)$$

[0114] As will be understood by the above-equations, if intensity I_{in} of entering light, absorption coefficient K, and distance L are constant, it is possible to estimate the density variation of the material M by measurement of variation of exiting light intensity I_{in}. Conversely, by the same principle, it is possible to estimate the density variation of the material M by measurement of intensity variation of reflected light. When the material M is blood, the measurement of the density variation is equivalent to the measurement of the blood pulse wave or the measurement of pulsation.

[0115] Fig. 12 is a graph showing an example of variation of light absorption while time passes when outside light is entered to a part of a human body including blood vessels. In Fig. 12, light absorption I_4 at an artery varies while light absorption I_2 at tissues is constant since the tissue density does not vary. In addition, light absorption I_3 at a vein is constant since there is no pulsation in veins and no density variation.

[0116] Fig. 13 is a graph showing an example of distribution of blood pressure in various parts of a human body. As will be understood from Fig. 13, the blood pulsation decreases as the distance from the heart becomes larger, and disappears at veins. On the other hand, light absorption I_4 at an artery changes since the blood density varies in accordance with the blood pulsation as shown in Fig. 12. Accordingly, when a light is entered to the blood vessels, for example, the radial artery 100, the measurement of the intensity of the emitting or reflected light is effected by the light absorption I_2 through I_4. If the sun of the light absorption I_3 at a vein and light absorption I_4 at an artery is assumed as 100%, the ratio of light absorption I_4 at an artery is from 1 to 2% and the ratio of light absorption I_s is from 98 to 99%.

[0117] In accordance with the above-described principle, the optical pulsation measuring sensors 113 receive the light rays reflected by the radial artery 100 and its vicinity, thereby detecting the blood pulse wave. In addition, since the pressing legs 68 and 72 can press down the more elastic or softer parts at the sides of the radial artery 100, four optical pulsation measuring sensors 113 of each pressure measuring device 80 can be readily positioned on the skin above the radial artery 100. Furthermore, since the distal ends of the optical pulsation measuring sensors 113 are upper than the distal ends of the pressing legs 68 and 72, the radial artery 100, which is more inflexible or harder than other tissues, is readily positioned between the pressing legs 68 and 72. In other words, twelve optical pulsation measuring sensors 113 of three pressure measuring device 80 can be readily positioned on the skin over the radial artery 100 although it is unnecessary that the patient moves his arm 7 and unnecessary that the diagnostician tends the supporting members 10 in accordance with the embodiment.

[0118] Furthermore, since two rigid pressing legs 68 and 72 press down the softer parts at the sides of the

radial artery 100, it is readily adjust the initial pressure on the radial artery 100 given by the optical pulsation measuring sensors 113 of the beams 110.

2-2. VARIANTS OF SECOND EMBODIMENT

[0119] Fig. 14 illustrates a variant of the second embodiment. In Fig. 14, each of the optical pulsation measuring sensors 113 includes a light-emitting element 113a and a light-receiving element 113b that are separated from each other. Although the light-emitting elements 113a are attached to the lower end faces of the bent portions 112 of the beam 110, the light-receiving elements 113b are arranged at the bottom of the hollow 5b of the arm support 5(see Fig. 1). Another arrangement may be possible in which the light-receiving elements 113b are suspended by the supporting member 10 in such a manner that they can receive the light rays penetrating through the patient's arm 7 from the light-emitting elements 113a attached to the bent portions 112.

3. THIRD EMBODIMENT

[0120] Fig. 15 shows a pressure measuring device according to third embodiment of the present invention. In this embodiment, a wristband, constituted of band pieces 121a and 121b, of a watch 120 is used for a supporting member for the pressure measuring device. The wrist band pieces 121a and 121b, attached to both ends of a watch body 120a, cooperate to encircle the patient's wrist and are connected by a known hook 122. The circular length of the watch 120 may be adjusted by loosening and fastening of the hook 122, so that the retaining force to the wrist can be adjusted.

[0121] The reverse side of the wrist band piece 121a is provided with an optical pulsation measuring sensor 113. Instead of the sensor 113, another type of pressure measuring sensor may be used. By the retaining force of the wrist band pieces 121a and 121b, the pressure measuring sensor or optical pulsation measuring sensor 113 presses the skin over the radial artery 100.

[0122] A pair of pressing legs 68 and 72 are also attached to the reverse side of the wrist band piece 121a, so as to protrude inwards. At least one of the pressing legs 68 and 72 is movable along the circular or lengthwise direction of the wrist band piece 121a, and is stably positioned after stopping the movement. The means for moving and positioning the pressing legs 68 and/or 72 can be a screw, hook, and the like although it is not illustrated.

[0123] The pressure measuring sensor or optical pulsation measuring sensor 113 is situated back from the distal ends of the pressing legs 68 and 72. Therefore, the blood vessel is positioned between the pressing legs 68 and 72, so that the sensor can be readily positioned on the skin above the blood vessel. In addition, the measuring device is manufactured lighter in weight very much in accordance with this embodiment.

4. FOURTH EMBODIMENT

[0124] Fig. 16 shows a pressure measuring device according to a fourth embodiment of the present invention. An elastic arched collar 130 is used for a supporting member for the pressure measuring device in this embodiment. The collar 130 is detachably arranged inside a collar 131, which is a part of clothing, so as to encompass the patient's neck. The circular length of the collar 130 is adjustable, so that the retaining force to the neck can be altered.

[0125] A pressure measuring sensor or optical pulsation measuring sensor 113 is secured to the reverse or inner surface of the collar 130, so as to be able to press the skin over the carotid artery of the patient. A pair of pressing legs 68 and 72 are also attached to the reverse surface of the collar 130, so as to protrude inwards. At least one of the pressing legs 68 and 72 is movable along the circular or lengthwise direction of the collar 130, and is stably positioned after stopping the movement.

[0126] The pressure measuring sensor or optical pulsation measuring sensor 113 is situated back from the distal ends of the pressing legs 68 and 72. Therefore, the blood vessel is positioned between the pressing legs 68 and 72, so that the sensor can be readily positioned on the skin above the blood vessel.

5. FIFTH EMBODIMENT

5-1. STRUCTURE OF PULSE WAVE MEASURING DEVICE OF THE EMBODIMENT

[0127] Fig. 23 is a perspective view showing a pulse wave measuring device 201 according to a fifth embodiment of the present invention while Fig. 24 is a side view thereof. As illustrated in Figs. 23 and 24, the pulse wave measuring device 201 comprises an arm holder 202 on which the patients arm is held; a pair of supporting members 203 of a slim and bent shape of which both ends are mounted on the arm holder 202; a horizontal or transverse sliding member 204 arranged on the supporting members 203; a perpendicular sliding member 205 attached to the transverse sliding member 204 movably in the perpendicular direction; and a strain gauge or measuring means 206 attached at the bottom of the perpendicular sliding member 205.

[0128] Fig. 25 is a view taken along line XXV-XXV in Fig. 24. As shown in Figs. 23 through 25, the arm holder 202 is constituted of a bottom plate 202a having a concave upper surface; a cushion 202b mounted on the bottom plate 202a; a finger holding portion 202c to which the patient's first to fourth fingers are inserted when patient's arm is held in the arm holder 202; and a band 202d loosely wound around the patient's arm. With such a constitution, when the patient's arm is held

in the arm holder 202, the arm is not tightly restricted and the skin over the radial artery is oriented upwardly.

[0129] Although the arm holder 202 is shown in Figs. 23 through 25, other types of arm holders, e.g., a rubber-band like am holder 212 in Fig. 26 or arm holder 222 in Fig. 27 may be used instead. The arm holder 222 comprises a holding box 223 of a U-shaped cross section and a lining cushion 224 inside the holding box 223. The patient's arm is put into the U-shaped cushion 224, and then loosely secured by a holding band 225. Another type of arm holder may be utilized as long as it does not retain the patient's arm tightly and the skin directly on the radial artery can be oriented upwardly.

[0130] As shown in Fig. 25, each of the supporting members 203 is constituted of a pair of legs 2031 affixed to the bottom plate 202a of the arm holder 202 by an adhesive, and a supporting portion 2032 of which both ends are supported respectively by the legs 2031. However, another manner for fixing the legs 2031 can be adapted instead of the adhesive. As shown in Fig. 28, ridges 2032a protrude from both sides of the upper portion of each supporting portion 2032. The upper surface of the supporting portion 2032 is provided with a series of teeth, so as to be a zigzag toothed portion 2033.

[0131] As illustrated in Fig. 24, a pair or grooves 2040 are formed at both ends of the bottom of the transverse sliding member 204. As shown in Fig. 23, a pair of protruding ridges 2040a are formed at the edges of each groove 2040. The bottom face of each groove 2040 is provided with a series of teeth, so as to be a zigzag or toothed portion 2041, which meshes with the toothed portion 2033 of one of the supporting members 203. The supporting portions 2032 of both supporting members 203 are inserted into the grooves 2040 of the transverse sliding member 204, so that the transverse sliding member 204 is slidable transversely (perpendicularly to Figs. 24 and 28) in relation to the supporting members 203 and vertical movement of the transverse sliding member 204 is restricted. As shown in Figs. 24 and 25, a through-hole 2042, penetrating in the vertical direction, is formed at the transverse sliding member 204. As shown in Fig. 24, a pair of opposing inner faces of the through-hole 2042 are provided with teeth, so as to be zigzag or toothed portions 2043.

[0132] As shown in Fig. 24, a pair of opposing outer faces of the perpendicular sliding member 205 are provided with teeth, so as to be zigzag or toothed portions 2051, which mesh with the toothed portions 2043 of the through-hole 2042. The perpendicular sliding member 205 is inserted into the through-hole 2042 in such a fashion that the toothed portions 2051 mesh with the toothed portions 2043, whereby the perpendicular sliding member 205 is slidable vertically or perpendicularly in relation to the transverse sliding member 204. A pair of protrusions or pull portions 2052, on which diagnostician's fingers may pull, project from side faces of the perpendicular sliding member 205.

[0133] The strain gauge 206 includes a resistor of metal or semiconductor and utilizes piezoresistive effect: i.e., the resistance varies when strain is applied. The strain gauge 206 may be in contact with the skin directly on the radial artery 100 in Fig. 25 by sliding operation of the sliding members 204 and 205, whereby the pulse wave according to pulsation of the radial artery 100 is transmitted to the strain gauge 206. Therefore, by means of continuous measurement of the resistance of the strain gauge 206, the pulse wave can be measured. However, instead of the strain gauge 206, another type of pressure sensor, including a piezoelectric element, that converts strain to electric signal, e.g., electric energy, electroresistance, or electrostatic capacity is utilized. In Fig. 25, a cross section of the arm 7 is shown for clearly indicating the radius 101, ulna 102, brachioradialis tendon 103, and flexor carpi radialis tendon 104.

[0134] The signal output from the strain gauge of the pulse wave measuring device 201 is supplied to an analog-to-digital converter 502 shown in Fig. 29, and converted to digital signals at fixed sampling intervals. The digital signals are supplied to a microcomputer 503 that obtains the pulse waveform on the basis of the digital signals and make a monitor display 504 indicate the waveform. Accordingly, the pulse waveform measured by the pulse wave measuring device 201 can be visibly indicated.

5-2. USAGE OF PULSE WAVE MEASURING DEVICE OF FIFTH EMBODIMENT

[0135] Next, usage of the pulse wave measuring device 201 according to this embodiment will be described. In the following, the embodiment is exemplified by measurement of pulse wave of the human radial artery. However, it is not intended to restrict the scope of the invention to measure human pulse wave, and rather the device can be used for measuring pulse wave of other animals.

[0136] First, the pulse wave measuring device 201 is set on the patient's forearm as shown in Fig. 23. The diagnostician next slides the sliding member 204 transversely in relation to the supporting members 203, thereby positioning the strain gauge 206 at a situation above the radial artery. Since the toothed portion 2033 of the supporting members 203 and the toothed portion 2041 of the transverse sliding member 204 are in mesh with each other, resistance is exerted against the glide. However, the teeth of the toothed portions 2033 and 2041 are formed so that the member 204 slides by diagnostician's fingers at a force, whereby the position adjustment is facilitated.

[0137] Therefore, the diagnostician can adjust the position of the transverse gliding member 204 by finger pushing or finger grasping. Then, he slides the perpendicular sliding member 205 downwardly, so that the strain gauge 206 is positioned to give the radial artery

an appropriate pressure. The toothed portions 2043 and 2051 are formed so that the perpendicular sliding member 205 is prevented from being moved by the pulsation force. More specifically, although there is individuality of the force by pulsation, it is preferable that the toothed portions 2043 and 2051 are formed so that the member 205 is moved by a force more than about 300 gram-force. In this case, the diagnostician can easily lower the member 205 overcoming the resistance force although pulsation cannot move the member 205 by the resistance force. Therefore, as shown in Fig. 30, the diagnostician can adjust the height of the strain gauge 206 appropriately using with only one hand in a simple manner. In addition, be can hang his two fingers on the protrusions 2052 and can pull up the perpendicular sliding member 205.

[0138] The position of the strain gauge 206 is adjusted while the diagnostician watches it. In addition, trial measurements are conducted at a plurality of positions, and the best position, at which the amplitude of the pulse waveform indicated by the monitor display 504 is the greatest, is selected. Then, the strain gauge 206 is moved to the best position.

[0139] After the positioning of the strain gauge 206 at the best measurement position in the above manner described above, the diagnostician commences to measure blood pulse wave. While the measurement, since the toothed portions 2043 and 2051 of the sliding members 204 and 205 are in mesh with each other and the toothed portions 2033 and 2041 of the members 203 and 204 are also in mesh with each other, the strain gauge 206 is not moved by a force equivalent to the pulsation force. Therefore, it is possible to continue to apply an appropriate pressure on the radial artery so as to obtain more accurate measurement results by the embodiment although it has been impossible by conventional devices including a sensor with a pen-like holder. Furthermore, since the pulse wave measuring device 201 is adjusted into the measurement position manually, it is unnecessary to provide a driving device and so on, so that the structure is simplified.

5-3. VARIANTS OF FIFTH EMBODIMENT

[0140] A variant of the fifth embodiment will be explained with reference to Fig. 31. In Fig. 31, the same reference symbols are attached to common structural elements to the fifth embodiment, and description thereof will be omitted.

[0141] As shown in Fig. 31, the pulse wave measuring device comprises a supporting member 207 attached to the arm holder 202. The supporting member 207 is constituted of four legs 2071 attached to the arm holder 202; and a supporting portion 2072 of which corners are respectively supported by the legs 2071. A through-hole penetrating in the vertical direction is formed at the supporting portion 2072. The inner opposite surfaces of the through-hole 2073 are provided with teeth, so as to be zigzag or toothed portions 2074, which can be in mesh with the toothed portions 2051 of the perpendicular sliding member 205. The perpendicular sliding member 205 is inserted into the through-hole 2073 in a manner that the toothed portions 2074 and 2051 are meshed with each other.

[0142] With such a structure, the height of the strain gauge 206 is vertically adjusted in the simple manner similarly to the fifth embodiment. In addition, after the start of the measurement, the strain gauge 206 is prevented from being moved by a force similar to the pulsation force, so that accurate measurement results can be obtained as similar to the fifth embodiment.

[0143] Another variant will be described with reference to Fig. 32. In Fig. 32, the same reference symbols are attached to common structural elements to the fifth embodiment, and description thereof will be omitted. As shown in Fig. 32, the pulse wave measuring device comprises an arm holder 202, supporting members 208, a perpendicular sliding member 209, a horizontal or transverse sliding member 2100, and a strain gauge 206.

[0144] Two supporting members 208 are attached to the arm holder 202. A pair of side surfaces of the supporting members 208, which are facing to each other, are provided with the toothed portions 2081. A pair of side opposite surfaces of the perpendicular sliding member 209 are also provided with toothed portions 2091, which mesh with the toothed portions 2081. The perpendicular sliding member 209 is situated between the supporting members 208 in a manner that it is slidable vertically in relation to the supporting members 208. Two toothed potions 2092 are formed on the upper surface of the perpendicular sliding member 209. A through-hole penetrating vertically is formed at the toothed portions 2091. In addition, a loop-shaped strip or a pull portion 2104 is attached to the perpendicular sliding member 209. The diagnostician's fingers can pull on the strap 2104 so as to slide the perpendicular sliding member 209 upwardly.

[0145] A pair of grooves 2101 opening downward are formed at the lower surface of the transverse sliding member 2100, and the bottoms thereof are provided with teeth, so as to be toothed portions 2102, which are in mesh with the toothed potions 2092 of the perpendicular sliding member 209. The toothed potions 2092 of the perpendicular sliding member 209 are inserted into the grooves 2102 of the transverse sliding meter 2100, so that the transverse sliding member 2100 is slidable in relation to the perpendicular sliding member 209 in the transverse direction (perpendicular direction to Fig. 32) and vertical movement of the transverse sliding member 2100 is restricted.

[0146] A projection 2103, which is formed at the lower surface of the transverse sliding member 2100, protrudes downward and is inserted into the through-hole 2093 of the perpendicular sliding member 209. A strain gauge 206 is mounted on the lowermost end of the pro-

jection 2103.

[0147] With such a structure, the position of the strain gauge 206 is vertically and transversely adjusted in the simple manner similarly to the fifth embodiment. In addition, after the start of the measurement, the strain gauge 206 is prevented from being moved by a force similar to the pulsation force, so that accurate measurement results can be obtained as similar to the fifth embodiment.

[0148] In another variant of the fifth embodiment, as shown in Fig. 33, it is possible to make a finger-insertion hole 2053, into which a finger of the diagnostician can be inserted, at the perpendicular sliding member 205. With such a structure, the diagnostician can insert his finger into the insertion hole 2053 and can press down the perpendicular sliding member 205. Therefore, it is easy to adjust the position of the strain gauge 206. In addition, the inserted finger with another finger or thumb can readily pick up the strain gauge 206. The same finger-insertion hole may be made at the perpendicular sliding member 205 in Fig. 31 or the transverse sliding member 2100 in Fig. 32.

6. SIXTH EMBODIMENT

6-1. STRUCTURE Of PULSE WAVE MEASUREMENT DEVICE OF SIXTH EMBODIMENT

[0149] With reference to Figs. 34 and 35, a pulse wave measuresent device according to a sixth embodiment, which is more preferable than the fifth embodiment, will be described. In Figs. 34 and 35, the same reference symbols are attached to common elements to the fifth embodiment, and description thereof will be omitted.

[0150] Fig. 34 shows a pulse wave measuring device 2200 comprising a pair of supporting members 203, and a pair of transverse or horizontal sliding members 2201 slidably and respectively arranged on the upper surfaces of the supporting members 203. Side surfaces, facing to each other, of the transverse sliding members 2201 are provided with toothed portions 2202. A perpendicular sliding member 2203 is situated between the transverse sliding members 2201 in a manner that the member 2204 is slidable vertically. The opposing side surfaces of perpendicular sliding member 2203 are provided with toothed portions 2204, which mesh, with the toothed portions 2202.

[0151] A through-hole penetrating perpendicular is formed at the perpendicular sliding member 2203. A finger-insertion member 2206 is rotatably inserted into the through-hole 2205. More specifically, a circular groove 2207 is formed at the inner surface of the through-hole 2205. A peripheral ridge, formed on the outer peripheral surface of the finger-insertion member 2206, engages with the groove 2207, thereby restricting vertical movement of the finger-insertion member 2206. In addition, a pair of L-shaped pull members 2252, on which the diagnostician's fingers can hang or pull, are mounted on the perpendicular sliding member 2203.

[0152] As best shown in Fig. 35, the finger-insertion member 2206 is bent at an angle of about 45 degree in relation to the perpendicular line to the tangential plane on the patient's skin. A finger of the diagnostician may be inserted into the insertion hole 2210 formed at the finger-insertion member 2206. The lower opening 2235 of the insertion hole 2210 at the lowermost end of the finger-insertion member 2206 is covered with an elastic film or membrane 2211. A small groove 2212 is formed at the elastic membrane 2211. When measuring blood pulse wave, the elastic membrane 2211 press down the more elastic or softer skin parts at the sides of the radial artery, whereby the skin over the radial artery is readily positioned in the groove 2212.

[0153] Fig. 36 is a view taken along line XXXVI-XXXVI of Fig. 35, especially showing the finger-insertion member 2206. As shown in Fig. 36, a strain gauge 206 is mounted on the lower end surface of the finger-insertion member 2206. The strain gauge 206 is arranged at the periphery of the opening 2235 and in the same line of the groove 2212, so that the strain gauge 206 is positioned on the radial artery 100 when the skin over the radial artery 100 is positioned in the groove 2212.

6-2. USE OF PULSE WAVE MEASURING DEVICE OF SIXTH EMBODIMENT

[0154] Next, usage of the pulse wave measuring device 2200 according to the sixth embodiment will be next described. In the following, the embodiment is exemplified by measurement of pulse wave of the human radial artery. However, it is not intended to restrict the scope of the invention to measure human pulse wave, and rather the device can be used for measuring pulse wave of other animals.

[0155] First, the pulse wave measuring device 2200 is set on the patient's forearm as shown in Figs. 34 and 35. The diagnostician next inserts his finger into the finger-insertion hole 2210. Then, he slides the transverse sliding members 2201 as similar to the fifth embodiment, thereby positioning the strain gauge 206 above the radial artery 100.

[0156] After the positioning of the transverse sliding members 2201, the diagnostician slides the perpendicular sliding member 2203 downwardly using with the finger inserted into the hole 2210, so that the strain gauge 206 is moved at a position to give an appropriate pressure to the radial artery. He can search the appropriate position using with his finger sense although there is the elastic membrane 2211 between the finger and the patient's skin. That is, the strain gauge 206 can be positioned at the appropriate position by means of the diagnostician's sense of touch. Consequently, in accordance with this embodiment, the positioning of the strain gauge 206 is more accurate and easier than that according to the fifth embodiment using with the diagnostician's sense of sight.

[0157] In addition, since the insertion hole 2210 is inclined at 45 degree, the finger inclination, articular bend, contact feeling, and the like may be natural and similar to those in the normal or manual diagnosis. Therefore, the strain gauge 206 is positioned accurately.

[0158] As shown in Fig. 37, the diagnostician can insert his second finger into the insertion hole 2210, and can pull his forefinger and third finger on the pull members 2252, so as to lift the perpendicular sliding member 2203 with the strain gauge 206. Therefore, the adjustment of the strain gauge 206 to the appropriate position can be facilitated while using with the finger's sense of touch.

[0159] After the completion of the positioning of the strain gauge 206 as described above, the pulse wave measurement is started. While the measurement, since the toothed portions 2202 and 2204 of the sliding members 2201 and 2203 are in mesh with each other and the toothed portions 2033 and 2041 of the members 203 and 204 are also in mesh with each other, the strain gauge 206 is not moved by a force equivalent to the pulsation force.

[0160] Additionally, by revolving the finger-insertion member 2206, the positioning of the patient's skin over the radial artery 100 into the groove 2212 is facilitated. More specifically, by revolving the member 2206, if the insertion hole 2210 is oriented as shown in Fig. 35, so that the diagnostician's finger in the hole 2210 is aligned in a plane perpendicular to the patient's forearm, the groove 2212 is oriented in the direction of the radial artery. Consequently, if the diagnostician aligns his finger in the hole 2210 in the direction, which is convenient for detecting the pulse manually, the patient's skin over the radial artery 100 is readily positioned into the groove 2212.

[0161] Accordingly, the radial artery 100 is stably positioned in the groove 2212, so that the strain gauge 206 is prevented from being moved in the transverse direction. In addition, the adjustment of the pressure on the blood vessel can be facilitated. Therefore, it is possible to continue to give an appropriate pressure on the radial artery, whereby more accurate measurement results can be obtained. The pulse waveform is visually indicated in the monitor display 504 on the basis of the output signal from the strain gauge 206. In the measurement, since the finger-insertion member 2206 is rotatably inserted in the through-hole 2205, the diagnostician can naturally arrange his finger in relation to the patient's arm in both cases of the patient's right and left hands.

7. SEVENTH EMBODIMENT

7-1. STRUCTURE OF PULSE WAVE MEASUREMENT DEVICE OF SEVENTH EMBODIMENT

[0162] Next, with reference to Figs. 38 and 39, a pulse wave measuring device of a seventh embodiment of the present invention will be described. In Figs. 38 and 39, the same reference symbols are attached to common elements to the fifth or sixth embodiment, and description thereof will be omitted.

[0163] As shown in Figs. 38 and 39, the pulse wave measuring device 2300 includes a transverse sliding member 204 at which formed is a screw hole 2301 penetrating vertically. A hollow bolt 2305 is screwed in the screw hole 2301. A finger-insertion member 2302 is rotatably inserted in the inner space of the hollow bolt 2305. A peripheral ridge 2307 formed at the finger-insertion member 2302 is put in the circular groove 2306 formed at the inner surface of the hollow bolt 2305, so that vertical movement of the finger-insertion member 2302 is restricted.

[0164] As shown in Fig. 39, the finger-insertion member 2302 is provided with a finger-insertion hole 2301, that is inclined at about 45 degree, into which the diagnostician's finger may be inserted. The lower opening 2235 of the insertion hole 2210 at the lowermost end of the finger-insertion member 2206 is covered with an elastic film or membrane 2211. A small groove 2212 is formed at the elastic membrane 2211. When measuring blood pulse wave, the elastic membrane 2211 press down the more elastic or softer skin parts at the sides of the radial artery and the skin over the radial artery is readily positioned in the groove 2212. A strain gauge 206 is attached to the lover surface of the finger-insertion member 2302 as similar to the sixth embodiment (see Fig. 36).

7-2. USAGE OF PULSE WAVE MEASURING DEVICE OF SEVENTH EMBODIMENT

[0165] Next, usage of the pulse wave measuring device 2300 according to the seventh embodiment will be next described. In the following, the embodiment is exemplified by measurement of pulse wave of the human radial artery. However, it is not intended to restrict the scope of the invention to measure human pulse wave, and rather the device can be used for measuring pulse wave of other animals.

[0166] First, the pulse wave measuring device 2300 is set on the patient's forearm as shown in Fig. 38. The diagnostician next slides the sliding member 204 transversely, as similar to the fifth embodiment, thereby positioning the strain gauge 206 above the radial artery 100.

[0167] After the positioning of the transverse sliding member 204, the diagnostician rotates the hollow bolt 2305 to move the finger-insertion member 2302 downwardly while the finger is inserted into the hole 2310, so that the strain gauge 206 is moved at a position to give an appropriate pressure to the radial artery 100. He can search the appropriate position using with his finger sense although there is the elastic membrane 2211 between the finger and the patient's skin. That is, the strain gauge 206 can be positioned at the appropriate position by means of the diagnostician's sense of touch.

Consequently, in accordance with this embodiment as similar to the sixth embodiment, the positioning of the strain gauge 206 is more accurate and easier in comparison with the fifth embodiment. In this case, while the second finger is inserted in the insertion hole 2310, the other fingers may revolve the hollow bolt 2305 to move it vertically. Therefore, while the second finger can search the appropriate position, the position of the strain gauge 206 is adjusted.

[0168] After the completion of the positioning of the strain gauge 206 as described above, the pulse wave measurement is started. While the measurement, since the hollow bolt 2305 attached to the finger-insertion member 2302 is held in the screw hole 2301, the strain gauge 206 is not moved although the pulsation force is exerted thereto.

[0169] Additionally, by revolving the finger-insertion member 2302, the positioning of the patient's skin over the radial artery 100 into the groove 2212 is facilitated as similar to the sixth embodiment. Accordingly, the radial artery 100 is stably positioned in the groove 2212, so that the strain gauge 206 is prevented from being moved in the transverse direction. In addition, the adjustment of the pressure on the blood vessel can be facilitated. Therefore, it is possible to continue to give an appropriate pressure on the radial artery, whereby more accurate measurement results can be obtained. The pulse waveform is visually indicated in the monitor display 504 on the basis of the output signal from the strain gauge 206. In the measurement, since the finger-insertion member 2302 is rotatably inserted in the hollow bolt 2305, the diagnostician can naturally arrange his finger in relation to the patient's arm in both cases of the patient's right and left hands.

8. OTHER VARIANTS OR MODIFICATIONS

[0170] Fig. 40 shows a variant of finger-insertion member, which may be used in any of the sixth and seventh embodiments. As shown in Fig. 40, at the lower surface of the finger-insertion member 2206 or 2302, a plurality of strain gauges 2150 are arranged abreast at the periphery of the opening 2235. The center one of the strain gauges is aligned in the same line of the groove 2212 of the elastic membrane 2211.

[0171] With such a structure, the positional or angular relationship between each strain gauge 2150 and the blood vessel can be solely determined when the strain gauges are positioned. Therefore, the displacement of the blood vessel at various angles according to the pulsation can be evaluated by analyzing pulse waveforms obtained respectively by the strain gauges 2150.

[0172] Fig. 41 shows another variant of finger-insertion member, which may be used in any of the sixth and seventh embodiments. As shown in Fig. 41, in the finger-insertion member 2206 or 2302, a pair of strain gauges 206 are disposed at two positions between which the elastic membrane 2211 lies. Consequently, at the measurement, two strain gauges 206 are aligned along the direction of the blood vessel. Therefore, it is possible to diagnose two pulse waveforms between which there is a time difference.

[0173] In addition, more than two strain gauges 206 may be provided along the direction of the radial artery. Moreover, it is possible to combine this variant with the aforementioned variant shown in Fig. 40, i.e., a pair of groups of abreast strain gauges 2150 are attached to two positions between which the elastic membrane 2211 lies.

[0174] Another modification of finger-insertion member, which may be used in any of the sixth and seventh embodiments, is shown in Fig. 42. As shown in Fig. 42, in the fiber-insertion member 2206 or 2302, a ring-shaped strain gauge 206 is attached to the periphery of the opening 2235, so as to enclose the elastic membrane 2211. With such a structure, if the diagnostician's finger recognizes the radial artery over the elastic membrane 2211, the ring-shaped strain gauge 206 will be certainly in contact with the skin over the radial artery. Therefore, in spite of the direction of the finger-insertion member 2206 or 2302, the strain gauge 206 can be positioned on the skin above the radial artery. Consequently, it is unnecessary to use the groove 2212 for positioning the strain gauge 206 on the radial artery.

[0175] Another modification of finger-insertion member, which may be used in any of the sixth and seventh embodiments, is shown in Fig. 43. As shown in Fig. 43, in the finger-insertion member 2206 or 2302, the elastic membrane 2211 is not disposed at the opening 2235 of the insertion hole 2210 or 2310. Namely, the insertion-hole 2210 or 2310 is completely penetrated, so that the diagnostician can project his fingertip from the opening 2235. With such a structure, since the finger may touch the skin above the radial artery directly, the adjustment of the position of the strain gauge 206 can be facilitated in order to obtain more accurate measurement results.

[0176] It is not intended to limit the configuration of the insertion hole 2210 or 2310 to the aforementioned configuration, but rather any configuration permitting the inserted finger to detect the measured portion may be utilized. For example, it is possible to form the insertion hole into which a plurality of fingers can be inserted. Additionally, it is possible to arrange a plurality of finger-insertion members so as to align along the patient's radial artery.

[0177] In a variant of the pulse wave measuring device of the fifth through seventh embodiments, as shown in Fig. 46, it is possible to provide supporting portions 2032b instead of the straight supporting portions 2032 of the supporting members 203 on the arm holder 202. Both ends of each supporting portion 2032b are curved. Alternatively, as shown in Fig. 47, it is possible to provide supporting portions 2032c instead of the straight supporting portions 2032. Each supporting portion 2032c is curved entirely and the upper surface thereof is convex.

[0178] By virtue of the arrangement shown in any of Figs. 45 and 46, the strain gauge 206 can be moved in parallel with the arm's skin. Therefore, anywhere the strain gauge 206 is moved, the strain gauge 206 can give a pressure to the tangential plane of the patient's skin vertically (give a pressure on the patient's skin vertically), so that an accurate measurement is achieved.

[0179] Furthermore, it is possible to apply the pulse wave measuring device, according to any of the fifth to seventh embodiments, to the organism status diagnosing device disclosed in WO-97/16114 which diagnoses health central status on the basis of measurement of blood pulse wave at peripheral vessels. Since an accurate pulse waveform can be measured by virtue of the pulse wave measuring device according to any of the fifth to seventh embodiments, accurate central physiological status can be diagnosed using with the organism status diagnosing device.

[0180] In any of the above-described embodiments, the measured vessel is the human radial artery, but it is not intended to limit the present invention thereto. If the supporting manner for the measurement device is modified, the device can measure pulse waves at other arteries, for example, the carotid artery. Fig. 17 shows various arteries and veins of a human being, and the device according to the present invention can measure the arteries illustrated here. Furthermore, it is possible to measure pulse waves of animals other than a human being.

[0181] In addition, it is not intended to limit the present invention to measure blood pulse waves of organism. Rather, the invented device can measure other articles where pulsation occurs.

[0182] Moreover, the pressure measuring device 80 can be used for another pressure measurement other than pulsation measurement.

Claims

1. A pulse wave measuring device for measuring pulse wave at a blood vessel of an organism, comprising:

   a vessel pressing portion being pressed against a skin over the blood vessel of the organism;
   a pulsation measuring sensor for measuring pulsation of the blood vessel pressed by the vessel pressing portion;
   two vessel-vicinity pressing portions being harder than the blood vessel of the organism and having distal ends, respectively, the distal ends being pressed against the skin of the organism at both sides of the vessel pressing portion; and
   adjusting means for adjusting an interval between the vessel-vicinity pressing portions.

2. A pulse wave measuring device according to claim 1, wherein the vessel pressing portion is situated back from the distal ends of the vessel-vicinity pressing portions.

3. A pulse wave measuring device for measuring pulse wave at a blood vessel of an organism, comprising:

   a vessel pressing portion being pressed against a skin over the blood vessel of the organism;
   a pulsation measuring sensor for measuring pulsation of the blood vessel pressed by the vessel pressing portion; and
   two vessel-vicinity pressing portions being harder than the blood vessel of the organism and having distal ends, respectively, the distal ends being pressed against the skin of the organism at both sides of the vessel pressing portion, the vessel pressing portion being situated back from the distal ends of the vessel-vicinity pressing portions.

4. A pulse wave measuring device according to one of claims 1 to 3, wherein the pulsation measuring sensor is a pressure sensor which outputs a pulse wave signal according to varying stress transmitted from the vessel pressing portion because of pulse wave of the blood vessel.

5. A pulse wave measuring device according to claim 4, comprising:

   a beam supported by a support;
   a plurality of the vessel pressing portions provided at the beam and arranged at intervals along a direction of the blood vessel of the organism; and
   a plurality of the pressure sensors respectively corresponding to the vessel pressing portions.

6. A pulse wave measuring device according to one of claims 1 to 3, wherein the pulsation measuring sensor comprises emitting means for emitting a wave to make the wave progress toward the blood vessel; and receiving means for receiving the wave which is reflected from or penetrated through the blood vessel, and for outputting, on the basis of the received wave, a pulse wave signal according to pulse wave.

7. A pulse wave measuring device for measuring a pulse wave at a blood vessel of an organism, comprising:

   a beam supported by a support;
   a plurality of vessel pressing portions provided

at the beam and arranged at intervals along a direction of the blood vessel of the organism, each of the vessel pressing portion being pressed against a skin over the blood vessel of the organism;

a plurality of pressure sensors respectively corresponding to the vessel pressing portions, each of the pressure sensors outputting a pulse wave signal according to varying stress transmitted from the corresponding vessel pressing portion because of pulse wave of the blood vessel; and

two vessel-vicinity pressing portions being harder than the blood vessel of the organism and having distal ends, respectively, the distal ends being pressed against the skin of the organism at both sides of the vessel pressing portions.

8. A pulse wave measuring device according to claims 5 or 7, wherein each of the pressure sensors comprises a piezoelectric element mounted on the beam for outputting an electric signal according to varying stress transmitted from the corresponding vessel pressing portion, the beam including a proximal portion and a thinner portion formed between the proximal portion and the vessel pressing portions, the thinner portion being thinner than other portions of the beam, the piezoelectric element being longer than the thinner portion and mounted on the thinner portion entirely and on another portion, which is closer to the proximal portion or vessel pressing portion than the thinner portion, partially.

9. A pulse wave measuring device according to claim 8, wherein an area of cross section of the thinner portion of the beam, on which the piezoelectric element is mounted, is equal to or less than 60% of an area of total cross section of the thinner portion and the piezoelectric element mounted thereon.

10. A pulse wave measuring device according to claim 5 or 7, wherein each of the pressure sensors comprises a piezoelectric element mounted on the beam for outputting an electric signal according to varying stress transmitted from the corresponding vessel pressing portion, an area of cross section of the thinner portion of the beam, on which the piezoelectric element is mounted, being equal to or less than 60% of an area of total cross section of the thinner portion and the piezoelectric element mounted thereon.

11. A pulse wave measuring device according to one of claims 8 to 10, wherein the beam is divided so as to include a plurality of the thinner portions and the vessel pressing portions in order to measure stress variation at a plurality points on the blood vessel, and a plurality of the piezoelectric elements are provided on the thinner portions, respectively.

12. A pulse wave measuring device comprising:

a supporting member;

a perpendicular sliding member which is supported by the supporting member and slidable perpendicularly in relation to the supporting member;

measuring means situated at the perpendicular sliding member for measuring pulse wave at a blood vessel of an organism; and

first and second toothed portions formed at mutual sliding faces of the supporting member and the perpendicular sliding member, respectively and meshed with each other.

13. A pulse wave measuring device comprising:

a supporting member;

a transverse sliding member which is supported by the supporting member and slidable transversely in relation to the supporting member;

a perpendicular sliding member which is supported by the transverse sliding member and slidable perpendicularly in relation to the transverse sliding member;

measuring means situated at the perpendicular sliding member for measuring pulse wave at a blood vessel of an organism;

third and fourth toothed portions formed at mutual sliding faces of the supporting member and the transverse sliding member, respectively and meshed with each other; and

fifth and sixth toothed portions formed at mutual sliding faces of the transverse sliding member and the perpendicular sliding member, respectively and meshed with each other.

14. A pulse wave measuring device comprising:

a supporting member;

a perpendicular sliding member which is supported by the supporting member and slidable perpendicularly in relation to the supporting member; a transverse sliding member which is supported by the perpendicular sliding member and slidable transversely in relation to the perpendicular sliding member;

measuring means situated at the transverse sliding member for measuring a pulse wave at a blood vessel of an organism;

seventh and eighth toothed portions formed at mutual sliding faces of the supporting member and the perpendicular sliding member, respec-

tively and meshed with each other, and

ninth and tenth toothed portions formed at mutual sliding faces of the perpendicular sliding member and the transverse sliding member, respectively and meshed with each other.

15. A pulse wave measuring device according to claim 12, wherein first and second toothed portions are formed so as to restrict mutual slide of the supporting member and the perpendicular sliding member if a pulsation force is exerted thereto along their slidable direction when measuring pulse wave.

16. A pulse wave measuring device according to claim 13, wherein fifth and sixth toothed portions are formed so as to restrict mutual slide of the transverse sliding member and the perpendicular sliding member if a pulsation force is exerted thereto along their slidable direction when measuring pulse wave.

17. A pulse wave measuring device according to claim 14, wherein seventh and eighth toothed portions are formed so as to restrict mutual slide of the supporting member and the perpendicular sliding member if a pulsation force is exerted thereto along their slidable direction when measuring pulse wave.

18. A pulse wave measuring device according to one of claims 12, 13, 15, and 16, wherein the perpendicular sliding member includes an insertion hole, in which a diagnostician's finger can be inserted, and an elastic membrane arranged within the insertion hole and at one end of the insertion hole.

19. A pulse wave measuring device according to claim 14 or 17, wherein the transverse sliding member includes an insertion hole, in which a diagnostician's finger can be inserted, and an elastic membrane arranged within the insertion hole and at one end of the insertion hole.

20. A pulse wave measuring device according to one of claims 12, 13, 15, and 16, wherein the perpendicular sliding member includes an insertion hole penetrating perpendicularly, so that a diagnostician's finger can pass therethrough.

21. A pulse wave measuring device according to claim 14 or 17, wherein the transverse sliding member includes an insertion hole penetrating perpendicularly, whereby a diagnostician's finger can pass therethrough.

22. A pulse wave measuring device according to claim 18, wherein a groove is formed at the elastic membrane, the skin over the blood vessel of the organism being capable of positioned into the groove.

23. A pulse wave measuring device according to claim 19, wherein a groove is formed at the elastic membrane, the skin over the blood vessel of the organism being capable of positioned into the groove.

24. A pulse wave measuring device according to claim 22, wherein the perpendicular sliding member is provided with finger-insertion means at which the insertion hole is formed, the finger-insertion means being rotatable in relation to the perpendicular sliding member.

25. A pulse wave measuring device according to claim 23, wherein the transverse sliding member is provided with finger-insertion means at which the insertion hole is formed, the finger-insertion means being rotatable in relation to the transverse sliding member.

26. A pulse wave measuring device according to claim 22, wherein the perpendicular sliding member is provided with a pull portion on which a diagnostician's finger can pull, so as to slide the perpendicular sliding member.

27. A pulse wave measuring device comprising:

a supporting member;

a transverse sliding member which is supported by the supporting member and slidable transversely in relation to the supporting member, a screw hole being formed perpendicularly at the transverse sliding member;

eleventh and twelfth toothed portions formed at mutual sliding faces of the supporting member and the transverse sliding member, respectively and meshed with each other;

a perpendicular sliding member which is screwed in the screw hole of the transverse sliding member and movable perpendicularly to the transverse sliding member by rotation; and

measuring means situated at the perpendicular sliding member for measuring pulse wave at a blood vessel of an organism.

28. A pulse wave measuring device according to claim 27, wherein the perpendicular sliding member includes an insertion hole, in which a diagnostician's finger can be inserted, and an elastic membrane arranged within the insertion hole and at one end of the insertion hole.

29. A pulse wave measuring device according to claim 27, wherein the transverse sliding member includes an insertion hole penetrating perpendicularly, whereby a diagnostician's finger can pass therethrough.

30. A pulse wave measuring device according to claim 28, wherein a groove is formed at the elastic membrane, the skin over the blood vessel of the organism being capable of positioned into the groove.

31. A pulsation measuring device for measuring pulsation at a measured subject of a measured thing, comprising:

a subject pressing portion being pressed against a covering over the measured subject of the measured thing;
a pulsation measuring sensor for measuring pulsation of the measured subject pressed by the subject pressing portion;
two subject-vicinity pressing portions being harder than the measured subject of the measured thing and having distal ends, respectively, the distal ends being pressed against the covering of the measured thing at both sides of the subject pressing portion; and
adjusting means for adjusting an interval between the subject-vicinity pressing portions.

32. A pulsation measuring device according to claim 31, wherein the subject pressing portion is situated back from the distal ends of the subject-vicinity pressing portions.

33. A pulsation measuring device for measuring pulsation at a measured subject of a measured thing, comprising:

a subject pressing portion being pressed against a covering over the measured subject of the measured thing;
a pulsation measuring sensor for measuring pulsation of the measured subject pressed by the subject pressing portion; and
two subject-vicinity pressing portions being harder than the measured subject of the measured thing and having distal ends, respectively, the distal ends being pressed against the covering of the measured thing at both sides of the subject pressing portion, the subject pressing portion being situated back from the distal ends of the subject-vicinity pressing portions.

34. A pulsation measuring device according to one of claims 31 to 33, wherein the pulsation measuring sensor is a pressure sensor which outputs a pulsation signal according to varying stress transmitted from the subject pressing portion because of pulsation of the measured subject.

35. A pulsation measuring device according to claim 34, comprising: a beam supported by a support;
a plurality of the subject pressing portions provided at the beam and arranged at intervals along a direction of the measured subject of the measured thing; and
a plurality of the pressure sensors respectively corresponding to the subject pressing portions.

36. A pulsation measuring device according to one of claims 31 to 33, wherein the pulsation measuring sensor comprises emitting means for emitting a wave to make the wave progress toward the measured subject; and receiving means for receiving the wave which is reflected from or penetrated through the measured subject, and for outputting, on the basis of the received wave, a pulsation signal according to pulsation.

37. A pulsation measuring device for measuring pulsation at a measured subject of a measured thing, comprising:

a beam supported by a support;
a plurality of subject pressing portions provided at the beam and arranged at intervals along a direction of the measured subject of the measured thing, each of the subject pressing portion being pressed against a covering over the measured subject of the measured thing;
a plurality of pressure sensors respectively corresponding to the subject pressing portions, each of the pressure sensors outputting a pulsation signal according to varying stress transmitted from the corresponding subject pressing portion because of pulsation of the measured subject; and
two subject-vicinity pressing portions being harder than the measured subject of the measured thing and having distal ends, respectively, the distal ends being pressed against the covering of the measured thing at both sides of the subject pressing portions.

38. A pulsation measuring device according to claims 35 or 37, wherein each of the pressure sensors comprises a piezoelectric element mounted on the beam for outputting an electric signal according to varying stress transmitted from the corresponding subject pressing portion, the beam including a proximal portion and a thinner portion formed between the proximal portion and the subject pressing portions, the thinner portion being thinner than other portions of the beam, the piezoelectric element being longer than the thinner portion and mounted on the thinner portion entirely and on another portion, which is closer to the proximal portion or subject pressing portion than the thinner portion, partially.

39. A pulsation measuring device according to claim 38, wherein an area of cross section of the thinner portion of the beam, on which the piezoelectric element is mounted, is equal to or less than 60% of an area of total cross section of the thinner portion and the piezoelectric element mounted thereon.

40. A pulsation measuring device according to claim 35 or 37, wherein each of the pressure sensors comprises a piezoelectric element mounted on the beam for outputting an electric signal according to varying stress transmitted from the corresponding subject pressing portion, an area of cross section of the thinner portion of the beam, on which the piezoelectric element is mounted, being equal to or less than 60% of an area of total cross section of the thinner portion and the piezoelectric element mounted thereon.

41. A pulsation measuring device according to one of claims 38 to 40, wherein the beam is divided so as to include a plurality of the thinner portions and the subject pressing portions in order to measure stress variation at a plurality points on the measured subject, and a plurality of the piezoelectric elements are provided on the thinner portions, respectively.

42. A pulsation measuring device comprising:

a supporting member;
a perpendicular sliding member which is supported by the supporting member and slidable perpendicularly in relation to the supporting member;
measuring means situated at the perpendicular sliding member for measuring pulsation at a measured subject of a measured thing; and
first and second toothed portions formed at mutual sliding faces of the supporting member and the perpendicular sliding member, respectively and meshed with each other.

43. A pulsation measuring device comprising;

a supporting member;
a transverse sliding member which is supported by the supporting member and slidable transversely in relation to the supporting member;
a perpendicular sliding member which is supported by the transverse sliding member and slidable perpendicularly in relation to the transverse sliding member;
measuring means situated at the perpendicular sliding member for measuring pulsation at a measured subject of a measured thing;
third and fourth toothed portions formed at mutual sliding faces of the supporting member and the transverse sliding member, respectively and meshed with each other; and
fifth and sixth toothed portions formed at mutual sliding faces of the transverse sliding member and the perpendicular sliding member, respectively and meshed with each other.

44. A pulsation measuring device comprising:

a supporting member;
a perpendicular sliding member which is supported by the supporting member and slidable perpendicularly in relation to the supporting member;
a transverse sliding member which is supported by the perpendicular sliding member and slidable transversely in relation to the perpendicular sliding member; measuring means situated at the transverse sliding member for measuring pulsation at a measured subject of a measured thing;
seventh and eighth toothed portions formed at mutual sliding faces of the supporting member and the perpendicular sliding member, respectively and meshed with each other; and
ninth and tenth toothed portions formed at mutual sliding faces of the perpendicular sliding member and the transverse sliding member, respectively and meshed with each other.

45. A pulsation measuring device according to claim 42, wherein first and second toothed portions are formed so as to restrict mutual slide of the supporting member and the perpendicular sliding member if a pulsation force is exerted thereto along their slidable direction when measuring pulsation.

46. A pulsation measuring device according to claim 43, wherein fifth and sixth toothed portions are formed so as to restrict mutual slide of the transverse sliding member and the perpendicular sliding member if a pulsation force is exerted thereto along their slidable direction when measuring pulsation.

47. A pulsation measuring device according to claim 44, wherein seventh and eighth toothed portions are formed so as to restrict mutual slide of the supporting member and the perpendicular sliding member if a pulsation force is exerted thereto along their slidable direction when measuring pulsation.

48. A pulsation measuring device according to one of claim 42, 43, 45, and 46, wherein the perpendicular sliding member includes an insertion hole, in which a measurer's finger can be inserted, and an elastic membrane arranged within the insertion hole and at one end of the insertion hole.

49. A pulsation measuring device according to claim 44 or 47, wherein the transverse sliding member includes an insertion hole, in which a measurer's finger can be inserted, and an elastic membrane arranged within the insertion pole and at one end of the insertion hole.

50. A pulsation measuring device according to one of claims 42, 43, 45, and 46, wherein the perpendicular sliding member includes an insertion hole penetrating perpendicularly, so that a measurer's finger can pass therethrough.

51. A pulsation measuring device according to claim 44 on 47, wherein the transverse sliding member includes an insertion hole penetrating perpendicularly, whereby a measurer's finger can pass therethrough.

52. A pulsation measuring device according to claim 48, wherein a groove is formed at the elastic membrane, the covering over the measured subject of the measured thing being capable of positioned into the groove.

53. A pulsation measuring device according to claim 49, wherein a groove is formed at the elastic membrane, the covering over the measured subject of the measured thing being capable of positioned into the groove.

54. A pulsation measuring device according to claim 52, wherein the perpendicular sliding member is provided with finger-insertion means at which the insertion hole is formed, the finger-insertion means being rotatable in relation to the perpendicular sliding member.

55. A pulsation measuring device according to claim 53, wherein the transverse sliding member is provided with finger-insertion means at which the insertion hole is formed, the finger-insertion means being rotatable in relation to the transverse sliding member.

56. A pulsation measuring device according to claim 52, wherein the perpendicular sliding member is provided with a pull portion on which a measurer's finger can pull, so as to slide the perpendicular sliding member.

57. A pulsation measuring device comprising:

a supporting member;
a transverse sliding member which is supported by the supporting member and slidable transversely in relation to the supporting member, a screw hole being formed perpendicularly at the transverse sliding member;
eleventh and twelfth toothed portions formed at mutual sliding faces of the supporting member and the transverse sliding member, respectively and meshed with each other;
a perpendicular sliding member which is screwed in the screw hole of the transverse sliding member and movable perpendicularly to the transverse gliding member by rotation; and
measuring means situated at the perpendicular sliding member for measuring pulsation at a measured subject of a measured thing.

58. A pulsation measuring device according to claim 57, wherein the perpendicular sliding member includes an insertion hole, in which a measurer's finger can be inserted, and an elastic membrane arranged within the insertion hole and at one end of the insertion hole.

59. A pulsation measuring device according to claim 57, wherein the transverse sliding member includes an insertion hole penetrating perpendicularly, whereby a measurer's finger can pass therethrough.

60. A pulsation measuring device according to claim 58, wherein a groove is formed at the elastic membrane, the covering over the measured subject of the measured thing being capable of positioned into the groove.

61. A pressure measuring device comprising:

a beam having at least one proximal portion supported by a support;
a subject pressing portion provided at the beam and pressed against a measured subject; and
a piezoelectric element mounted on the beam for outputting an electric signal according to varying stress transmitted from the subject pressing portion, the beam including a thinner portion formed between the proximal portion and the subject pressing portion, the thinner portion being thinner than other portions of the beam, the piezoelectric element being longer than the thinner portion and mounted on the thinner portion entirely and on another portion partially, which is closer to the proximal portion or subject pressing portion than the thinner portion.

62. A pressure measuring device according to claim 61, wherein an area of cross section of the thinner portion of the beam, on which the piezoelectric element is mounted, is equal to or less than 60% of an

area of total cross section of the thinner portion and the piezoelectric element mounted thereon.

63. A pressure measuring device comprising:

a beam having at least one proximal portion supported by a support;
a subject pressing portion provided at the beam and pressed against a measured subject; and
a piezoelectric element mounted on the beam for outputting an electric signal according to varying stress transmitted from the subject pressing portion, an area of cross section of the thinner portion of the beam, on which the piezoelectric element is mounted, being equal to or less than 60% of an area of total cross section of the thinner portion and the piezoelectric element mounted thereon.

64. A pressure measuring device according to one of claims 61 to 63, wherein the beam is divided so as to include a plurality of thinner portions and the subject pressing portions in order to measure stress variation at a plurality points on the measured subject, and a plurality of the piezoelectric elements are provided on the thinner portions, respectively.

FIG. 1

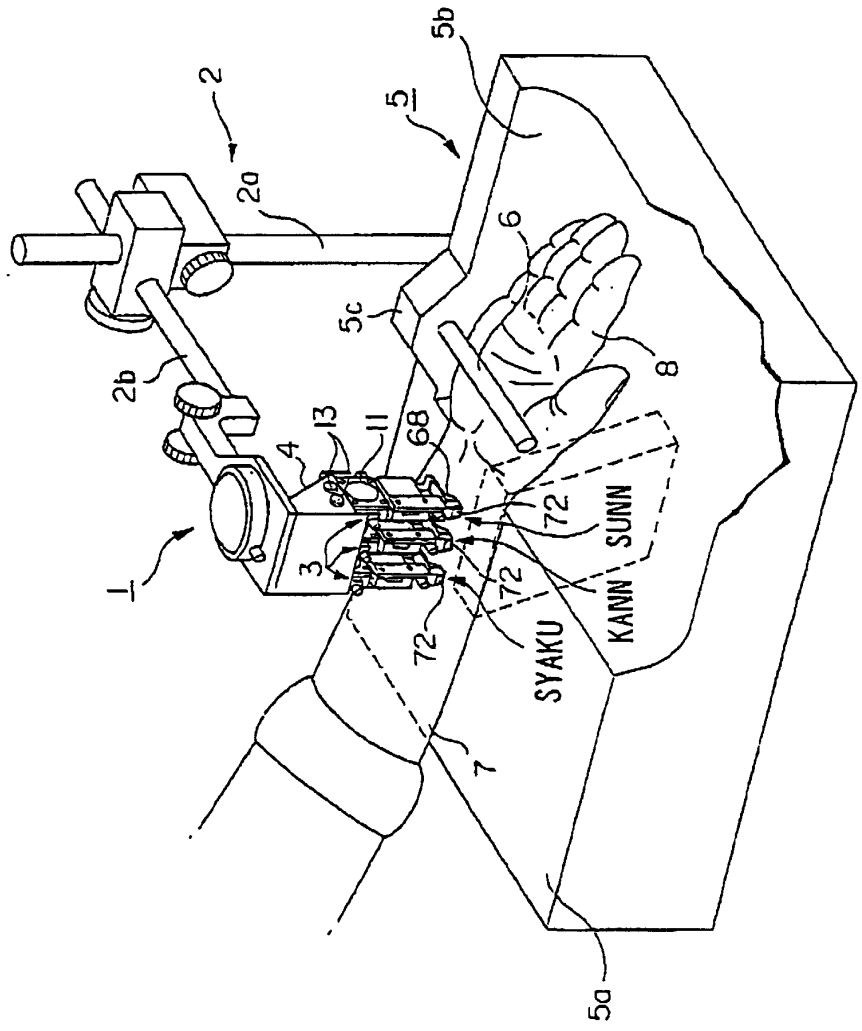

FIG. 2B FIG. 2A

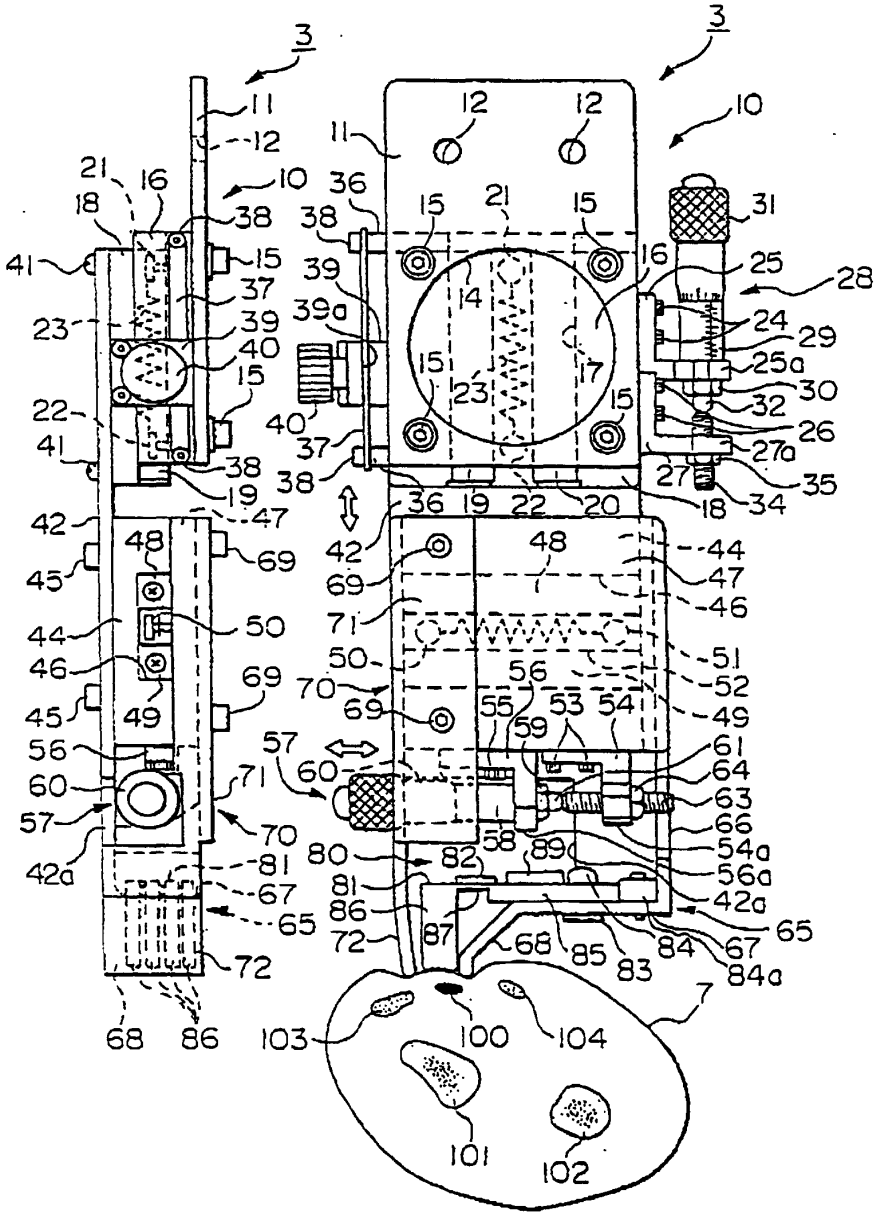

FIG. 3

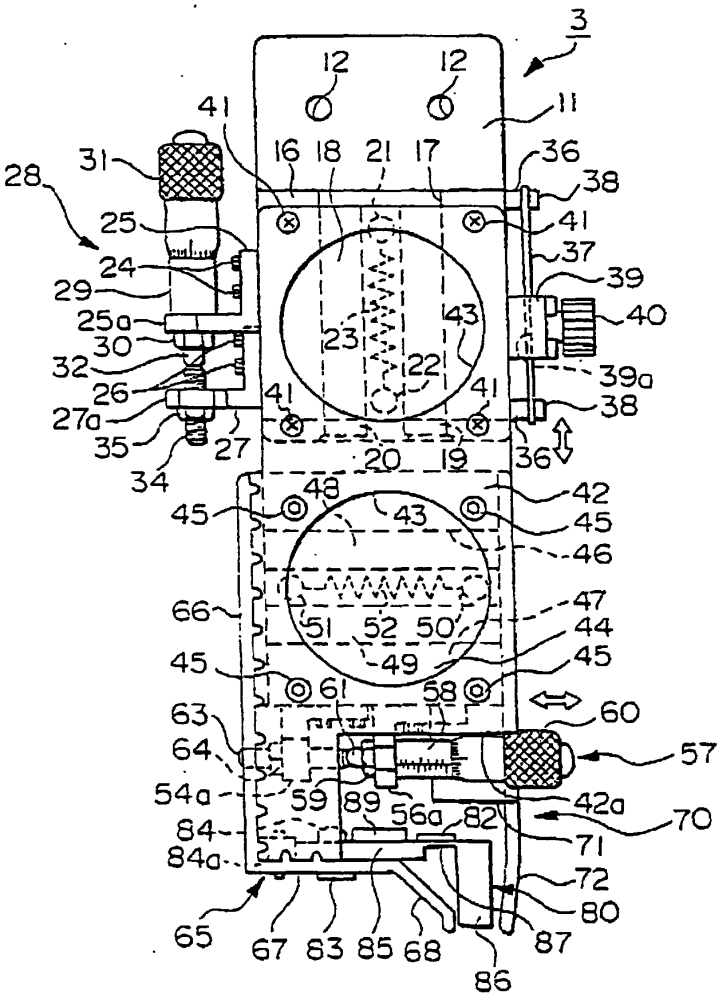
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FIG. 4

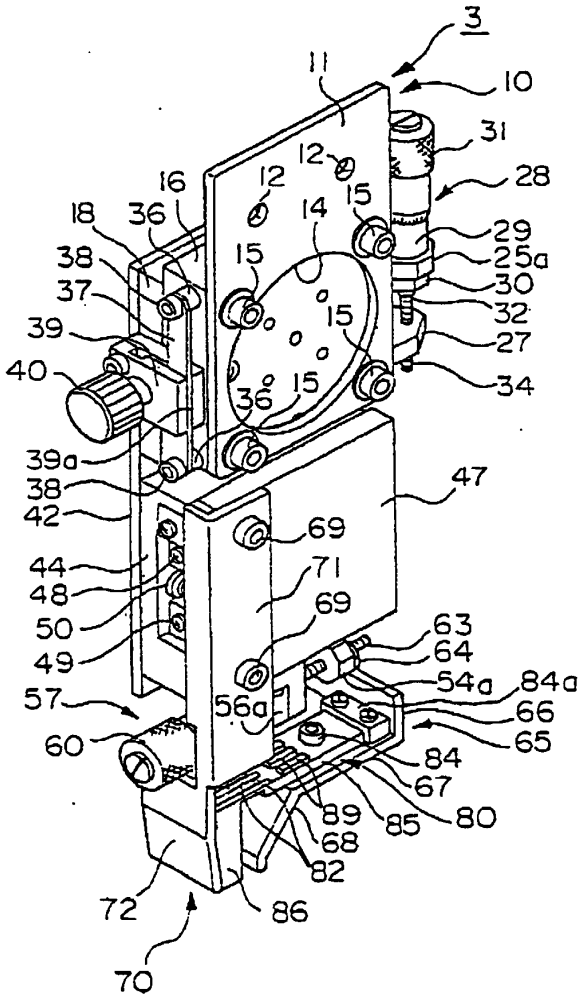
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FIG. 5

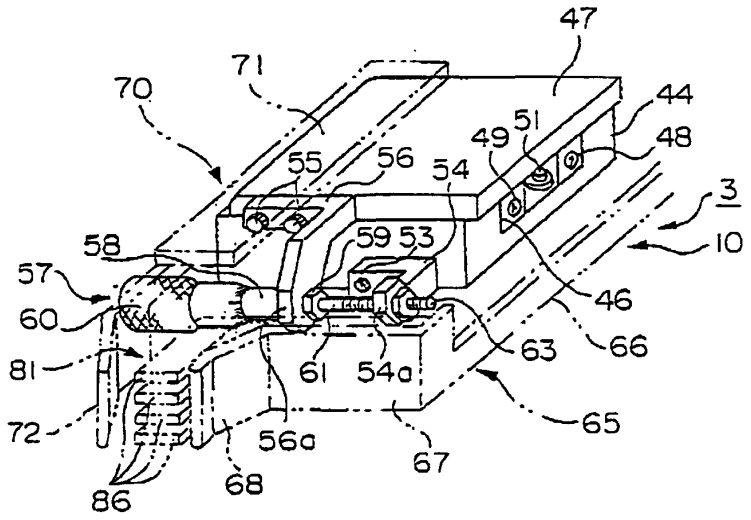

FIG. 6B

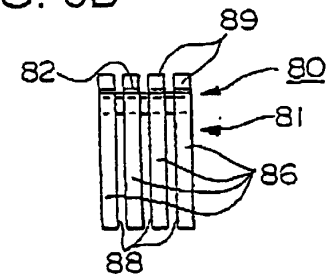

FIG. 6A

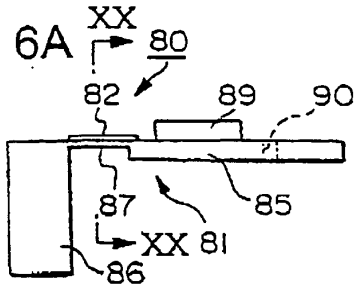

FIG. 6C

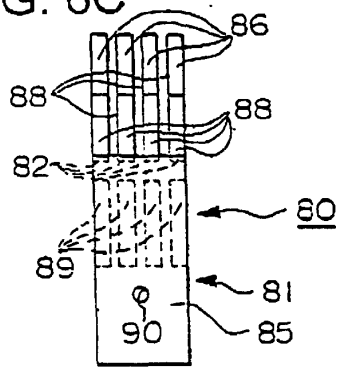

FIG. 7

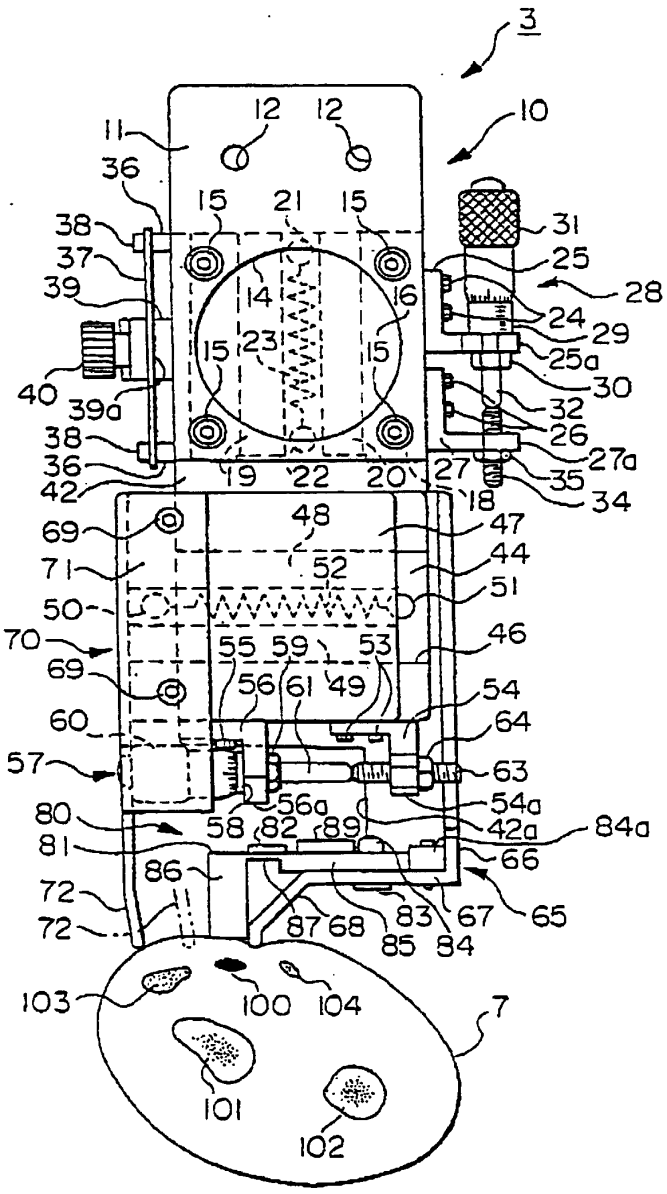
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FIG. 8

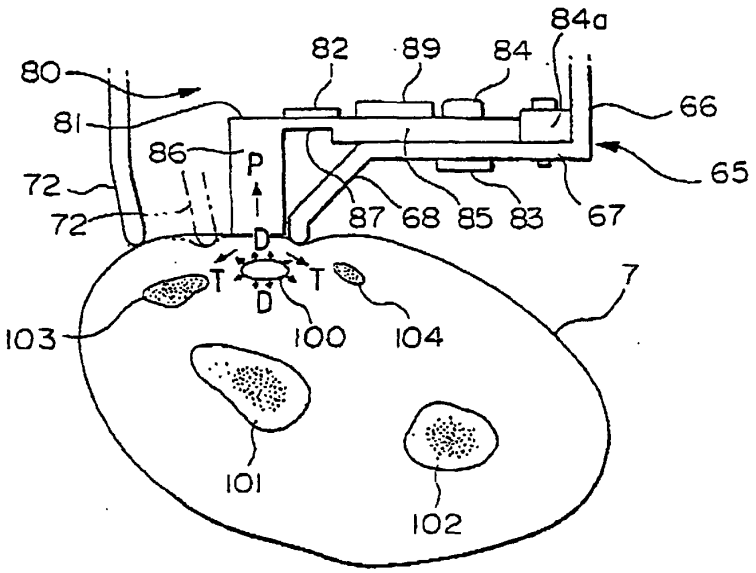
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FIG. 9

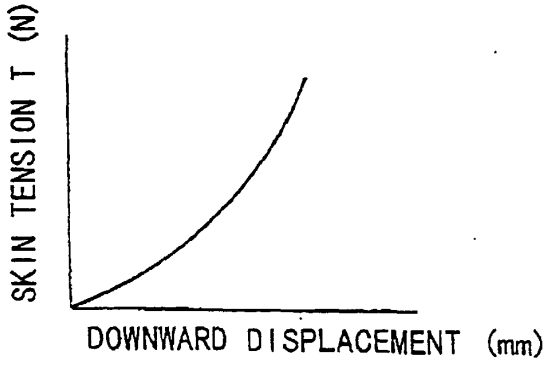

SKIN TENSION T (N)
DOWNWARD DISPLACEMENT (mm)

FIG. 10

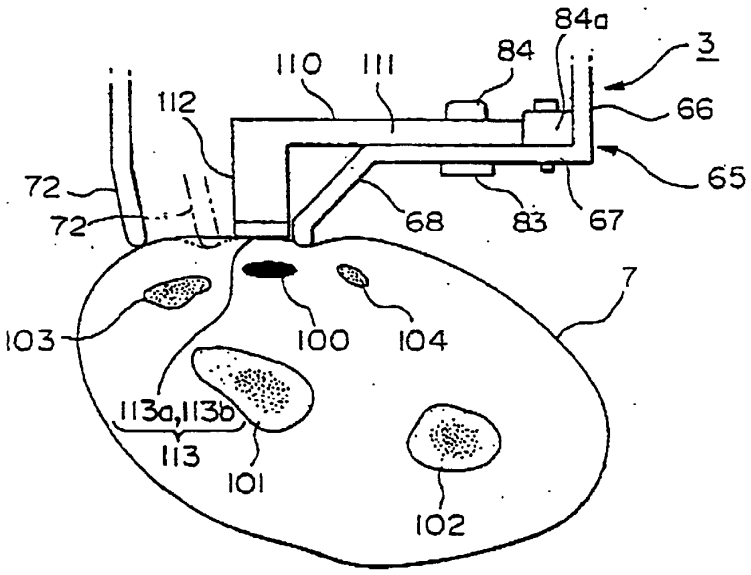
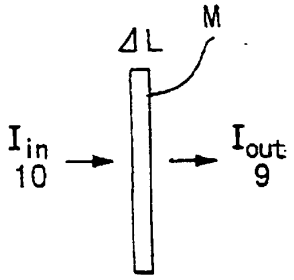


FIG. 11A

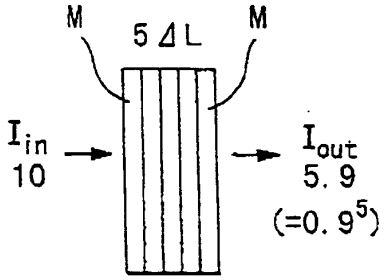


$I_{out}/I_{in}=1-kC\Delta L$

k: ABSORPTION COEFFICIENT
L: MATERIAL THICKNESS

DIAGRAM FOR DESCRIBING LAMBERT-BEER LAW

FIG. 11B



$I_{out}/I_{in}=(1-kC\Delta L)^5$

k: ABSORPTION COEFFICIENT
L: MATERIAL THICKNESS

DIAGRAM FOR DESCRIBING LAMBERT-BEER LAW

FIG. 12

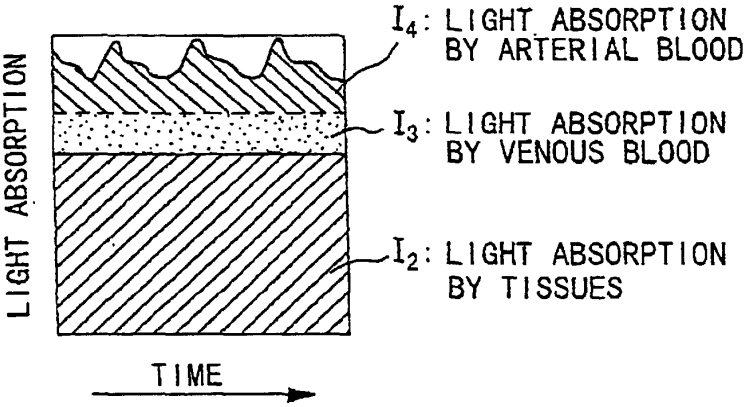

LIGHT ABSORPTION
I_4: LIGHT ABSORPTION BY ARTERIAL BLOOD
I_3: LIGHT ABSORPTION BY VENOUS BLOOD
I_2: LIGHT ABSORPTION BY TISSUES
TIME

FIG. 13

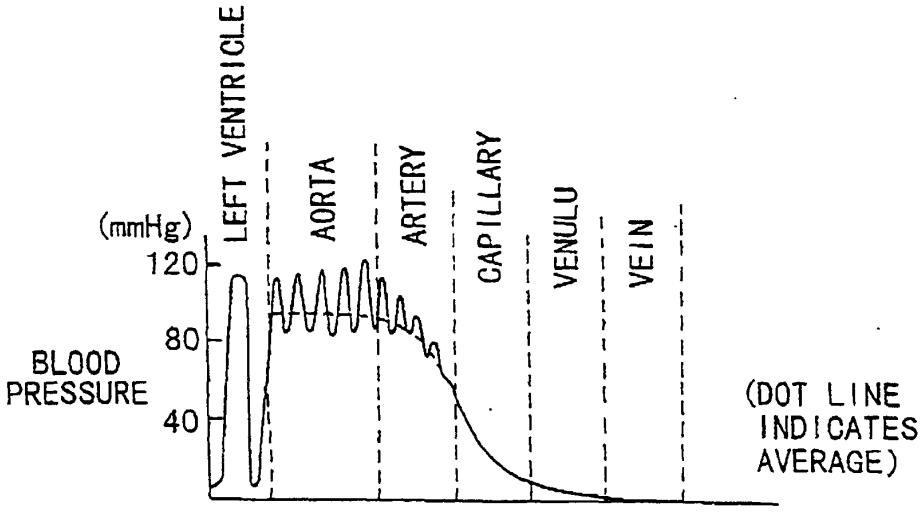

LEFT VENTRICLE
AORTA
ARTERY
CAPILLARY
VENULU
VEIN
(mmHg)
120
80
40
BLOOD PRESSURE
(DOT LINE INDICATES AVERAGE)

FIG. 14

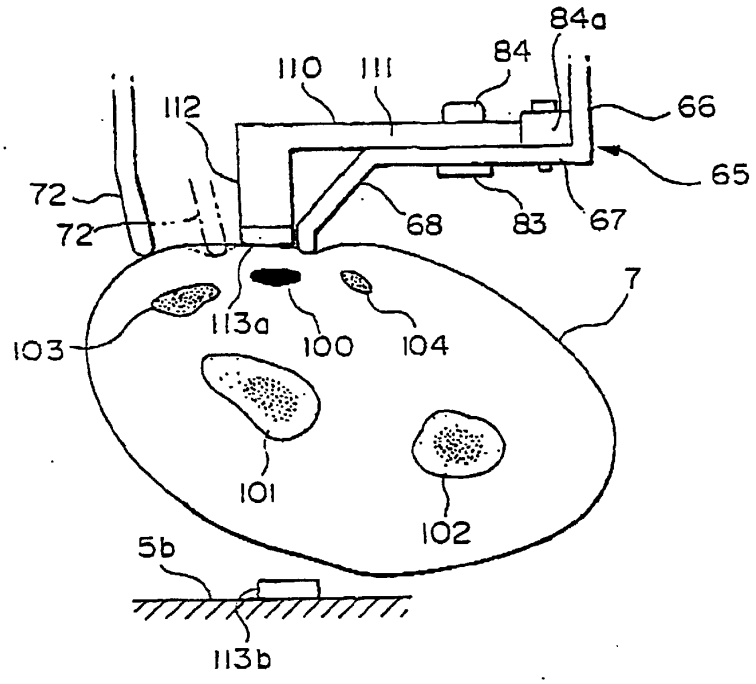

84a
84
110
111
112
66
65
72
72
68
83
67
7
113a
100
104
103
101
102
5b
113b

FIG. 15

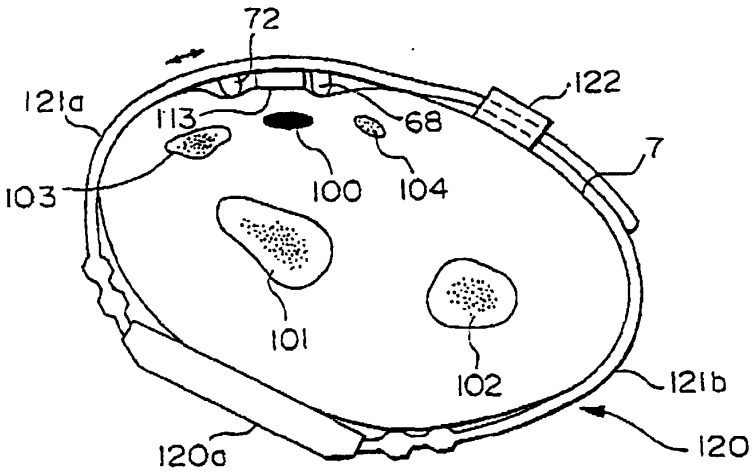

72
122
121a
113
68
7
103
100
104
101
102
121b
120
120a

FIG. 16

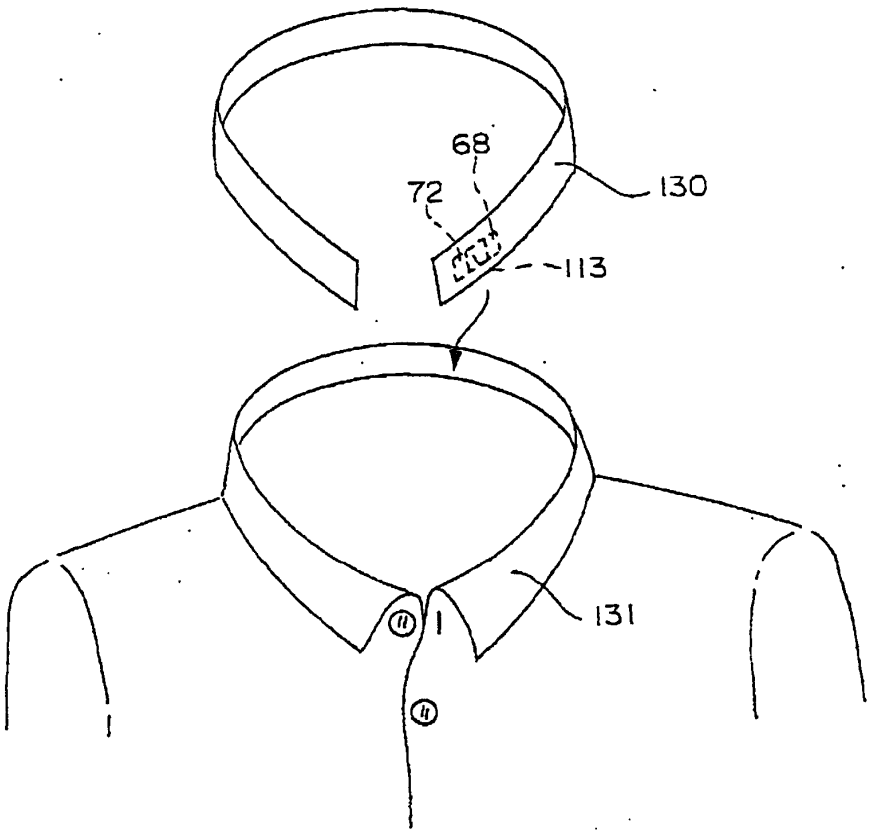


FIG. 17

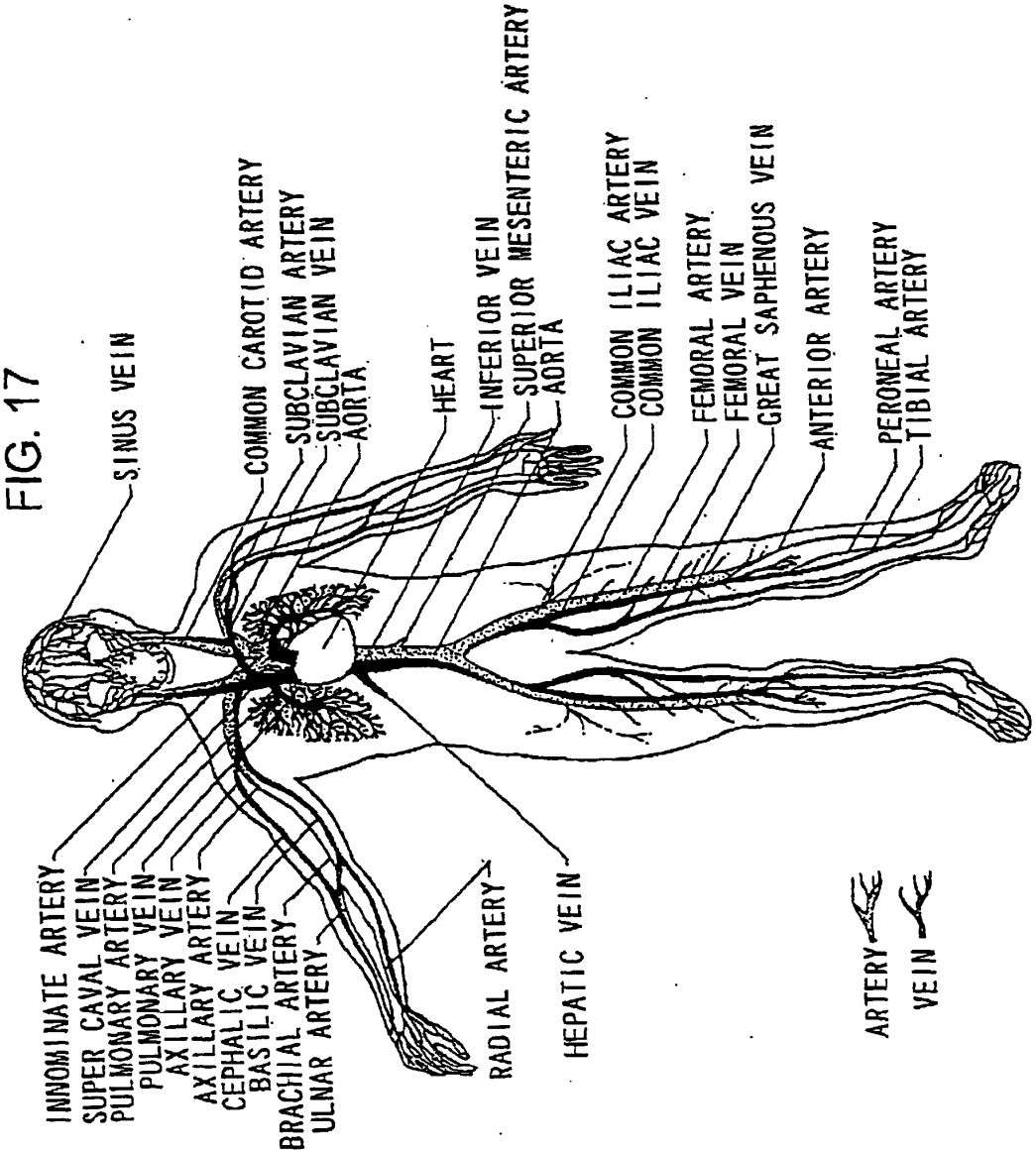

SINUS VEIN
COMMON CAROTID ARTERY
SUBCLAVIAN ARTERY
SUBCLAVIAN VEIN
AORTA
HEART
INFERIOR VEIN
SUPERIOR MESENTERIC ARTERY
AORTA
COMMON ILIAC ARTERY
COMMON ILIAC VEIN
FEMORAL ARTERY
FEMORAL VEIN
GREAT SAPHENOUS VEIN
ANTERIOR ARTERY
PERONEAL ARTERY
TIBIAL ARTERY
INNOMINATE ARTERY
SUPER CAVAL VEIN
PULMONARY ARTERY
PULMONARY VEIN
AXILLARY VEIN
AXILLARY ARTERY
CEPHALIC VEIN
BASILIC VEIN
BRACHIAL ARTERY
ULNAR ARTERY
RADIAL ARTERY
HEPATIC VEIN
ARTERY
VEIN

FIG. 18

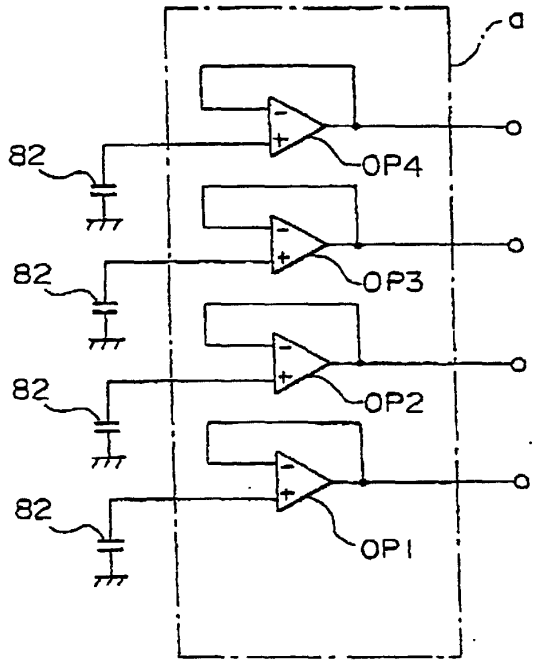


FIG. 19

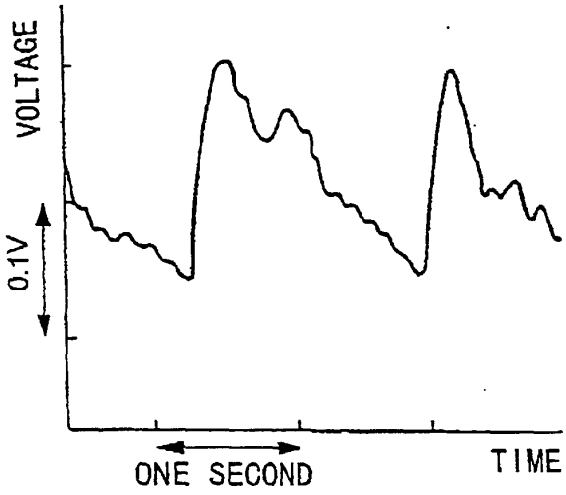


FIG. 20

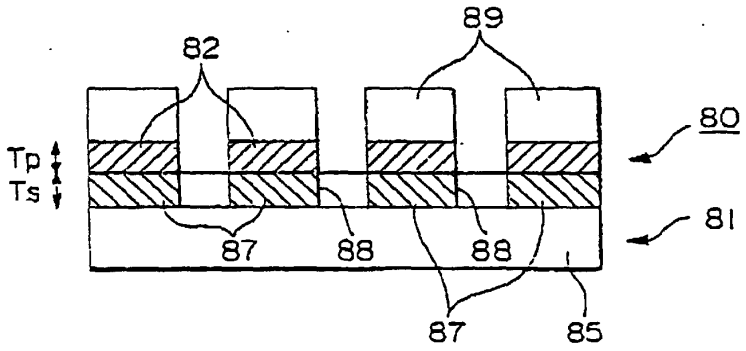

89
82
80
Tp
Ts
81
87
88
88
87
85

FIG. 21

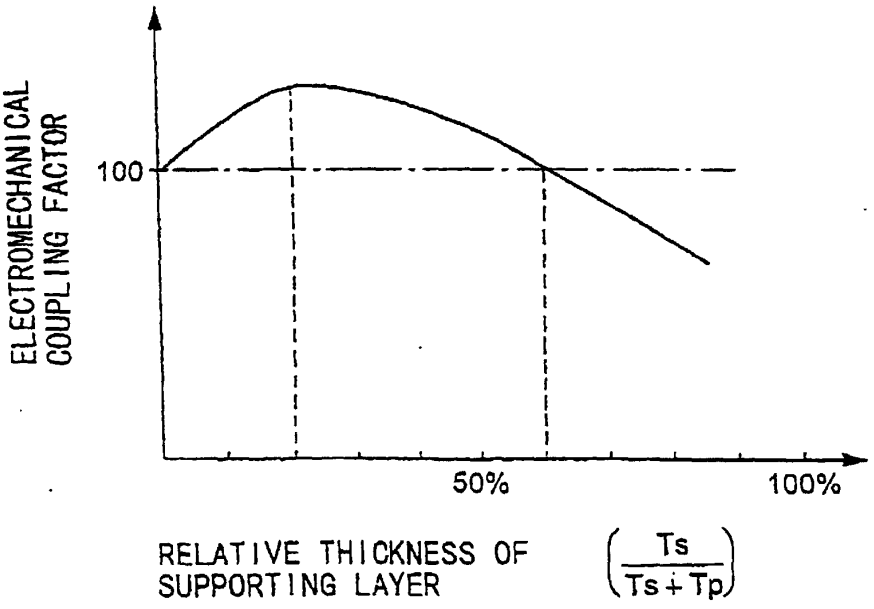

ELECTROMECHANICAL COUPLING FACTOR
100
50%
100%
RELATIVE THICKNESS OF SUPPORTING LAYER
(Ts / (Ts + Tp))

FIG. 22A

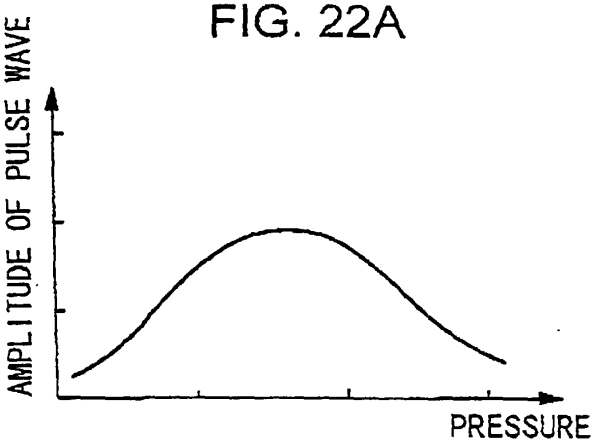


FIG. 22B

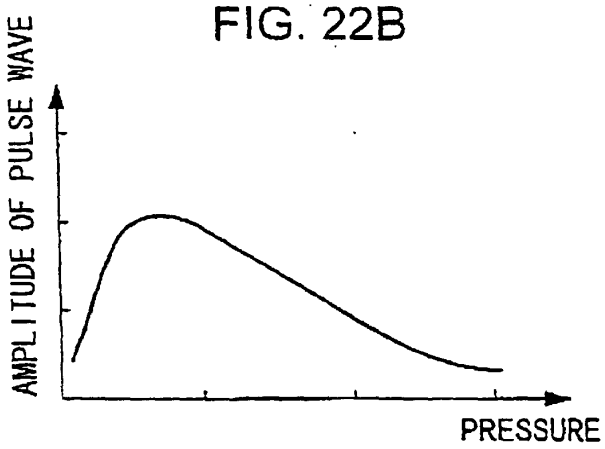


FIG. 22C

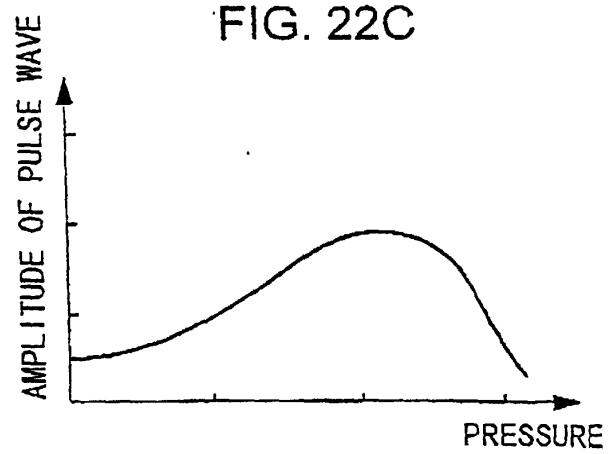


FIG. 23

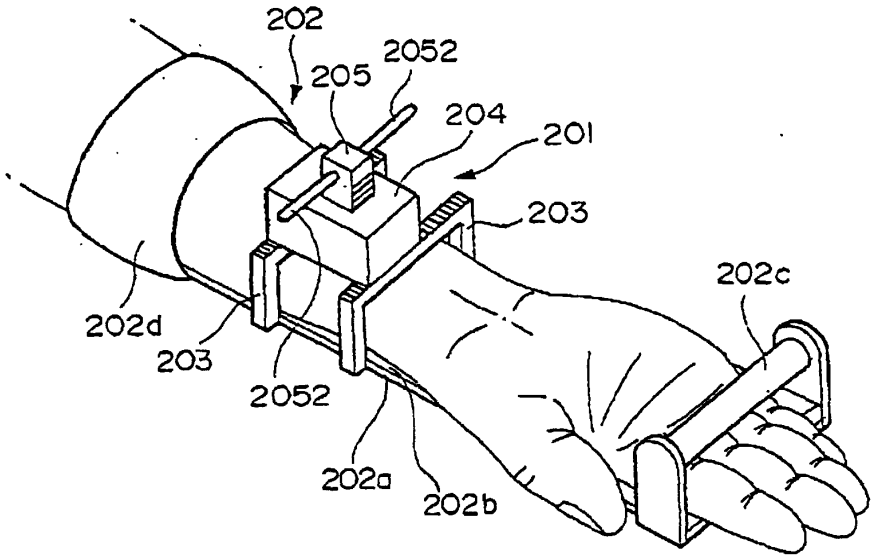

202
205
2052
204
201
203
202c
202d
203
2052
202a
202b

FIG. 24

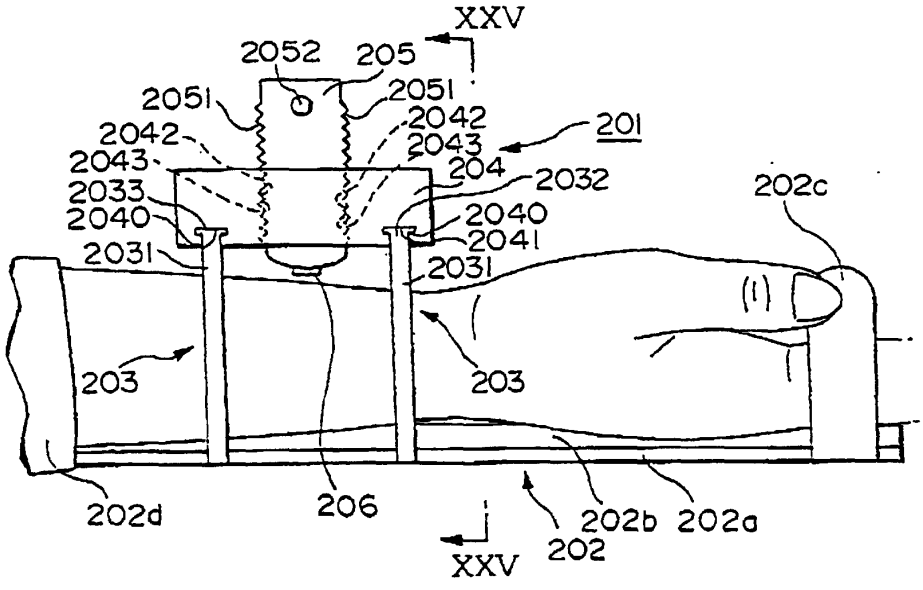

XXV
2052
205
2051
2051
2042
2042
2043
2043
201
204
2032
2033
2040
2040
2041
2031
2031
202c
203
203
202d
206
202b
202a
202
XXV

FIG. 25

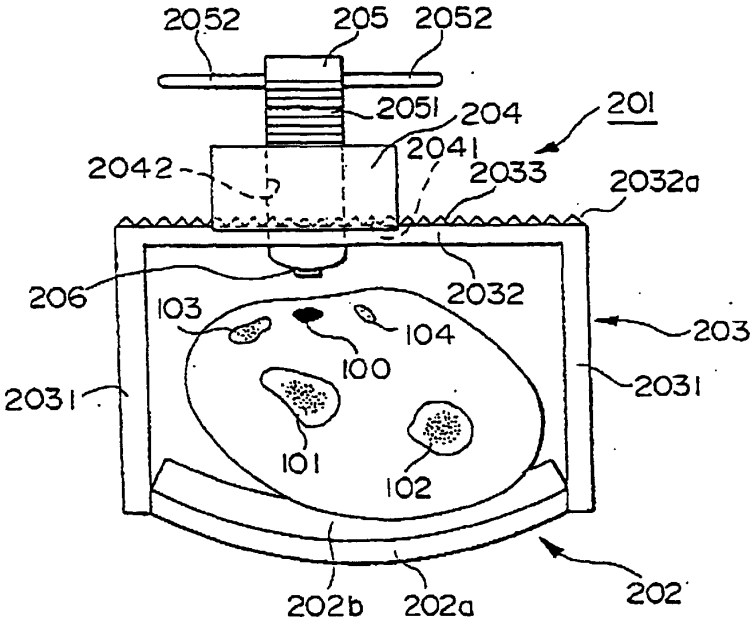

2052
205
2052
2051
204
201
2041
2042
2033
2032a
206
2032
103
104
203
100
2031
2031
101
102
202b
202a
202

FIG. 26

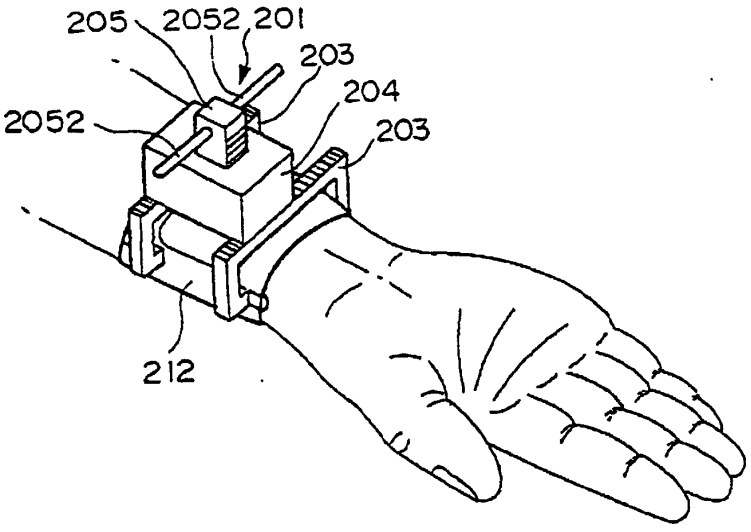

205
2052
201
203
204
2052
203
212

FIG. 27

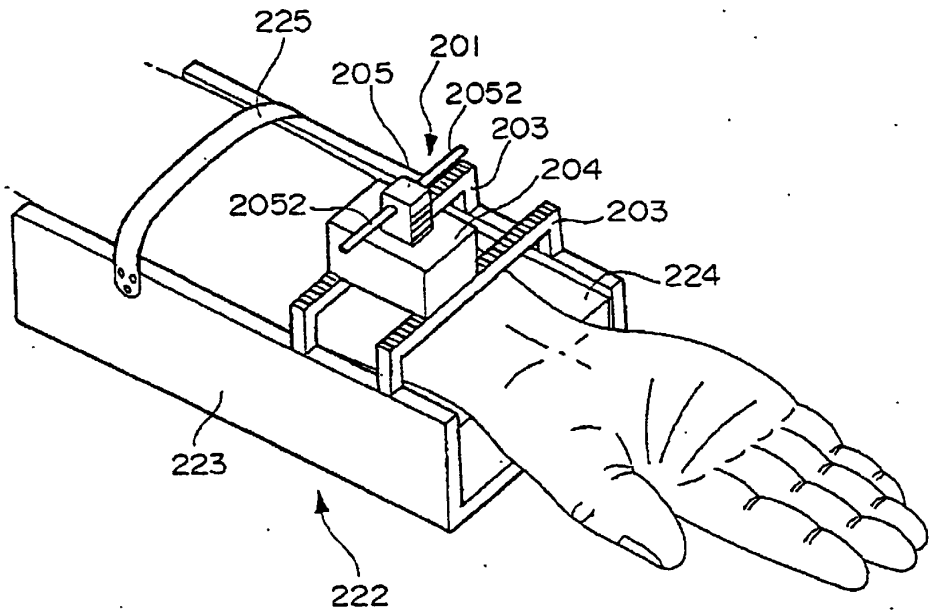

225
201
205
2052
203
204
2052
203
224
223
222

FIG. 28

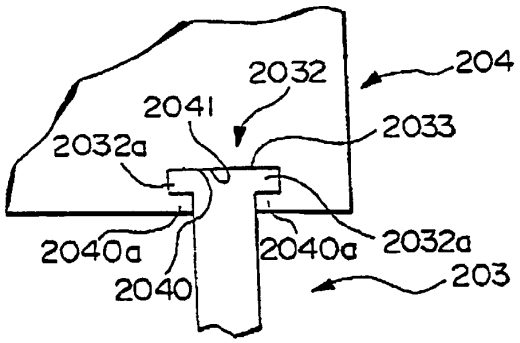

204
2032
2041
2033
2032a
2040a
2040a
2032a
2040
203

FIG. 29

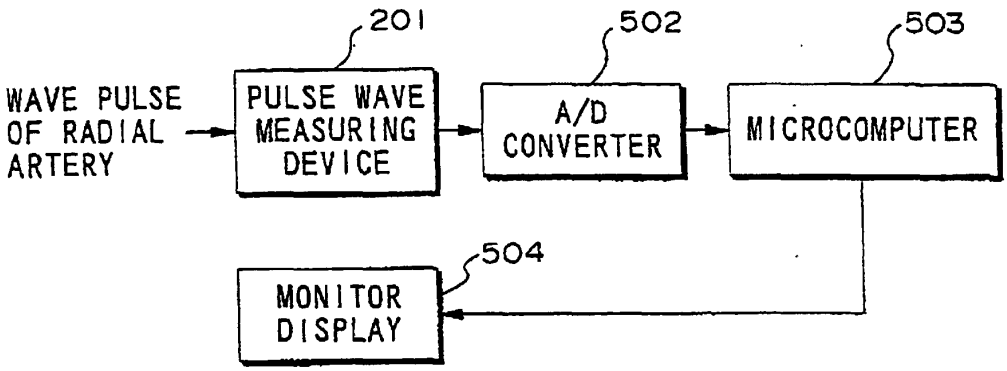

201
502
503
WAVE PULSE OF RADIAL ARTERY
PULSE WAVE MEASURING DEVICE
A/D CONVERTER
MICROCOMPUTER
504
MONITOR DISPLAY

FIG. 30

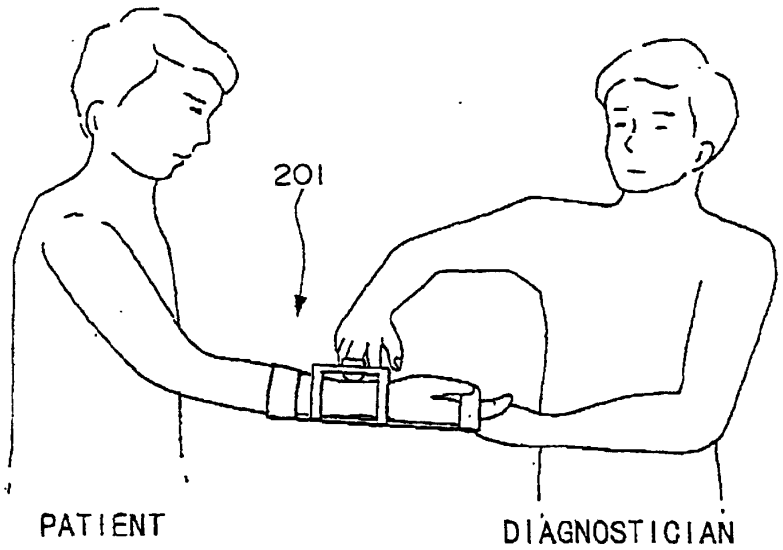

201
PATIENT
DIAGNOSTICIAN

FIG. 31

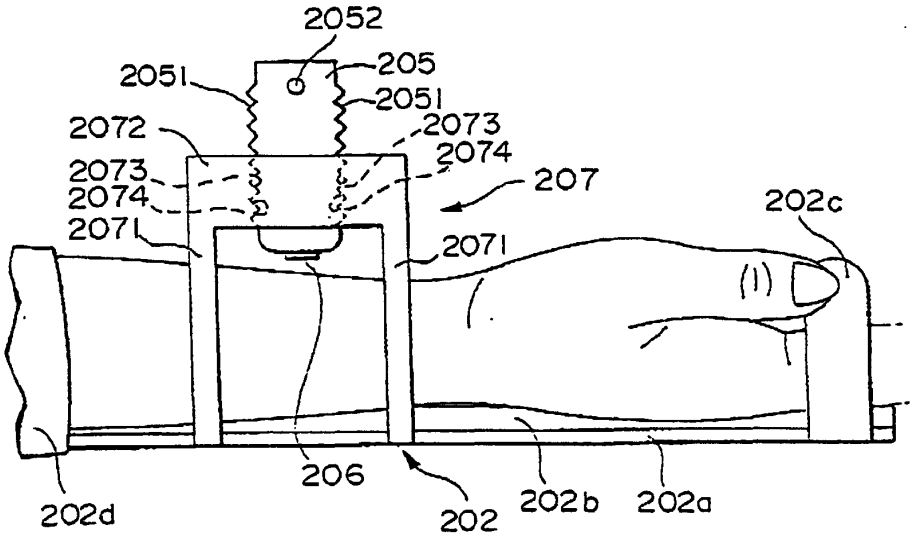

2052
205
2051
2051
2072
2073
2073
2074
2074
207
2071
2071
202c
206
202d
202
202b
202a

FIG. 32

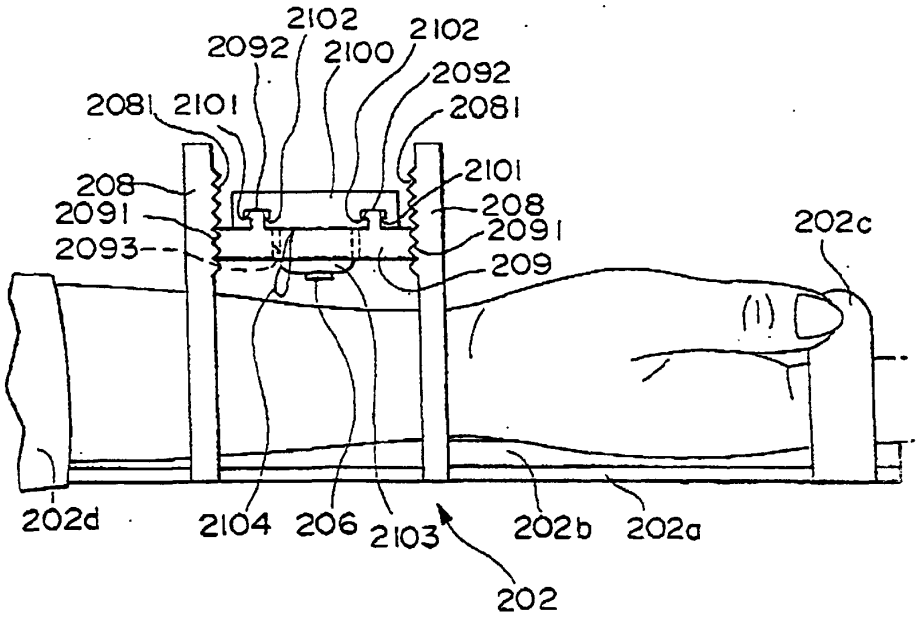

2102
2092
2100
2102
2092
2081
2081
2101
208
2101
2091
208
2093
2091
209
202c
202d
2104
206
2103
202b
202a
202

FIG. 33

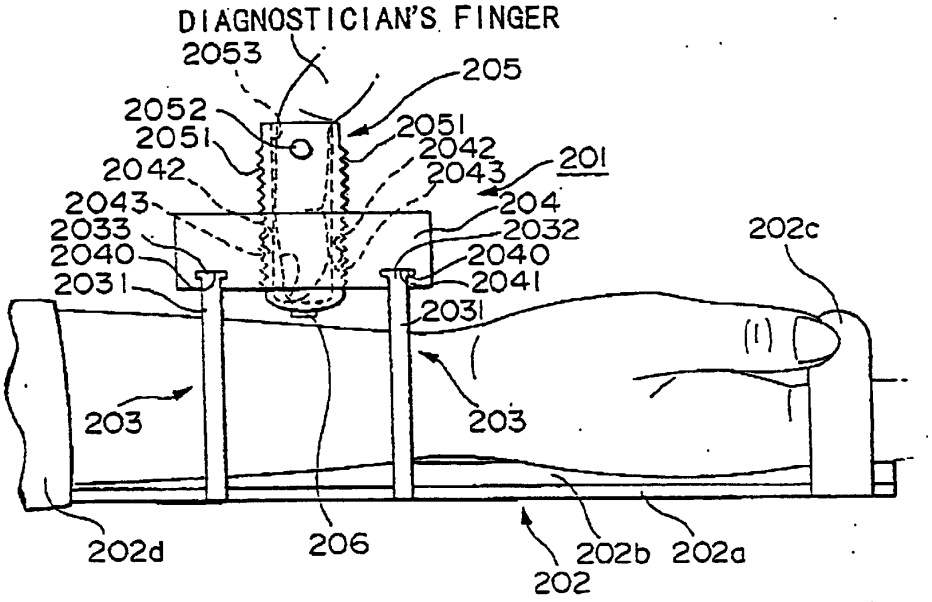

DIAGNOSTICIAN'S FINGER
2053
205
2052
2051
2051
2042
2042
2043
2043
2033
2040
2031
201
204
2032
2040
2041
2031
202c
203
203
202d
206
202
202b
202a

FIG. 34

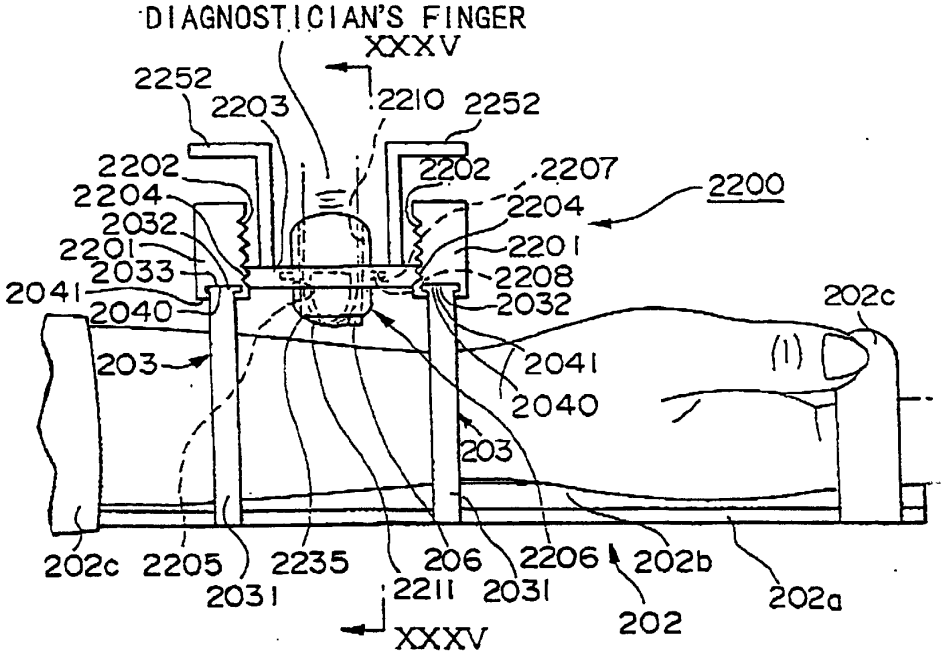

DIAGNOSTICIAN'S FINGER
XXXV
2252
2203
2210
2252
2202
2202
2207
2200
2204
2204
2032
2201
2201
2033
2208
2041
2040
2032
202c
203
2041
2040
203
202c
2205
2235
206
2206
202b
2031
2211
2031
202
202a
XXXV

FIG. 35

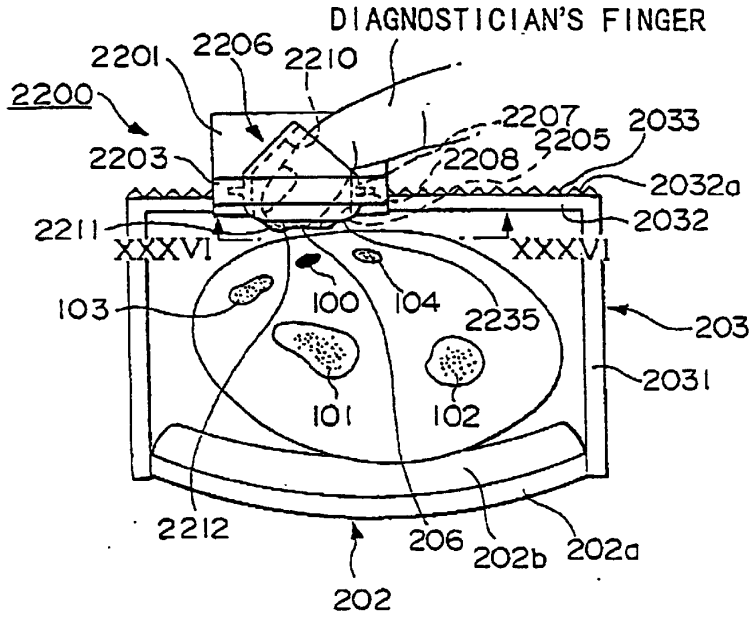

DIAGNOSTICIAN'S FINGER
2201
2206
2210
2200
2207
2033
2205
2203
2208
2032a
2211
2032
XXXVI
XXXVI
103
100
104
2235
203
2031
101
102
2212
206
202b
202a
202

FIG. 36

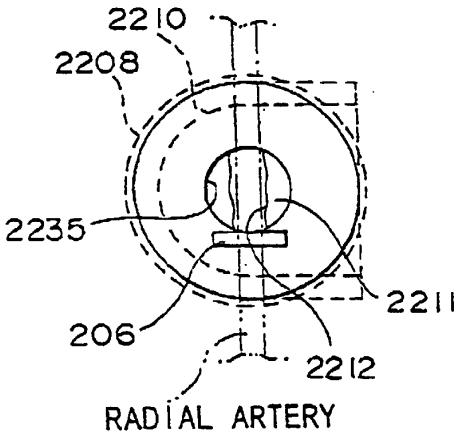

2210
2208
2235
2211
206
2212
RADIAL ARTERY

FIG. 37

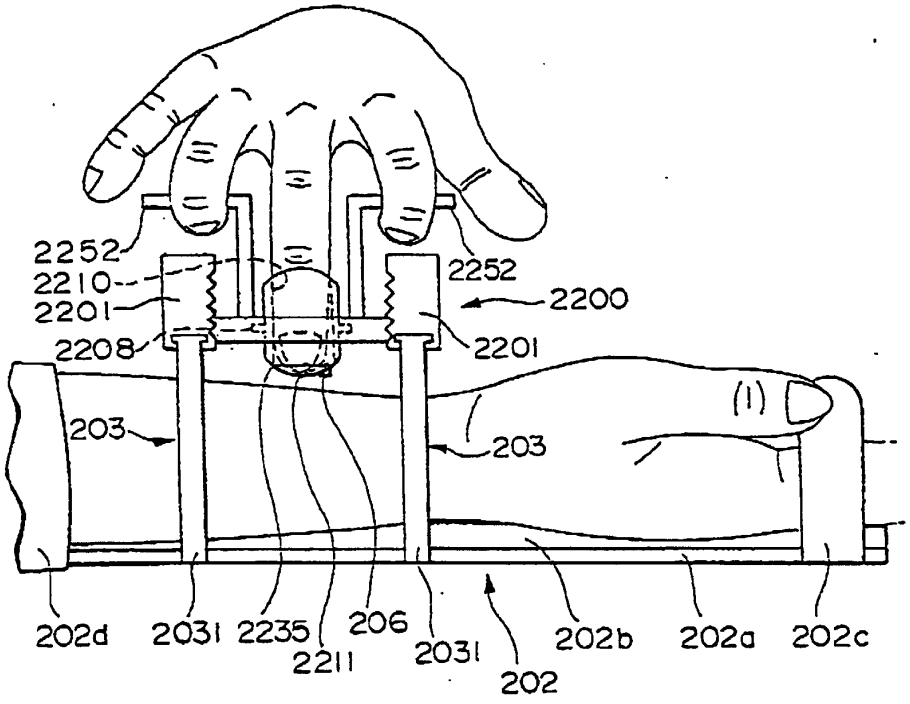

2252
2210
2201
2208
2252
2200
2201
203
203
(1)
202d
2031
2235
2211
206
2031
202
202b
202a
202c

FIG. 38

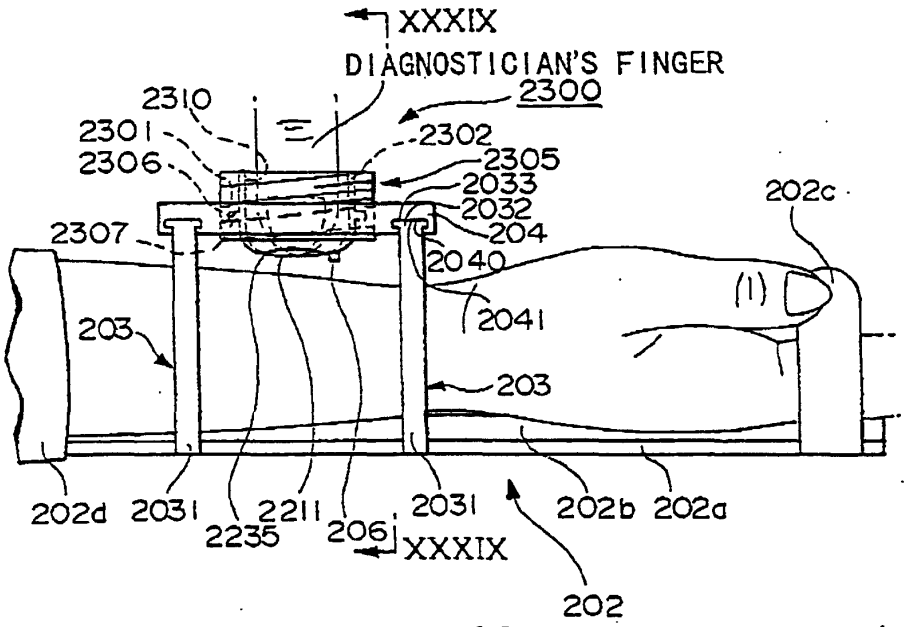

XXXIX
DIAGNOSTICIAN'S FINGER
2300
2310
2301
2302
2306
2305
2033
2032
204
2307
2040
202c
2041
203
203
202d
2031
2211
2235
206
2031
202b
202a
XXXIX
202

FIG. 39

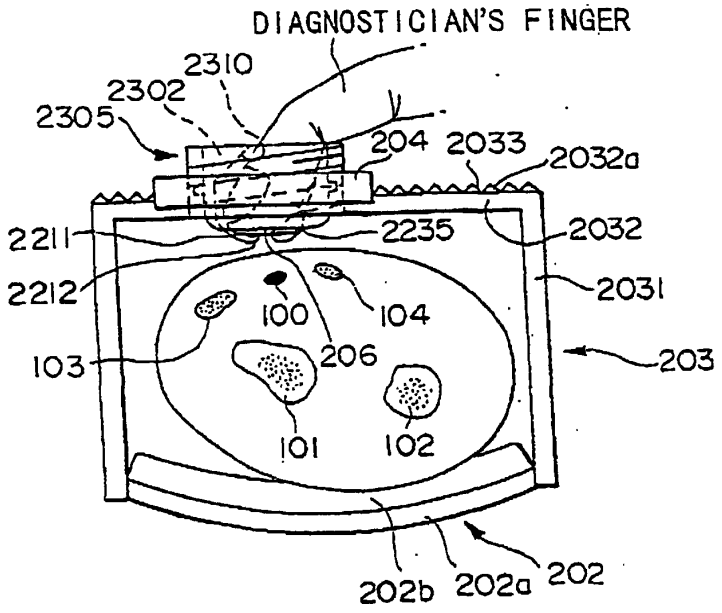

DIAGNOSTICIAN'S FINGER
2310
2302
2305
204
2033
2032a
2211
2235
2032
2212
2031
100
104
103
206
203
101
102
202b
202a
202

FIG. 40

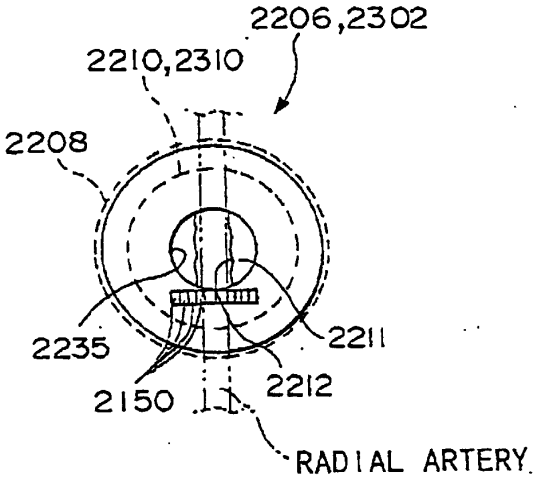

2206,2302
2210,2310
2208
2235
2211
2150
2212
RADIAL ARTERY

FIG. 41

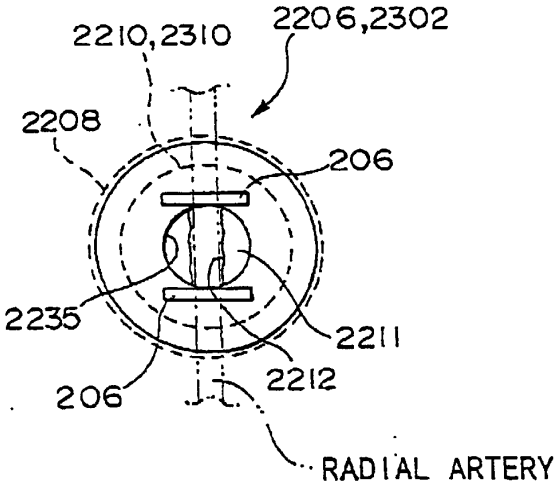

2210,2310
2206,2302
2208
206
2235
2211
206
2212
RADIAL ARTERY

FIG. 42

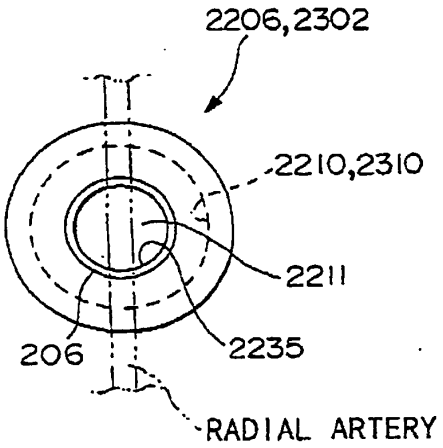

2206,2302
2210,2310
2211
2235
206
RADIAL ARTERY

FIG. 43

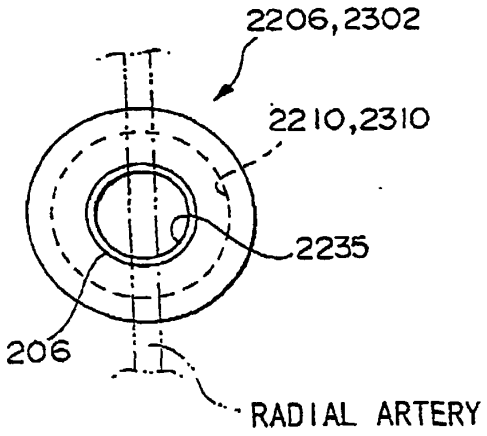

2206,2302
2210,2310
2235
206
RADIAL ARTERY

FIG. 44

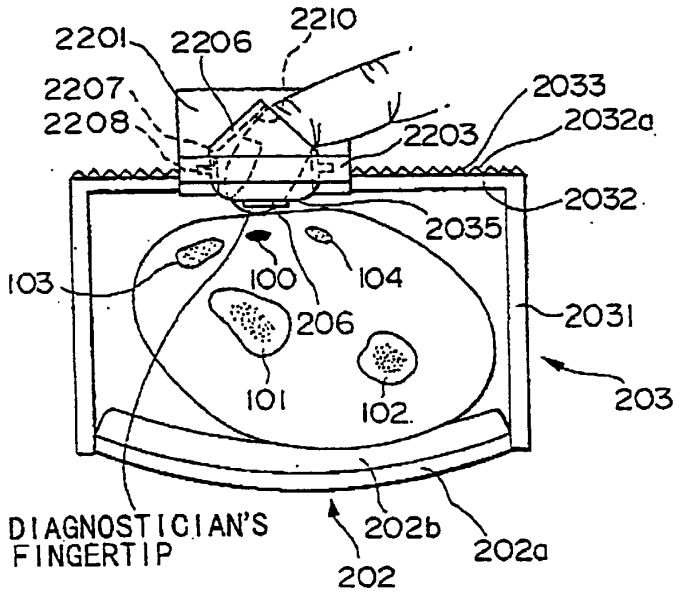

2201
2206
2210
2207
2208
2033
2032a
2203
2032
2035
103
100
104
206
2031
101
102
203
DIAGNOSTICIAN'S FINGERTIP
202b
202a
202

FIG. 45

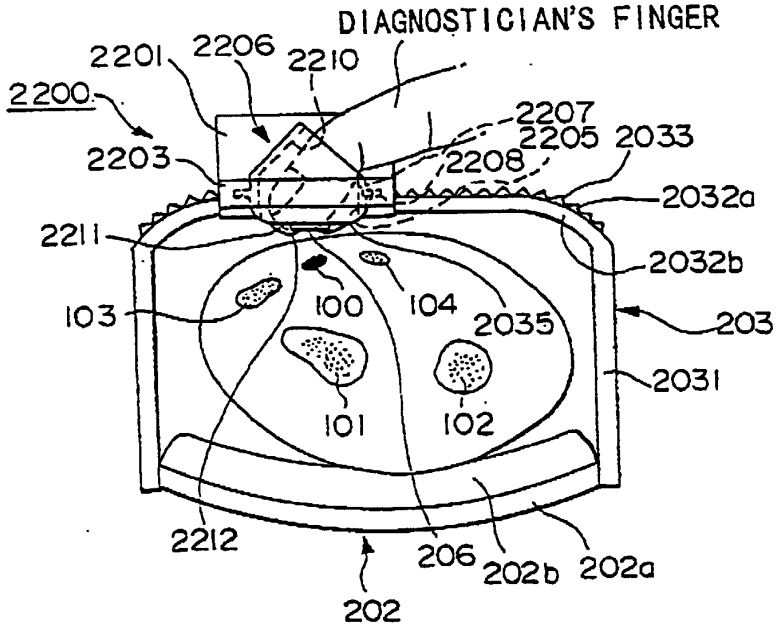
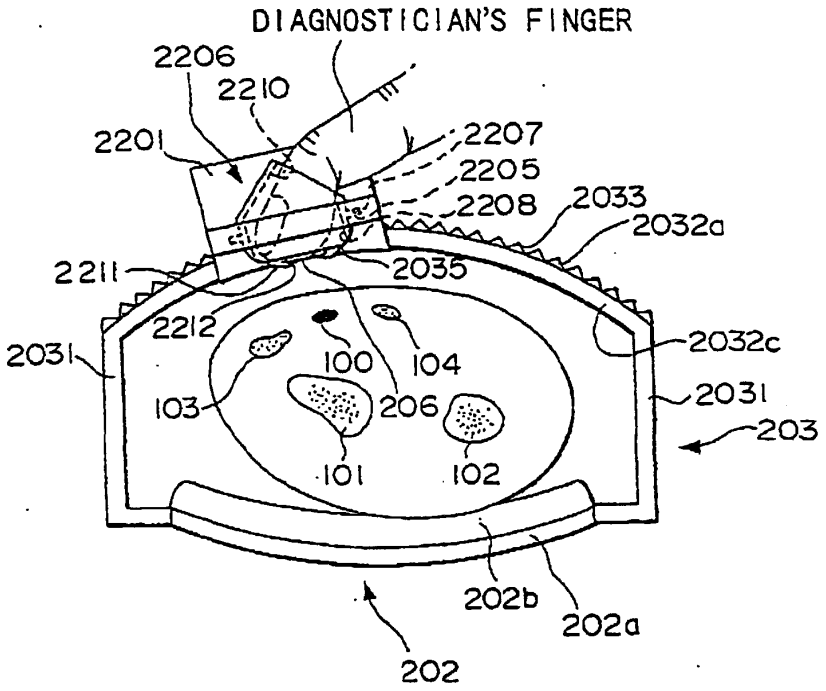

DIAGNOSTICIAN'S FINGER
2201
2206
2210
2200
2207
2205
2033
2203
2208
2032a
2211
2032b
103
100
104
2035
203
2031
101
102
2212
206
202b
202a
202

FIG. 46


DIAGNOSTICIAN'S FINGER
2206
2210
2201
2207
2205
2208
2033
2032a
2211
2035
2212
2032c
2031
100
104
103
206
2031
203
101
102
202b
202a
202

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/01276

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[6] A61B5/024

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[6] A61B5/024

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1945-1997 Toroku Jitsuyo Shinan Koho 1994-1997
Kokai Jitsuyo Shinan Koho 1971-1995

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A Y	JP, 53-23182, A (Michio Tani), March 3, 1978 (03. 03. 78) (Family: none)	1-6, 31-36 7-11, 22-26, 30, 37-41, 52-56, 60
A Y	Microfilm of Japanese Utility Model Application No. 159672/1988 (Laid-open No. 79904/1990) (Colin Electronics Co., Ltd.), June 20, 1990 (20. 06. 90) (Family: none)	1-6, 31-36 7-11, 22-26, 30, 37-41, 52-56, 60
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[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
April 30, 1998 (30. 04. 98)	May 12, 1998 (12. 05. 98)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/01276

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 51-25664, B1 (Fumihiko Daita), August 2, 1976 (02. 08. 76) (Family: none)	1-6, 31-36
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Y		7-11, 37-41
Y	JP, 4-15037, A (Sony Corp.), January 20, 1992 (20. 01. 92) (Family: none) & US,,A	12-30, 42-60
Y	Microfilm of Japanese Utility Model Application No. 13208/1972 (Laid-open No. 87688/1974) (Daini Seikosha K.K.), July 30, 1974 (30. 07. 74) (Family: none)	18-26, 48-56
Y	Microfilm of Japanese Utility Model Application No. 200906/1984 (Laid-open No. 109503/1986) (Nissho Corp.), July 11, 1986 (11. 07. 86) (Family: none)	27-30, 57-60

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 January 2004 (15.01.2004)

PCT

(10) International Publication Number
WO 2004/004558 A1

(51) International Patent Classification[7]: A61B 5/021

(21) International Application Number: PCT/SG2003/000159

(22) International Filing Date: 9 July 2003 (09.07.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/191,887 9 July 2002 (09.07.2002) US

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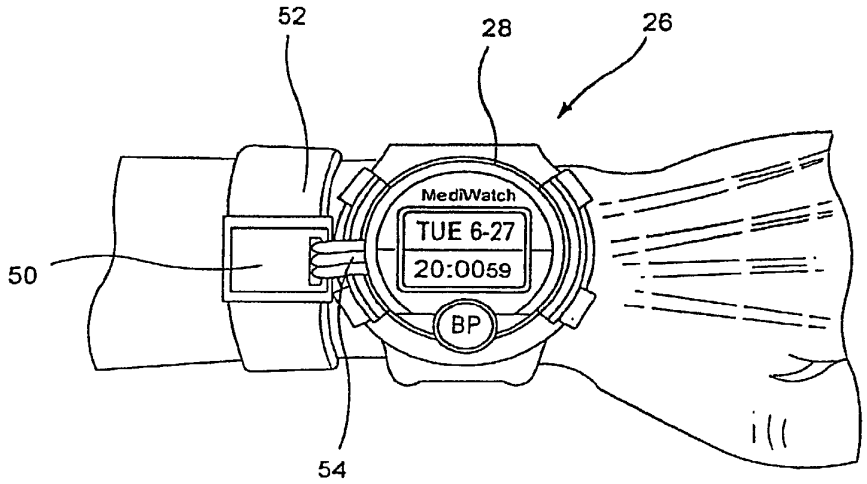
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND DEVICE FOR MONITORING BLOOD PRESSURE



(57) Abstract: The present invention relates to a device for non-invasive continuous monitoring of user's arterial blood pressure that is capable of being used in an ambulatory beat-to-beat blood pressure monitor (ABMP) including sensor means adapted to continuously detect blood pressure and to generate signals by contact with an external surface of the user's body at a location adjacent an artery. The device further includes microprocessor means for interpreting the signals generated by the sensor means to determine actual arterial blood pressure wherein the microprocessor is programmed to record a complete and continuous arterial pulse waveform.

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METHOD AND DEVICE FOR MONITORING BLOOD PRESSURE

FIELD OF THE INVENTION

The present invention relates to a method and device for monitoring blood pressure. In particular, such method and device is non-invasive to the human body and the device is preferably portable.

BACKGROUND AND PRIOR ART

Hypertension is a silent killer. According to the National Health Survey, 1998, about 27.3% of the Singapore population between the ages of 30-69 years are hypertensive. This translates to about 600,000 hypertensives based on the 2.2 million people in this age group, of whom about half have not been previously diagnosed. The prevalence of hypertension and its related complications are on the rise, with:

1. one new hospital admission for stroke every hour;
2. 25% of stroke patients are < 45 years old;
3. one heart attack every 3 hours as recorded by the Acute Myocardial Infarction Register;
4. more and younger patients requiring renal dialysis.

Such facts are not unique to Singapore. Many developed countries have comparable, if not higher, statistics. In other words, hypertension is a global problem of epidemic proportions.

In Singapore alone, there is at least one person coming down with stroke every hour. The numbers are rising year after year. Moreover, death from stroke in Singapore accounts for more than 12% of all deaths since 1996.

Together with heart ailment, it accounts for more than 32% of all deaths since 1996, ie. more than one-third of all mortalities in Singapore.

Further, every year there are about 27,000 to 30,000 pregnancies leading to successful deliveries. Of these, thousands of pregnant women suffer from a condition called pre-eclampsia. This is a condition whereby the mother suffers from a rise in blood pressure during pregnancy. The blood pressure can rise to dangerous levels without warning and it can lead to convulsion and brain damage to the mother, and sudden intra-uterine death of the baby. The morbidity and mortality of pre-eclampsia is directly related to the level and control of blood pressure of the patient.

The central event linking the 3 major ailments is blood pressure. In fact, in many instances of strokes and heart attacks, the usual and final pathway is a sudden and dangerous rise in blood pressure before catastrophe strikes.

Therefore, the detection and prevention of further rises or falls in the final pathway holds the key to the prevention and reduction of strokes, heart attacks and eclampsia.

Currently, patients who suffer from the above illnesses are monitored either as outpatients or in-patients in a hospital. The majority of these are outpatients. When one visits a doctor, be it monthly or fortnightly, the blood pressure reading is obtained by using a blood pressure cuff sphygmomanometer. They use occlusive methods, i.e. air is pumped into the cuff to occlude the artery and is slowly released to finally allow the blood to overcome the resistance and flow through. A flow turbulence is thus set up and picked up by the doctor listening to it. The blood pressure is then recorded. The self-monitoring devices that are available on the market generally all use occlusive methods, the difference being the turbulence are picked up by various methods, such as via a microphone. In other words, the number of readings is totally dependent on the number of times that the artery is being occluded, whether it is manual or pre-set electronically. The monitoring is therefore not continuous, in the sense of having beat-to-beat readings.

To make matters worse, whenever the doctor detects a normal or "good" blood pressure in his clinic, he usually makes 3 assumptions:

1. the patient's blood pressure from the last test must be "good";
2. his blood pressure until the next test will be "good"; therefore, he will not have a stroke, heart attack or convulsion as in the case of a pre-eclampsic woman.

Unfortunately, these assumptions are far from the truth as the above incidents have revealed. Casual blood pressure measurements taken in the doctor's office or by the patients themselves are not necessarily representative of a person's 24-hours blood pressure. Therefore, it would be advantageous to be able to catch the "final pathway" of sudden changes in blood pressure/pulse, by being able to monitor a person's blood pressure continuously and be able to sound the alarm at the right time to prevent a catastrophe.

One method of continuously monitoring blood pressure is suggested in United States Patent Number 5,485,848. That patent purports to disclose a non-invasive and non-intrusive portable device for monitoring a user's arterial blood pressure. However, that device has the disadvantage that it needs to fix a nominal or base pressure by fixing the strap tension. The calibration is also user-specific. It assumes that base pressure can be maintained constant for the

calibration to work. It is not practically possible to fix the base pressure of a moving wrist by the methods described. At most, it only keeps the strap circumference constant, instead of keeping the pressure constant. By fixing the circumference of the strap, pressure changes are even greater with movement and changes in position of the hand. Thus, the wrist position cannot change. In practice, it is difficult to keep the pressure constant as a slight change in wrist pressure and sensor position affects readings to an appreciable extent. Furthermore, the calibration involves extrapolation and interpolation of readings. Therefore, user conditions must remain uniform, since one has to show a linear relationship which may not exist if user conditions are otherwise. In accordance with the described formula for calculating blood pressure, the pressure sensed by the piezoelectric film transducer is dependent on the area of contact, distance from the artery and source of the signal. These are factors which cannot practically be fixed with the described device.

To provide continuity in monitoring, the blood pressure must be measured on a beat-to-beat basis, as in intra-arterial monitoring.

The time-keeping function of a watch should be integrated with the blood pressure data, as this will provide a meaningful interpretation of the trend or pattern of blood pressure seen or recorded over a period of time. The downloading of data over time may become important in an unfortunate event of the death of a wearer.

Similarly, in the collection of data by the sensor, the position of the sensor and the fixation of the sensor must be considered. In order to accurately collect data from every beat of the heart, the sensor compartment must be able to receive reliable data with the wrist in different positions. In the prior art, the data can only be reliably collected when the hand is held fixed at a certain position, i.e. with restrictions. The prior art may try to overcome the movement of the strap by increasing the strap pressure. Usually, this is not only impractical, but undesirable as the compression of veins will cause significant congestion in the hand distal to it in just a few minutes. This can lead to numbness and further medical complications.

The Median Nerve at the Carpal Tunnel would be compressed causing numbness of the finger in a few minutes. As a result, the hand or fingers will swell, causing further congestion. This not only greatly affects the signal, but is harmful to the wearer. Therefore, the challenge is to be able to design the strap system that is comfortable to the wearer over a long period and holds the sensor in position well so as to allow for natural movement of the hand/wrist and collects the data accurately.

The donning and doffing of the wrist monitor and the whole calibration has to be simple and user-friendly for it to be of value for a person who is not medically trained.

However, there is overwhelming evidence in the past 3-4 years that demand us to take a new look at blood pressure monitoring. According to Professor Eoin O'Brien from the Beaumont Hospital, Dublin, Ireland, different individuals fall into distinctly different blood pressure patterns, which can only be identified by 24-hours tracings of the blood pressure (as opposed to single, momentary clinic/office reading). The 9 (not exhaustive) main blood pressure patterns identified are:

1. Normal Blood Pressure;
2. Borderline Hypertension;
3. Isolated Systolic Hypertension;
4. Isolated Diastolic Hypertension;
5. Systolic & Diastolic Hypertension with night time dip;
6. Systolic & Diastolic Hypertension without night time dip;
7. Nocturnal Hypertension;
8. White Coat Hypertension;
9. White Coat Normotension.

Naturally, each individual pattern has its own risks and implications that require its unique management, which may or may not require pharmacological intervention. Without 24-hours blood pressure tracings, White Coat Hypertensive patients may unwittingly be put at increased risk due to unnecessary treatment. On the other hand, certain blood pressure patterns may predispose an individual to increased risk of a stroke or heart attack and early recognition of these patterns allow appropriate treatment to be given to arrest or slow the progression of the disease.

Against this medical background and clinical deficiency, the object of the present invention is to provide an improved device and method for continuous and non-invasive monitoring of arterial blood pressure.

SUMMARY OF THE INVENTION

According to one aspect the present invention consists in a device for non-invasive continuous monitoring of a user's arterial blood pressure

that is capable of being used as an ambulatory beat-to-beat blood pressure monitor (ABMP) including,

sensor means adapted to continuously detect said blood pressure and to generate signals representative thereof by contact with an external surface of the user's body at a location adjacent an artery;

microprocessor means for interpreting said signals generated by the sensor means to determine actual arterial blood pressure;

wherein the microprocessor is programmed to record a complete and continuous arterial pulse waveform.

In a further aspect the present invention consists in a method for continuous monitoring of a user's arterial blood pressure including the steps of:

recording a complete and continuous arterial pulse pressure waveform,

locating at least the dicrotic notch and the diastolic trough within said continuous arterial pulse waveform, and

calculating at least one parameter using said waveform and said diastolic trough and dicrotic notch locations.

It will be convenient to hereinafter describe the invention in greater detail by reference to the accompanying drawings which illustrate one particularly preferred embodiment. The particularity of the drawings and the related description is not to be understood as superseding the generality of the broad identification of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings relate to one preferred embodiment of the invention.

Figure 1 is an illustration of an intra-arterial blood pressure monitoring device of the prior art.

Figure 2 is a side view of a sensor according to the preferred embodiment of the invention.

Figure 3A is a top perspective view of a housing according to the preferred embodiment of the invention.

Figure 3B is a bottom perspective view of a housing according to the preferred embodiment of the invention.

Figure 4 is a side view of a sensor of Figure 2 used on the wrist of a wearer and placed adjacent to and partially occluding the radial artery of the wearer.

Figure 5 is an illustration of the sensor placed next to the radial artery wherein the user's hand is flexed.

Figure 6 is a side view of a portable blood pressure monitoring device of the present invention as preferably embodied in a watch.

Figure 7 is a perspective view of the watch of Figure 6.

Figure 8 is a pressure v time graph showing a typical single arterial pulse with its characteristic features.

Figure 9 is a cross sectional side elevation through the sensor and sensor housing according to the preferred embodiment of the invention illustrated in Figures 3A and 3B.

Figure 10 is a schematic block diagram of a blood pressure monitoring device designed according to the preferred embodiment of the present invention.

Figure 11 is a schematic circuit diagram of a blood pressure monitor device designed according to the preferred embodiment shown in Figure 10.

Figure 12 is a sample graph showing the voltage output produced by the sensor according to the described embodiment in response to a pressure applied to the sensor.

Figure 13 is a sample chart showing sensor readings of a wearer's blood pressure taken over 6 seconds.

Figure 14 is a perspective view of an auto-calibrator that is connected to the blood pressure monitoring device for calibration purposes.

Figure 15 is a flow-chart summarizing the steps involved in the calibration procedure.

Figure 16 is a flow-chart summarizing the steps involved in taking blood pressure readings.

Figure 17 is a flow-chart summarizing the steps involved in the data transfer and communications aspect of the invention.

Figure 18 is a flow-chart summarizing the steps involved in the watch determining whether to sound an alarm to warn of potentially dangerous blood pressure levels.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

According to the preferred embodiment of the present invention, there are several major components in the design of the device. They are the sensor system to measure the blood

pressure, a housing for the sensor, the strap system to secure the sensor relative to an artery and electronic processing unit housed in the watch head for calibration and other interfacing purposes.

MEASURING OF BLOOD PRESSURE

The principle behind the design of the present invention is to mimic the intra-arterial measurement of blood pressure. This intra-arterial method of blood pressure measurement is at present invasive to the human body.

Figure 1 is an illustration of an intra-arterial blood pressure monitoring device 1 of the prior art. The intra-arterial blood pressure monitoring device 1 generally comprises an intra-arterial cannula 2, that is inserted into the radial artery 6 of a patient's wrist 7. As is apparent from Figure 1, the radial artery 6 is adjacent to the radial bone 8. The intra-arterial cannula 2 is connected to a fluid interface 3, containing a fluid column. The fluid 5 interface 4 is connected by a tube to a microprocessor and sensor unit 4. The microprocessor and sensor unit 4 detects changes in the blood pressure in the radial artery 6 and this information is transmitted to a pressure display unit 5.

In the intra-arterial blood pressure measuring device 1 the blood pressure in the radial artery 6 is sensed, beat-to-beat by the blood column in the inducting cannula 2. This beat-to-beat change acts on the column of fluid, which is incompressible and will faithfully relay the pressure change to the microprocessor. The electronic change in signal is then converted to a digital form and displayed on a graph on the display 5, the systolic being the pressure value when the heart pumps, and diastolic, the pressure of the column at rest.

The primary disadvantage of the intra-arterial blood pressure monitoring device 1 is that it is invasive. The patient feels discomfort and pain as the intra-arterial cannula 2 is inserted into his skin 9 and artery 6. Furthermore, the device 1 is also not portable, such that it is normally only used in a hospital environment. It is not possible to monitor a person's blood pressure continuously when he is going about his normal daily activities. Intra-arterial measurements cannot be taken with any movement of the wrist. Therefore, the whole wrist must be immobilised, as during an operation.

This present invention utilises the principle of Applanation Tonometry to capture the arterial pulse waveform, from which the blood pressure patterns and other medically relevant

parameters are derived. Unlike currently available devices, this breakthrough method is neither occlusive nor invasive, and is capable of continuous, 24-hours beat-to-beat monitoring

In the design of the present invention, the whole system including the strap, the sensor and the wrist head have to be considered together in order to appreciate the similarity in principle to the intra-arterial cannula 2.

COMPONENTS OF THE SENSOR SYSTEM

Figure 2 is a side view of a sensor 10 according to one embodiment of the invention. An alternate variation of the sensor is shown in Figure 9.

Referring to Figure 2 the sensor 10 includes a transducer 12 which produces a voltage output according to pressure changes acting on its diaphragm 14. A plunger 16 is affixed next to the diaphragm 14 of the transducer 12.

The plunger 16 has a dome shaped or hemispherical head. The plunger 16 sits on the diaphragm 14 of the transducer 12. The purpose of the diaphragm 14 is to give a constant resting force on the transducer 12. The plunger 16 is able to float freely in a vertical direction due to a pre-determined gap between the base of plunger 16 and the diaphragm 14. The plunger 16 has an effective length which is the depth of the applanation, corresponding to a preferred range of 3mm to 10mm. The diameter of the plunger 16 is preferably between 3mm to 8mm which correspond to the physiological diameter of an artery.

In use the plunger 16 pushes into the wrist and partially occludes the radial artery. The hemispherical shape of plunger 16 ensures comfort over long hours of wearing and also enables pulsation to be faithfully transmitted to the transducer 12. Advantageously, it enables the transmission of the pulsation of the radial artery 20 to be picked up even though the wearer's hand may be at various positions as depicted in Figures 4 and 5.

A layer of gel 18 sits between the diaphragm 14 and the plunger 16, the gel layer 18 filters out interference and sharp changes due to unnatural movement. The gel layer 18 also dampens the noise to signal ratio.

Referring to Figure 4, in that embodiment the senor is fitted within a housing. The housing has an outer cover portion 300 and an inner carrier portion 301. The housing will be described further on with reference to Figures 3A and 3B. In this form the sensor includes a pressure transducer 912 which produces the voltage output according to pressure changes acting on its diaphragm 914. A plunger 916 has a domed head 917. The domed head 917 protrudes

through a circular aperture 310 in the housing 301. It is free to move towards the pressure transducer 912. When not pressed toward the pressure transducer 912 there is a slight gap between the plunger 916 and the diaphragm 914 of pressure transducer 912. The pressure transducer is thereby free floating. This ensures there is no preload of the plunger 916 against the pressure transducer 912.

Referring to Figures 4 and 5 the plunger depth is selected so that in most normal wrists (eg: wrist 24), the plunger can occlude not more than half the diameter of the radial artery 20 when the strap is comfortably worn. This will enable full and faithful transmission of the arterial pulsation to be picked up, including the expansion of the arterial walls, the turbulence of the flow and the vibration transmitted along the artery wall from the heart.

The Sensor Housing

Figures 3A, 3B and 9 illustrate the preferred housing. The housing includes an outer cover portion 300 and an inner carrying portion 301. The outer cover portion 300 has a smooth convex outer surface 302 and a pair of side guards 303 the purpose of the convex outer surface and side guards will be set forth later with reference to the padding and anchoring system. The inward face of cover portion 300 includes a receptacle 311 for receiving the transducer 912. A set of protruding legs 308 extend from the inward face of cover portion 300 toward the carrying portion 301.

The carrying portion 301 includes a generally circular recess 309 for receiving the body of the transducer 912. The circular recess 309 includes a series of concentric terraces ending at a circular aperture 310. The circular aperture 310 opens between the recess 309 through the inward face 321 of the carrying portion 301. The pressure transducer 912 has a flattened cylindrical main body 920 and an flanged upper end 921. The main body 920 rests on second terrace 923 within the recess 309. The flange of the flanged upper end 921 rests on first terrace 925. A pair of locating members 927 extend downward from the cover portion 300. The locating members 927 press against the flanged upper end 921 of the transducer 912 and locate the transducer 912 against the terraces 923 and 925. The plunger 916 has an annular retaining flange 930 at its end distal from its domed end 917. The retaining flange 930 seats on third terrace 929. Third terrace 929 appears as a lip surrounding aperture 310. This lip retains the plunger 916 to the housing. The spacing between terraces 929 and 923, the plunger 916 and the diaphragm 914 of pressure transducer 912 are all such that when the plunger 916 is urged toward leaving the housing

through aperture 310, but retained by terrace 929, a narrow space or gap 915 lies between the plunger 916 and the diaphragm 914. As referred to earlier this gap ensures there is no preload on the transducer 912.

The carrying portion 301 includes locating holes 307 in its outer surface, which receive the legs 308 of the cover portion 300. The carrying portion includes a notch 320 in the wall of recess 309. The notch 320 provides an opening to recess 309 with the cover portion 300 located on the carrying portion 301. This opening permits wiring connections to the sensor 10.

The carrying portion 301 includes a pair of connection legs 305 extending from either end. Each pair of connection legs 305 are adapted to receive and retain a spring loaded watch strap retaining bar.

Figure 4 is a side view of the sensor 10 of Figure 2 used on the wrist 24 of a wearer and placed adjacent to and partially occluding the radial artery 20 of the wearer. Figure 5 is an illustration of the sensor 10 placed next to the radial artery wherein the user's hand is flexed.

Referring to Figures 4 and 5 the sensor 10 is preferably placed adjacent to the radial artery 20. The radial artery 20 at the wrist 24 has been chosen because firstly, it rests on the radial bone 22 dorsally. The radial bone 22 allows for full transmission of the pulsation to be felt as it is rigid and would not allow for any significant soft tissue compensation. Vertically, the sensor system 10 is locked in together with the watch straps and watch head as one immovable and un-stretchable unit. The plunger 16 is thus behaving similarly to the intra-arterial cannula 2, and the fluid column 3. As the plunger 16 and the diaphragm 14 are the only moving units at each pulsation, the arterial pressure is accurately picked up as a waveform as each heart beat reaches the radial artery. Nevertheless, the advantage is that there is no need for the system to be invasive and it is portable.

The following reasons improve the functionality of the sensor system:

1. For a change in pressure between 0 mmHg - 300 mmHg, the displacement of the diaphragm against the pressure variation forms a linear relationship. The range of voltage change in the sensor for 20 such an equation is between 0.5V to 4V, after amplification of the signal.
2. The hemispherical plunger 16 allows for faithful transmission in various wrist positions.

3. The system does not require any fixation of strap pressure. Its main aim is to pick up the waveform of the pressure in the artery for calibration and calculation of blood pressure values in the software program.

The housing is designed to house the transducer and the plunger and to effect a vertical applanation force against the radial artery when used with an elastic strap. This is achieved by having a smooth convex outer surface (casing cover) with a guard along the side. The smooth convex surface allows the strap to slide over the casing while the guard maintains the strap in place. The casing chamber houses the transducer firmly with the diaphragm surface facing inwards. The inner surface of the housing is designed with seating for the plunger while allowing a pre-determined gap between the plunger surface and the diaphragm. The plunger protrudes from the pre-determined aperture in the inner casing.

The Strap System

Referring to Figures 6 and 7, according to the preferred embodiment of the present invention the housing enclosing the sensor is connected with a watch head 600 and with the wrist of a wearer by a system of straps and padding. The watch head 600 includes a first strap 617 extending from one side edge to connect with a first pair of straps securing legs 305 of the carrying portion 301 of the housing. The first strap portion 617 is preferably of a length set for a particular user such that with the watch head 600 against the outer plane of a user's wrist the plunger 16 of the sensor will imponge against the radial aretary. This requires the housing to be skewed to one side of the inner face of the user's wrist. The first strap portion 617 will hereafter be referred to as the radial watch strap 617.

The watch head 600 has a second strap portion 604 extending from its other side edge. The second strap portion 604 will be referred to as the ulnar strap. The ulnar strap 604 has an end 606 that passes outwardly through an oblong ring 607 and back upon itself. This outer end 606 fixes to the inner portion of the ulnar strap 604. This fixing is preferably adjustable, for example by a hook and loop fastener arrangement between the overlap of inner and outer portions. The radial strap 617 and the ulnar strap 604 are preferably substantially non-extensile.

A second oblong securing ring 609 is secured to the radial strap 617. Preferably this securment is by a short connecting loop 619 connected with the radial strap 617 and having an end 621 passing outwardly through the oblong ring 609 to double back on and be secured to itself. An elasticaly extensile strap portion 611 is connected with the second pair of strap

connecting legs 305 of the sensor housing. The elastic strap passes outwardly through the oblong ring 607. An outward portion 613 doubles back over the inward portion 611 and passes over the outside of the cover portion 300 of the sensor housing. The strap is constrained to sit over the convex outer surface by side walls 303. The other end 615 of elastic strap 613 passes outwardly through the second oblong ring 609 doubling back and being secured thereto to itself.

A cuff 602 of padding material is provided within the circle of watch head 600, straps 604 and 611, carrying portion 301 of the sensor housing and radial strap 617. The cuff 602 of padding material includes an aperture fitting over plunger 16 of the sensor. An annular double sided self-adhesive pad between the cuff and the sensor housing secures the cuff to the sensor housing with the plunger protruding through the aperture.

With the device in place on a user's wrist and the straps appropriately tensioned the elastic strap 613 extending across the convex surface of the cover portion 300 results in a perpendicular applanation force. It has been found to provide a suitably constant force under a range of user movement.

This consists of 2 segments, namely the sensor segment and the locking segment. The sensor segment has an elastic loop with one end attached to the watch head and the other end to housing, with the elastic portion positioned to slide over the convex surface of the outer casing. This will result in a vertical applanation force on the housing when the elastic loop is pulled.

The convex shape of the housing allows an even spread applied axial force onto the plunger with the aid of the elastic strap portion.

The Electronic Processing Unit

Figure 10 is a schematic block diagram of a blood pressure monitoring device designed according to the preferred embodiment of the present invention. Blood pressure readings 60 are taken by the sensor 10 and are amplified to a value that can be read by a microcontroller/ microprocessor 64. An example of the microcontroller/ microprocessor 64 suitable for use with the device may be the Motorola 68 series of microprocessor. Optionally, a temperature sensor as found in the art could also be included into the device to read the body temperature, and send the readings to the microcontroller/ microprocessor 64. The readings are preferably stored into a storage component 66. The microcontroller/ microprocessor 64 may also be coupled to various alarms 68, such as blood pressure, body temperature and heart-beat alarms to warn the user if a pre-determined value is reached. The device is powered by a power supply. The readings,

whether taken in real-time or stored in the storage component 66, can be downloaded into a personal computer 72 or other communication device.

In the preferred form of the invention these components, which comprise the electronic processing unit, are housed in the watch 600.

Figure 11 is a schematic circuit diagram of a blood pressure monitor device designed according to the preferred embodiment shown in Figure 10. It demonstrates the circuit connection of the primary components of the device, including the pressure sensor input 74, body temperature input 76, microprocessor 78, liquid-crystal display module 80 for display on the device, the EEPROM storage 82, blood pressure alarm 84, transceiver 86, power supply 88 and button switches 201.

The microprocessor is programmed to perform certain data collection, data processing and data transmission functions. The data collection preferably occurs on a continuous basis. Data processing is preferably performed at least to calculate estimated absolute pressure readings from the electrical sensor readings. This processed data may be then directly uploaded or transmitted for further processing outside the device or may be further processed within the device for either discrete analysis, such as for graphing blood pressures over time, and for waveform analysis as will be described further on.

Data collection

Figure 12 is a sample graph showing the voltage output produced by the sensor 10 according to the described embodiment in response to a pressure applied to the sensor 10. As mentioned above, the sensor includes a transducer 12. The transducer is preferably one which provides a change in voltage that is directly proportional to the amount of pressure applied onto the transducer to produce a linear graph similar to the one illustrated in Figure 12. It was found that a suitable transducer is the Foxboro/ICT Model 1865 transducer.

With the sensor system 10 used, and a microprocessor employed in the watch head 28 to calculate the readings produced by the sensor 10, up to 32 values per second were obtained during tests on the device. By varying the intervals of each detection, i.e. the number of values per second, the inventors have been able to obtain optimal waveforms at 32 readings per second. These waveforms correspond to the systolic/diastolic cycle of the heart when the readings were compared simultaneously with conventional Doppler machines.

Figure 13 is a sample chart showing sensor readings of a wearer's blood pressure taken over 6 seconds. There are a total of 6 systolic and 6 diastolic values provided. These systolic and diastolic readings are averaged under the calibration procedure described below.

Referring to Figure 8 a sample chart is shown being a Pressure v Time graph compiled using the continuous sensor readings rather than discrete readings of Figure 13. In Figure 8 the pressure waveform 81 for a single arterial pulse can be seen to begin at a first diastolic trough 82 and end at the next subsequent diastolic trough 85. The waveform 81 includes the systolic peak 83 and the dicrotic notch 84.

Calibration

Figure 14 is a perspective view of an auto-calibrator 50 that is connected to the blood pressure monitoring device (watch 26) for calibration purposes.

The auto-calibrator 50 has been designed to give an absolute value of the blood pressure using a conventional occlusive method. The concept is that a separate wrist-band 52 is strapped to the wrist 24 next to the watch 26. The wrist-band 52 uses a cuff system that is automated, self-inflating and measures the absolute blood pressure for reference by the blood pressure monitoring device (watch 26).

Instead of a liquid crystal display on the said auto-calibrator 50, the data read by the wrist-band may be immediately processed by its microprocessor (not shown) and downloaded to the watch 26 via a 3-pin outlet 54 to calibrate the system.

The electronically operated cuff-type non-continuous blood-pressure monitor set at the wrist level is already available in the market. The inventors have designed a software program and a microprocessor to download the systolic and diastolic readings into the watch-head 28 itself.

Simultaneous with the calibrator 50 taking the systolic and diastolic reading, the sensor 10 of the watch 26 takes the blood pressure readings and waveforms of the last 6 seconds. As mentioned, 10 readings are taken per second and 60 readings are therefore taken during the 6 seconds. A sample wave-form has been illustrated in Figure 13. The average of the peak readings (systolic) are calculated after sampling to obtain greater accuracy. Sampling includes filtering readings that do not correspond to an expected wave-form (for example, muscle contractions produce a sharper and symmetrically-formed peak). Correspondingly, the average of the trough readings (diastolic) are also calculated. The values of the average systolic and diastolic readings

respectively are compared to the systolic and diastolic readings from the auto-calibrator 50, to assign absolute values to the sensor readings with reference to a voltage level. It is then verified by the software program using the linear relationship of the pressure against voltage change characterized by the sensor 10 (a chart illustrating the linear relationship is shown in Figure 12) as a guide.

The calibrator 50 can then be removed and continuous blood pressure monitoring commences. At any one time, the value of the blood pressure can be checked or verified by the calibrator 50 (which reading may be displayed on the watch-head 28). This is useful when the alarm is sounded when, for example, the blood pressure is outside a pre-determined range, or reaches a preset value.

The pulse rate may also be calculated simply by the time interval between 2 systolic or diastolic values divided by 60 seconds. Therefore, this gives a beat-to-beat heart rate and therefore allows verification of the regularity of the heart beat when the data is provided over a period of time.

Steps in calibration

Figure 15 is a flow-chart summarizing the steps involved in the calibration procedure. In brief, these are to:

1. Put on the auto-calibrator adjacent to the watch in a neutral position of the wrist.
2. Connect the calibrator to the watch through the physical interface.
3. Switch on the calibrator to inflate and deflate the cuff automatically, thereby obtaining the systolic and diastolic readings. These readings are displayed on the watch-head and absolute values are assigned to the sensor readings.
4. Remove the auto-calibrator when calibration is complete.

The processor is programmed to calibrate the arterial pulse waveform from the pressure transducer output using equations 6, 6(a) and 6(b).

In particular the instantaneous blood pressure Pj at a sample point is calculated as:

$$P_j = \left(\frac{P_{sys} - P_{dia}}{A_{max} - A_{min}} \right) \times A_j + C \qquad (6)$$

Where: Psys denotes the calibrator measured Systolic Pressure correspond to Amax,

Pdia denotes the calibrator measured Diastolic Pressure corresponds to Amin,

Amax denotes the maximum measured value of an arterial pulse from the pressure transducer output,

Amin denotes the minimum measured value of an arterial pulse from the pressure transducer output,

Aj denotes the jth sample measured value of an arterial pulse from pressure transducer output, and

C denotes an arbitary constant calculated using one of the equations 6a or 6b.

$$C = P_{sys} - \left(\frac{P_{sys} - P_{dia}}{A_{max} - A_{min}} \right) \times A_{max} \qquad (6a)$$

or

$$C = P_{dia} - \left(\frac{P_{sys} - P_{dia}}{A_{max} - A_{min}} \right) \times A_{min} \qquad (6b)$$

Waveform Processing

A waveform is captured as a series of points from the continuous electrical signal generated by the pressure transducer. A complete arterial waveform including the dicrotic notch is captured. The peaks of the continuous waveform are isolated, the diastolic trough is located and the dicrotic notch is located.

The electrical sensor output is converted to pressure readings using the calibration set forth above with reference to equation 6. The electrical sensor output is also run through a peak gate providing a digitial output. The peak gate has a predetermined threshold voltage. When the sensor output is above the threshold voltage the peak gate is "on" or "open". When the sensor voltage is below the threshold voltage the peak gate is "off" or "closed". In the preferred embodiment of the present invention the peak gate threshold is preferably chosen to be approximately in the middle of the pressure transducer range in normal pressure monitoring use. For example if under normal conditions the sensor output ranges between 100 mV and 300 mV

then an appropriate peak gate threshold to choose would be 200 mV. The peak gate output is used in the preferred method of locating the systolic peak, diastolic trough and dicrotic notch. The peak gate logic could also be implemented in software, processing either the raw sensor signal or the calibrated pressure reading.

In the preferred embodiment of the invention the systolic peak, diastolic end point and dicrotic notch are located in accordance with the following method:

1. A series of sampling points is captured continuously.
2. Each sampling point is compared with the status of the peak gate, either "Peak gate Open" (PGO) or "Peak-gate Close" (PGC).
3. The highest sampling point taken during the "PGO" phase is assigned as the peak Systolic value.
4. From this point, the sampled values will show a downward trend even as the peak gate remains open until the peak gate threshold is reached. After this point, the PGC phase will follow.
5. After the PGC phase resumes the first peak (a rise followed by a fall), is detected. This peak is recorded as the "Dicrotic Notch".
6. The process of detecting the diastolic end point begins when the next PGO is triggered at the peak gate threshold voltage.
7. The sampled values are checked in the reverse direction i.e. comparing each point to the previous one, until the first rise is located. This indicates the diastolic end point. The sample pressure at this time point constitutes the end-diastolic pressure.
8. The logic cycle is repeated for each arterial waveform in turn.

The recorded arterial waveform, and location of the dicrotic notch and diastolic end point are used to calculate certain characteristics. These characteristics include the mean arterial pressure, a mean systolic pressure and a mean diastolic pressure. These calculated characteristics are further used to calculate a mean systolic pressure index and a mean diastolic pressure index.

In particular the microprocessor is programmed to perform calculations in accordance with the following equations.

The Mean Arterial Pressure (MAP) is computed using equation (1), as the area under the pressure waveform between 2 consecutive troughs.

$$MAP(mmHg) = \frac{\sum_{j=1}^{n-1}(P_j + P_{j+1})}{2(n-1)} \quad (1)$$

Where n denotes the total number of samples

Pj denotes the Pressure at sample j

j denotes the index for sample j

The Mean Systolic Pressure (MSP) is computed using equation (2), as the area under the curve of a single waveform from the starting point (previous trough) to the dicrotic notch of the waveform.

$$MSP\ (mmHg) = \frac{\sum_{j=1}^{j=d-1}(P_j + P_{j+1})}{2(d-1)} \quad (2)$$

Where d denotes the sample at the Dicrotic Notch

Pj denotes the Pressure at sample j

j denotes the index for sample j

This represents the average pressure during the systolic phase. The MSP index is the index obtained by dividing MSP by MAP as in equation (3):

$$MSP\_Index = \frac{MSP}{MAP} \quad (3)$$

The Mean Diastolic Pressure (MDP) is computed using equation (4) as the area under the curve starting from the dicrotic notch to the immediate trough. This corresponds to the average pressure during diastole.

$$MDP\,(mmHg\,) = \frac{\sum_{j=d}^{j=n-1}\left(P_j + P_{j+1}\right)}{2(n-d)} \qquad (4)$$

Where n denotes the total number of samples

d denotes the sample at the Dicrotic Notch

Pj denotes the Pressure at sample j

j denotes the index for sample j

The MDP index is calculated using equation (5):

$$MDP\_Index = \frac{MDP}{MAP} \qquad (5)$$

The mean systolic pressure the mean diastolic pressure the MSP index and the MDP index are believed to be useful quantified measures of the shape of the pressure waveform which will have clinical uses as indicators of one or more medical conditions.

It will be appreciated that final processing of waveforms to produce the MAP, MSP, MDP, MSP_index and MDP_index may be conducted either within the device or externally of the device, for example using waveform data downloaded from the device at intervals or continuously transmitted from the device to a receiving computer or other device.

Another objective of the collection and storage of data is to be able to see trends in blood pressure readings and determine the danger-point of the change in blood pressure during a pre-determined period of time. Since blood pressure readings are stored in the watch memory module with respect to a time, such trends in change of blood pressure over a period of time can be monitored. Figure 16 is a flow-chart summarizing the steps involved in taking blood pressure readings.

The sequence of steps involved in taking discrete, pulse by pulse, blood pressure readings begins by executing a blood pressure reading loop of steps 161, 162 and 164. This loop includes

reading the date and time from the internal clock of the device at step 161, taking an instantaneous blood pressure reading at step 162 and storing the date and time and associated blood pressure reading in memory at step 164. This loop is executed at short intervals over a one half hour period. Until it has been determined at step 165 that the half hour period has elapsed the loop returns to step 161.

The microprocessor is programmed so that once it determines at step 165 that the half hour is up it proceeds to average and store the blood pressure readings for the just elapsed half hour interval. The microprocessor is programmed to calculate at step 166 average systolic and diastolic blood pressure readings from the readings stored in memory. It is programmed to store at step 167 the current date and time and the average blood pressure readings calculated at step 166 in memory.

The microprocessor is programmed to determine at step 168 whether a full 24 hour time period has elapsed. If not then it returns to step 161 and the pressure reading loop. If the microprocessor determines at step 168 that a 24 hour time period has elapsed it is programmed to proceed to steps 169 and 170.

At step 169 the microprocessor reads the half hourly records for the immediately preceding 24 hour interval and averages these to a single record. At step 170 the microprocessor stores the present date and time and the averaged 24 hour reading into memory. It will be appreciated that in most operating circumstances the device will be repeating the loop of steps 161 162 and 164. This loop may also include provision for setting or resetting a blood pressure alarm using buttons 201 (eg: step 163).

Communication tool

The watch is preferably provided with an interface 89 to connect to a personal computer to download data or to a printer to print data. Figure 17 is a flow-chart summarizing the steps involved in the data transfer and communications aspect of the invention.

The flow chart of Figure 17 summarises the process that the personal computer software is programmed to implement according to the preferred embodiment of the present invention. In particular the software is programmed to begin by initialising the personal computer serial port at step 171. With the personal computer serial port initialised at step 171 the software proceeds to send a signal to the watch microprocessor at step 172. At step 173 the software determines whether the watch microprocessor has acknowledged the initial communication signal of step

172. If the signal has not been acknowledged it repeats step 172 and continues to loop step 172 until receipt is acknowledged. Once acknowledgement has been received from the watch microprocessor the software proceeds to step 174 and establish full communication through a handshaking process. The software then proceeds to perform a loop of steps 175 and 176 to upload data. At each repetition of step 175 the software uploads a single dataset from the memory of the device. Each reading includes the systolic and diastolic blood pressure readings, date and time. At step 176 the software determines whether the upload is complete. If not it returns and repeats step 175 for the next data set.

Once the microprocessor determines at step 176 that upload is complete the software proceeds to store the uploaded data in a database at step 177. The software provides the capability of printing out the data results, (eg: at step 179) and plotting summary graphs such as blood pressure v time and blood pressure v pulse rate, (eg: at step 178).

Although the watch may be connected directly to a personal computer by a direct cable connection such as IRS 323, Universal Serial Bus or other similar interface, the watch may advantageously be provided with wireless communication, particularly for the output of continuous waveforms.

Setting of alarm

It is believed that many catastrophic events occur when the blood pressure suddenly increases or decreases drastically in a patient. This is true in some stroke patients and very evident in pre-eclampsia patients. The aim of the continuous monitoring is firstly to discover and help the control of blood pressure. Secondly, in some cases, a tragedy may be avoided if there is an alarm system to detect these sudden and drastic changes. The alarm thresholds can be preset at the factory or individually set using buttons 201, and multiple alarms can be set for the blood pressure or pulse rates. Figure 18 is a flow-chart summarizing the steps involved in setting the alarm in the watch to warn of potentially dangerous blood pressure levels.

In particular the microprocessor is programmed to perform a continuing loop in conjunction with its data collection loop of steps 161, 162 and 164 of Figure 16. This loop begins with a step 181 of comparing the presently read blood pressure with a value as presently set using the set alarm function of step 163 in Figure 16.

The microprocessor proceeds to determine whether the blood pressure value is outside the set range at step 182. If the blood pressure is outside the set range at step 182 then it proceeds to

end the loop, which will be repeated each time a blood pressure reading is taken. If the microprocessor determines at step 182 that the blood pressure is outside the set range then it proceeds to step 183 to activate an alarm.

While a particular embodiment of the invention has been shown and described, it will be obvious to those skilled in the art that changes and modifications of the present invention may be made without departing from the invention in its broader aspects. As such, the scope of the invention should not be limited by the particular embodiment and specific construction described herein but should be defined by the appended claims and equivalents thereof. Accordingly, the aim in the appended claims is to cover all such changes and modifications as fall within the spirit and scope of the invention.

CLAIMS:

1. A device for non-invasive continuous monitoring of a user's arterial blood pressure that is capable of being used as an ambulatory beat-to-beat blood pressure monitor (ABMP) including,

sensor means adapted to continuously detect said blood pressure and to generate signals representative thereof by contact with an external surface of the user's body at a location adjacent an artery;

microprocessor means for interpreting said signals generated by the sensor means to determine actual arterial blood pressure;

wherein the microprocessor is programmed to record a complete and continuous arterial pulse waveform.

2. The device as claimed in claim 1 wherein the sensor means includes a pressure transducer that provides electrical output signal corresponding to an exerted pressure by pulsation of the artery.

3. A device as claimed in claim 1 wherein said microprocessor is programmed to detect at least the dicrotic notch and the diastolic trough within a continuous arterial pulse waveform.

4. A device as claimed in claim 3 wherein said microprocessor is programmed to calculate a mean diastolic pressure as the mean sensed pressure between a said detected dicrotic notch and the immediately following diastolic trough.

5. A device as claimed in claim 4 wherein said microprocessor is programmed to calculate a mean arterial pressure as the average pressure between two consecutive said diastolic troughs, and to calculate a mean diastolic pressure index as the quotient of the calculated mean diastolic pressure divided by the mean arterial pressure.

6. A device as claimed in claim 3 wherein said microprocessor is programmed to calculate a mean systolic pressure as the average pressure between a diastolic trough and the immediately subsequent dicrotic notch.

7. A device as claimed in claim 4 wherein said microprocessor is programmed to calculate a mean arterial pressure as the average pressure between two consecutive said diastolic troughs, and to calculate a mean systolic pressure index as the quotient of the calculated mean systolic pressure divided by the mean arterial pressure.

8. A device as claimed in claim 1 wherein said microprocessor is programmed to detect the peak systolic pressure and record the peak systolic pressure for at least a selection of recorded arterial pulses and to detect the diastolic trough and record a pressure at the diastolic trough for each pulse of said at least selection of arterial pulses.

9. A device as claimed in claim 8 wherein said device includes an alarm and said microprocessor is programmed to operate said alarm in response to an indicator falling outside a preselected range, said indicator being selected from: said systolic peak pressure, said diastolic trough pressure or the difference between said systolic peak pressure.

10. A device as claimed in claim 9 wherein said device includes user input means, and said microprocessor is programmed to allow setting or selection of a threshold for said indicator.

11. A device as claimed in claim 8 wherein said microprocessor is programmed to calculate an average systolic pressure as the average of the said pressure as recorded at said systolic peak for said at least selection of arterial pulses and an average diastolic pressure as the average pressure recorded at said diastolic trough for said at least selection of arterial pulses.

12. A device as claimed in claim 2 wherein a calibrator which measures the user's blood pressure by occluding an artery of the user and obtaining an absolute diastolic and systolic reading of the user's arterial blood pressure is operatively connectable to the device and said processor is programmed to calculate calibration constants from comparisons of said absolute readings and said sensor signals for ongoing calculation of pressure from said sensor signals.

13. A device as claimed in claim 1 including a first housing holding said sensor and a second housing enclosing said microprocessor, and at least one strap connecting said first housing and said second housing and together therewith forming a band to encircle the wrist of a wearer, said first housing having an outwardly facing pressure surface, with at least one said strap passing freely over said pressure surface.

14. A device as claimed in claim 13 wherein said straps include a second strap connecting between said first and second housing and a third strap connected with said second housing and said elastic strap, said elastic strap being connected at one end to said first housing, extending there from to said third strap before turning back upon itself to form a loop, said loop being connected to said third strap, to then pass over said pressing surfaces of said first housing, with the other end of said elastic strap being connected to said second housing or to said second strap.

15. A device as claimed in claim 13 including a joining ring, said elastic strap passing through said joining ring at said loop, and said third strap passing through said joining ring and

back upon itself to hold said joining ring within a loop thereof, said third strap including adjustable connection means operating between said in and outer portions.

16. A device as claimed in claim 13 including a padding cuff disposed within said band, said padding cuff including an aperture, said sensor including a plunger protruding from said first housing through said aperture, and said cuff being adhered to an inner face of said first housing.

17. A method for continuous monitoring of a user's arterial blood pressure including the steps of:

recording a complete and continuous arterial pulse pressure waveform,

locating at least the dicrotic notch and the diastolic trough within said continuous arterial pulse waveform, and

calculating at least one parameter using said waveform and said diastolic trough and dicrotic notch locations.

18. A method as claimed in claim 17 including calculating a mean diastolic pressure as the mean recorded pressure between a said detected dicrotic notch and the immediately following diastolic trough.

19. A method as claimed in claim 18 including calculating a mean arterial pressure as the average pressure between two consecutive said diastolic troughs, and calculating a mean diastolic pressure index as the quotient of the calculated mean diastolic pressure divided by the mean arterial pressure.

20. A method as claimed in claim 19 including calculating a mean systolic pressure as the average pressure between a diastolic trough and the immediately subsequent dicrotic notch.

21. A method as claimed in claim 20 including calculating a mean arterial pressure as the average pressure between two consecutive diastolic troughs, and calculating a mean systolic pressure index as the quotient of the calculated mean systolic pressure divided by the mean arterial pressure.

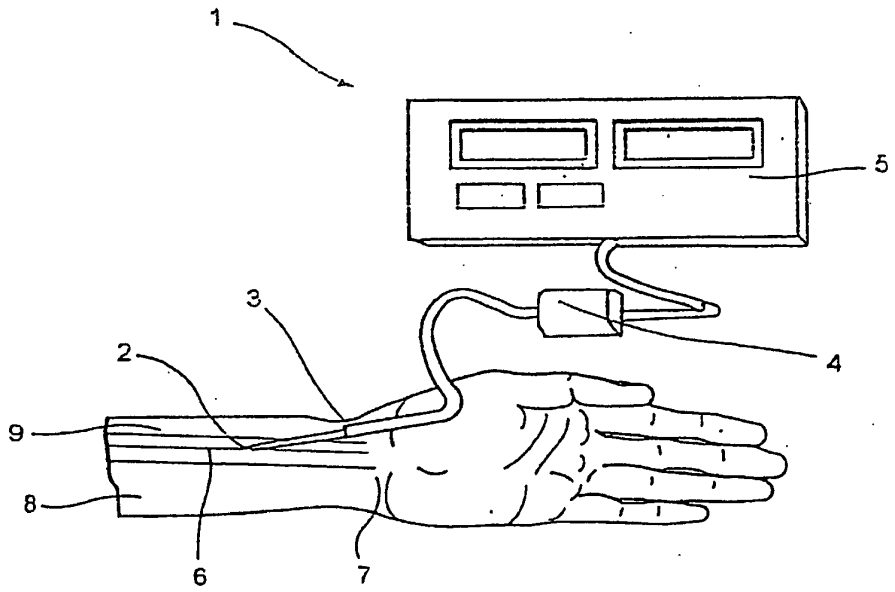

FIG. 1
PRIOR ART

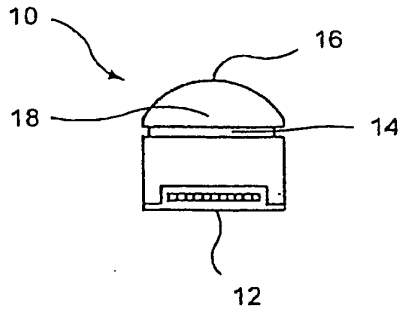

FIG. 2

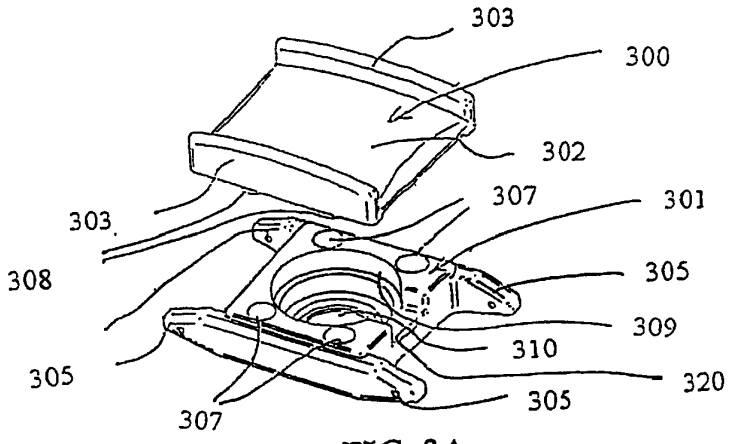
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FIG. 3A

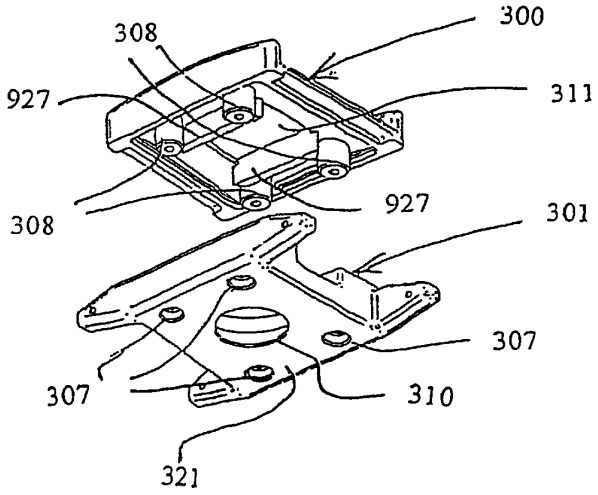
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FIG. 3B

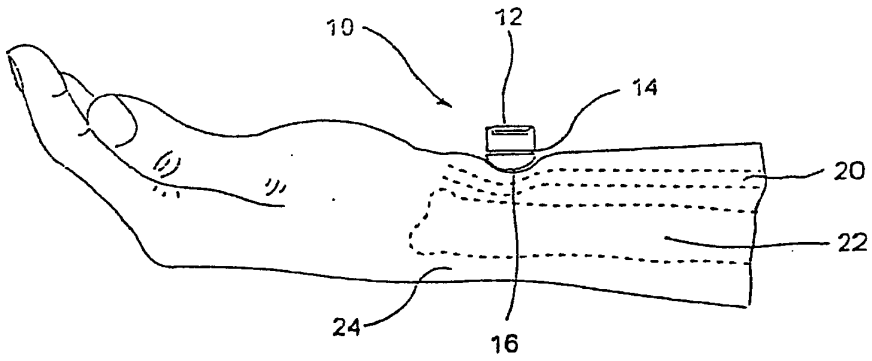

FIG. 4

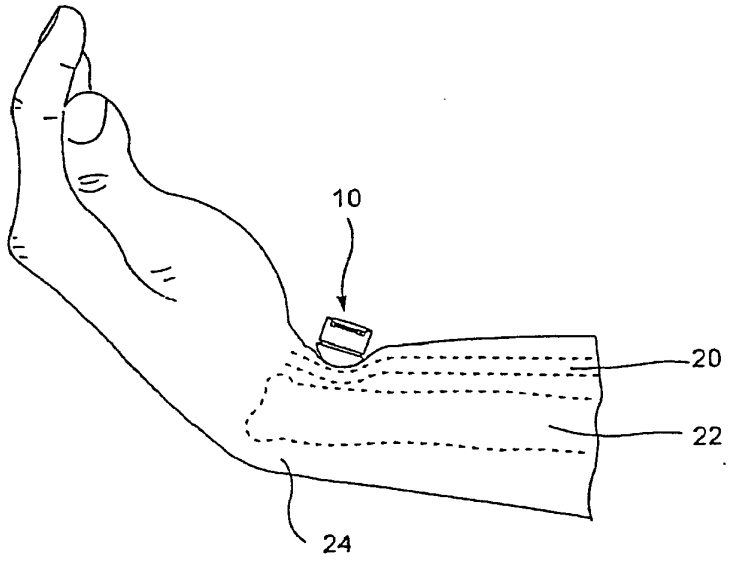

FIG. 5

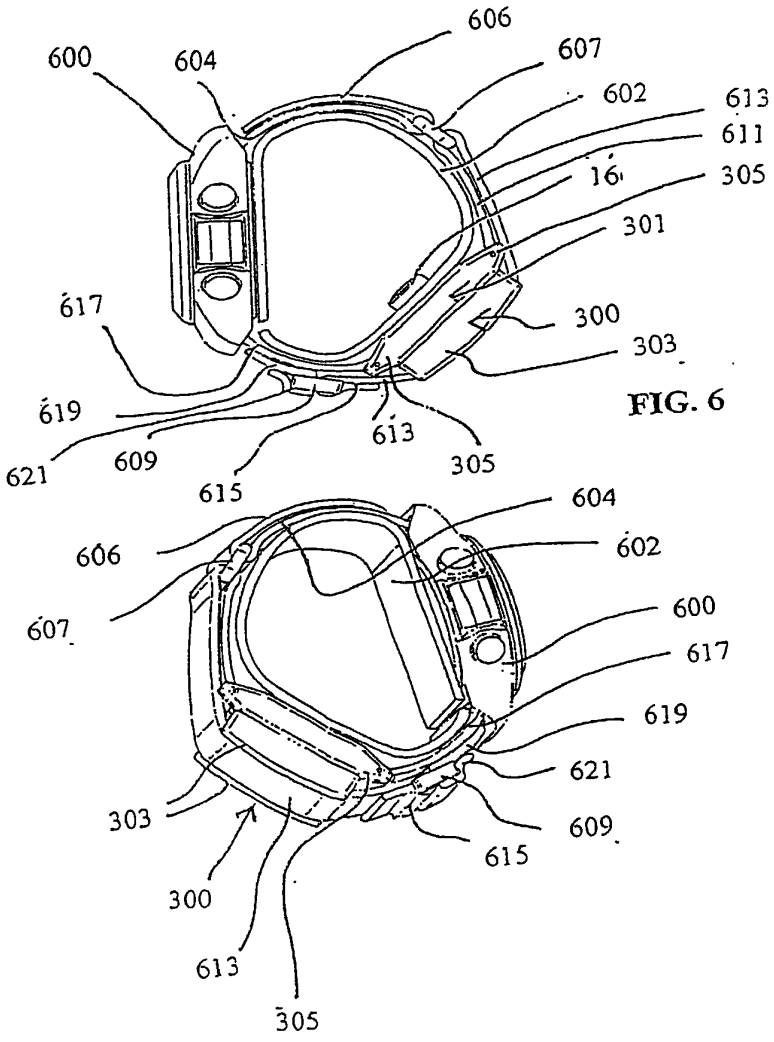
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FIG. 6

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FIG. 7

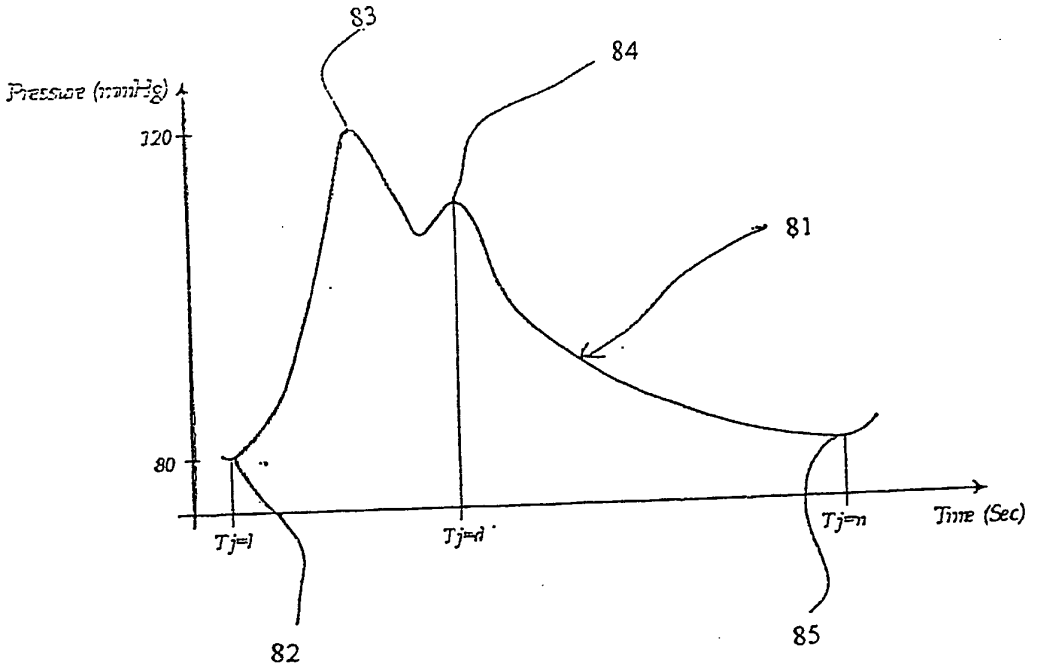

FIG. 8

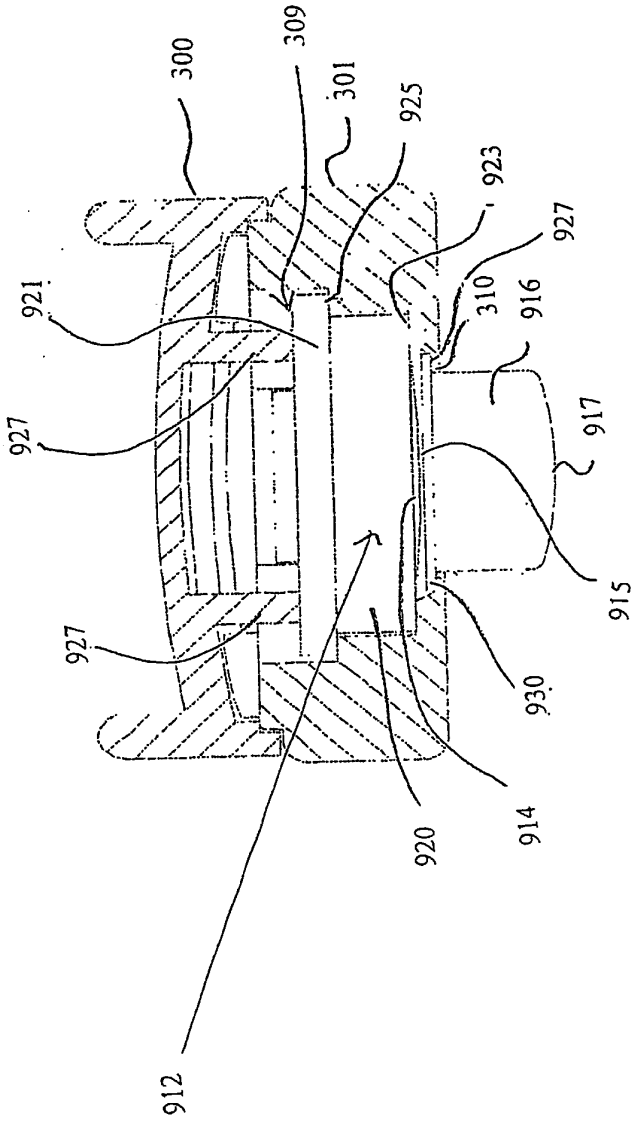
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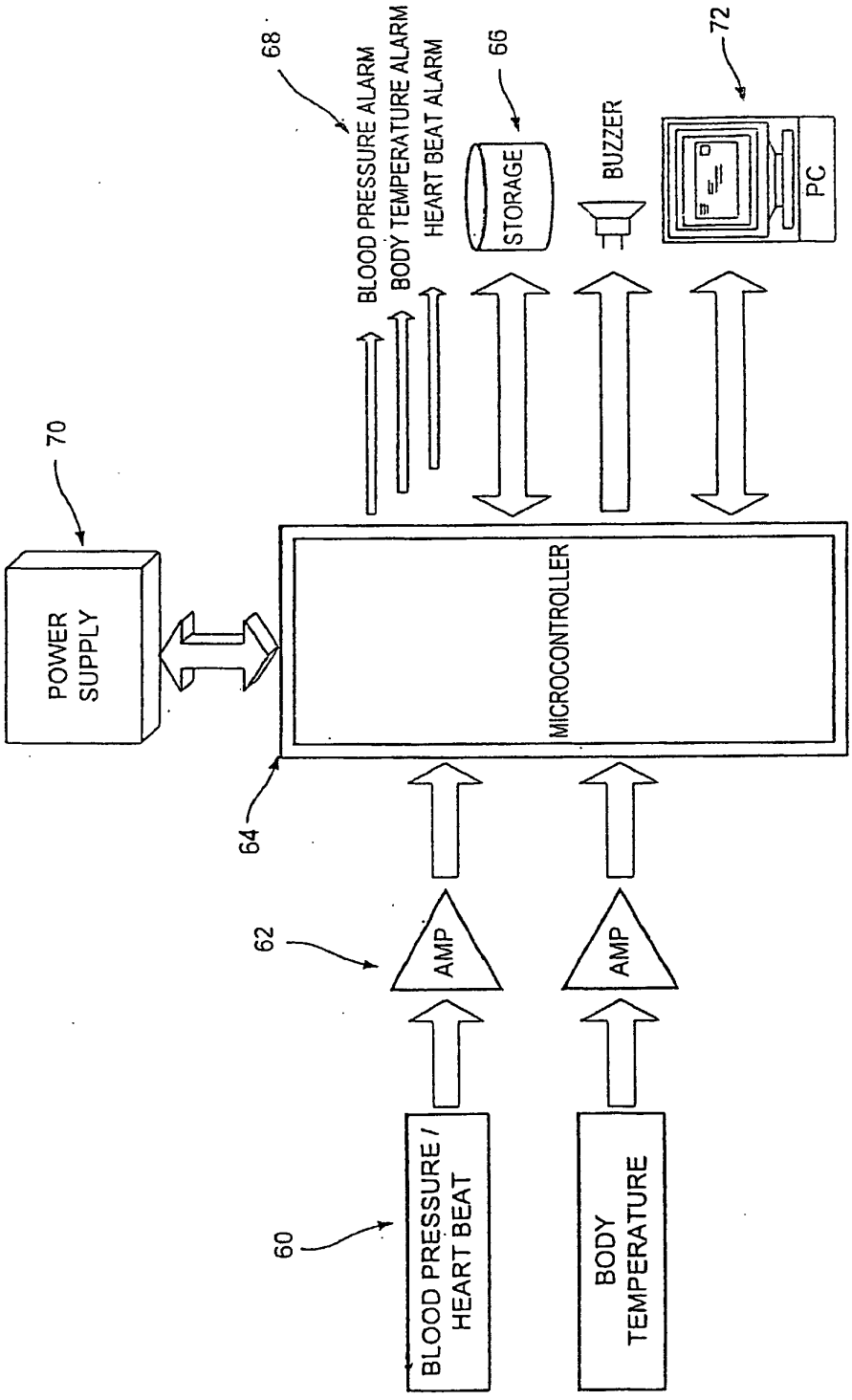
FIG. 9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BLOOD PRESSURE / HEART BEAT
BODY TEMPERATURE
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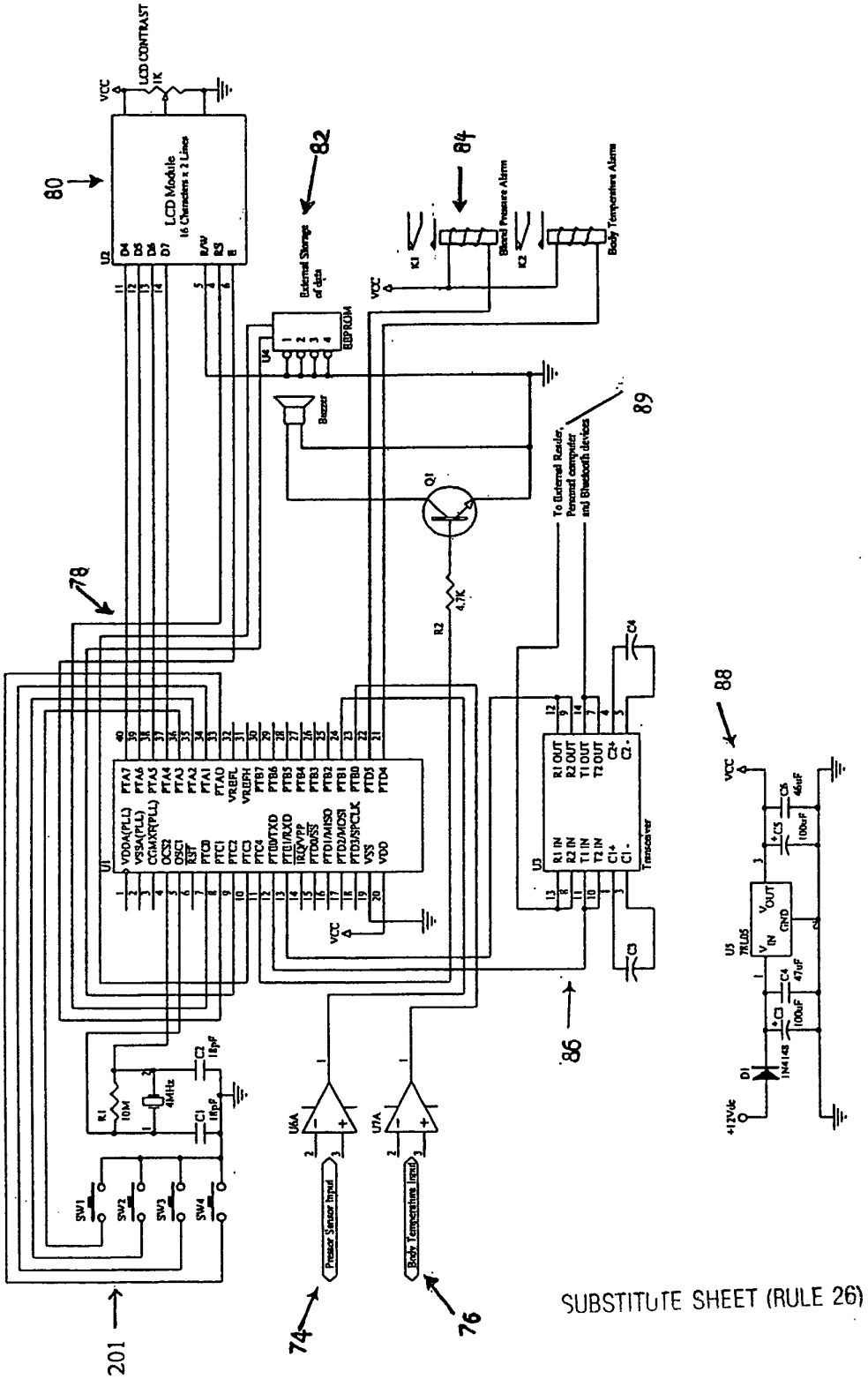
AMP
AMP
64
MICROCONTROLLER
POWER SUPPLY
70
68
BLOOD PRESSURE ALARM
BODY TEMPERATURE ALARM
HEART BEAT ALARM
66
STORAGE
BUZZER
72
PC

FIG. 10



SUBSTITUTE SHEET (RULE 26)

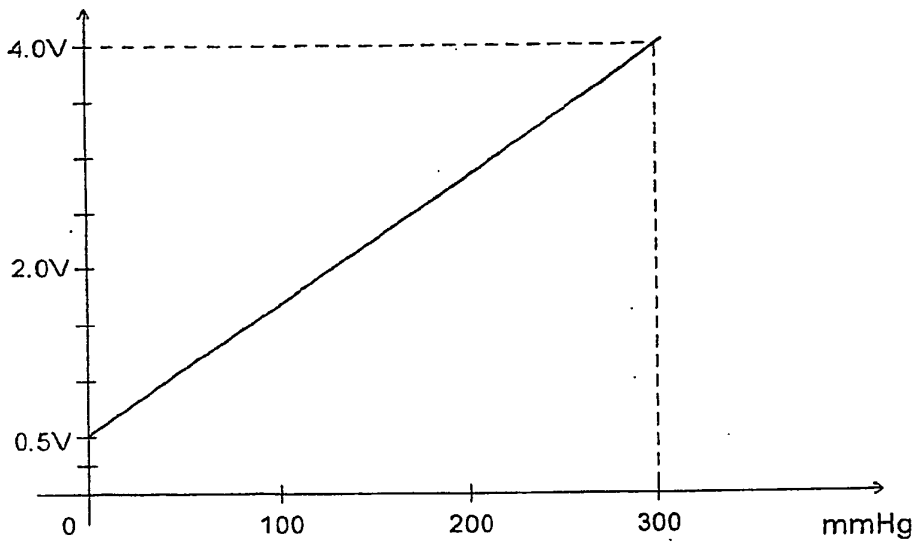
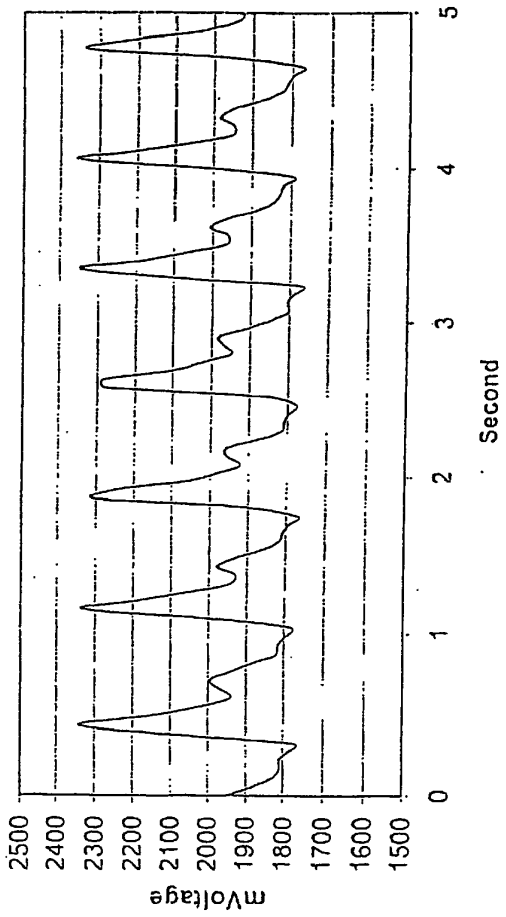


FIG. 12


mVoltage
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Second

FIG. 13

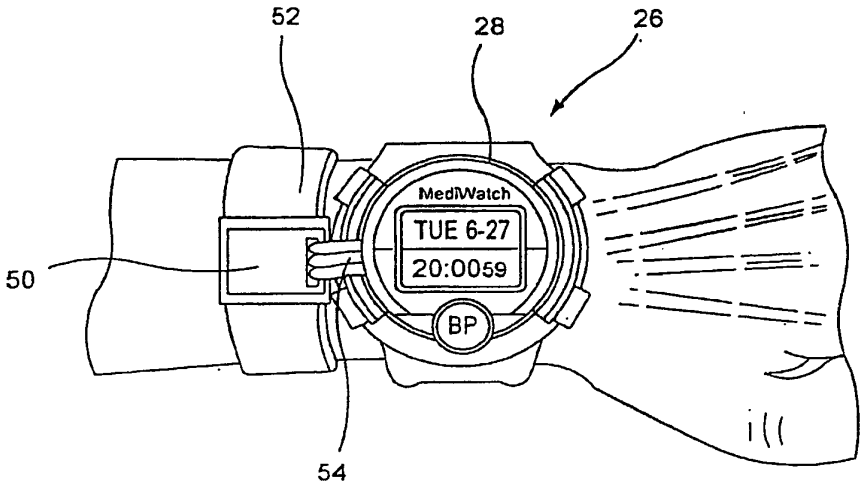

FIG. 14

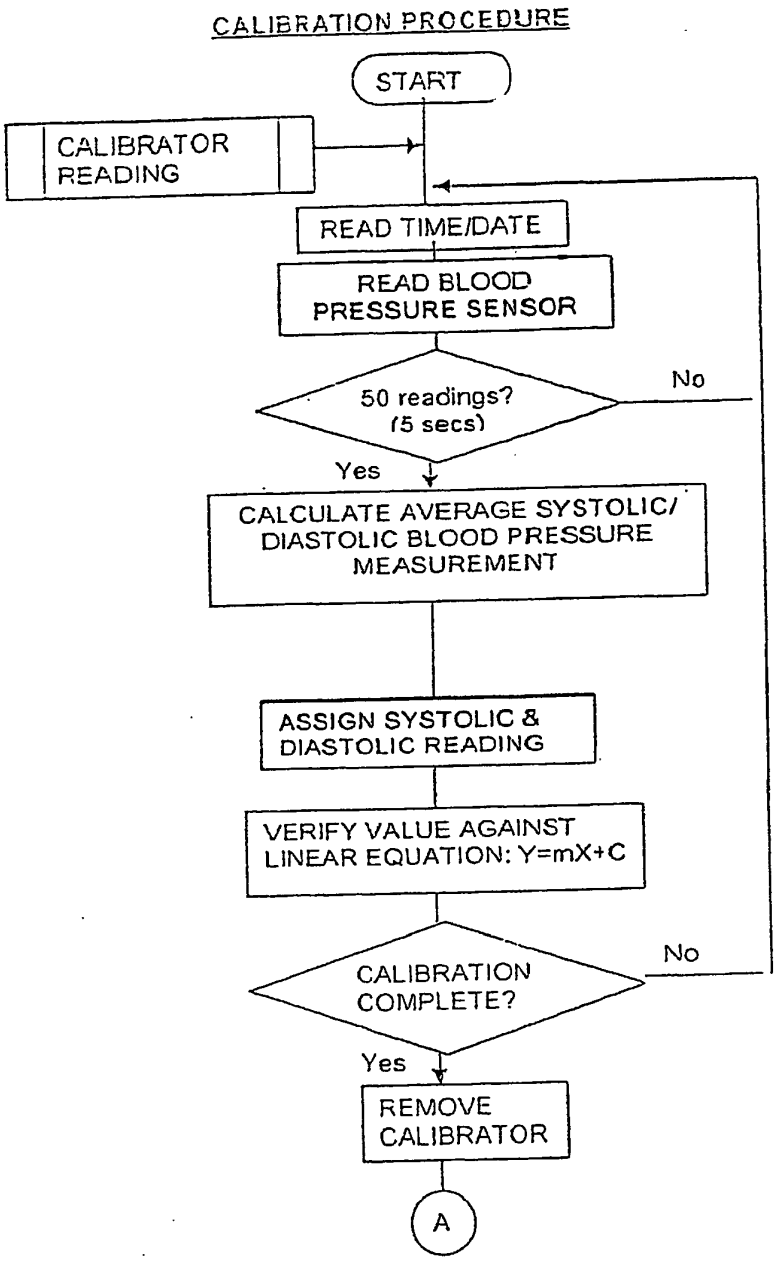
CALIBRATION PROCEDURE
START
CALIBRATOR READING
READ TIME/DATE
READ BLOOD PRESSURE SENSOR
50 readings? (5 secs)
No
Yes
CALCULATE AVERAGE SYSTOLIC/ DIASTOLIC BLOOD PRESSURE MEASUREMENT
ASSIGN SYSTOLIC & DIASTOLIC READING
VERIFY VALUE AGAINST LINEAR EQUATION: Y=mX+C
CALIBRATION COMPLETE?
No
Yes
REMOVE CALIBRATOR
A

FIG. 15

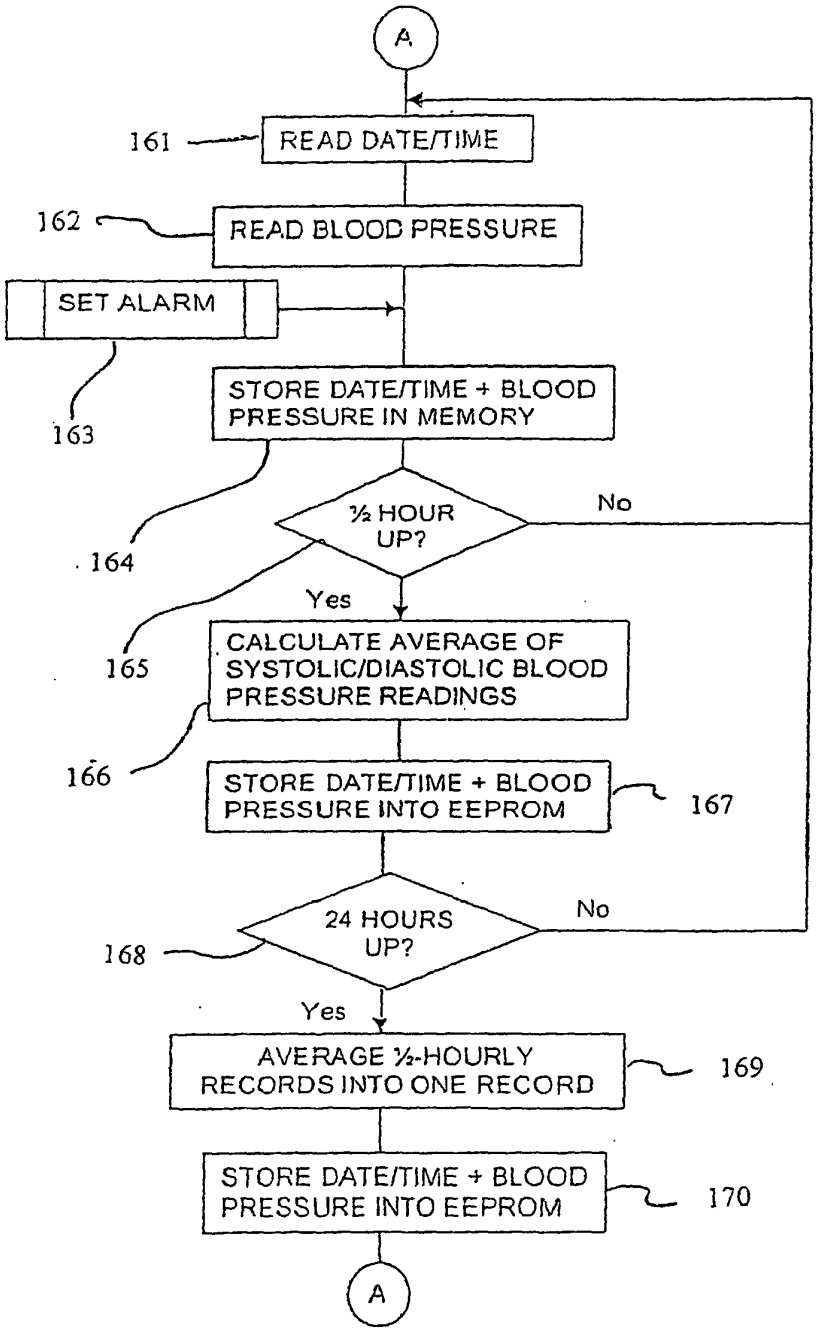
A
161
READ DATE/TIME
162
READ BLOOD PRESSURE
SET ALARM
163
STORE DATE/TIME + BLOOD PRESSURE IN MEMORY
164
½ HOUR UP?
No
Yes
165
CALCULATE AVERAGE OF SYSTOLIC/DIASTOLIC BLOOD PRESSURE READINGS
166
STORE DATE/TIME + BLOOD PRESSURE INTO EEPROM
167
24 HOURS UP?
168
No
Yes
AVERAGE ½-HOURLY RECORDS INTO ONE RECORD
169
STORE DATE/TIME + BLOOD PRESSURE INTO EEPROM
170
A

FIG. 16

DATA TRANSFER AND COMMUNICATIONS

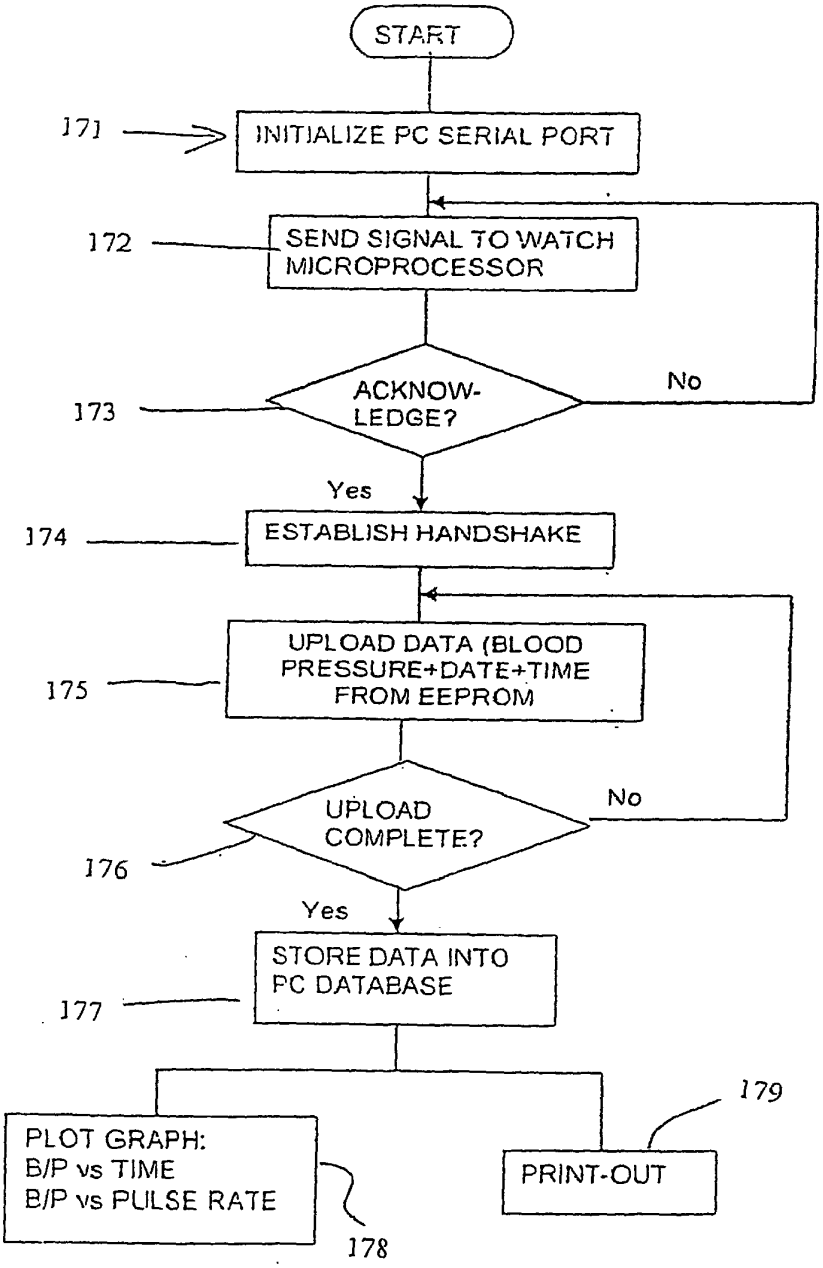

FIG. 17

SUBSTITUTE SHEET (RULE 26)

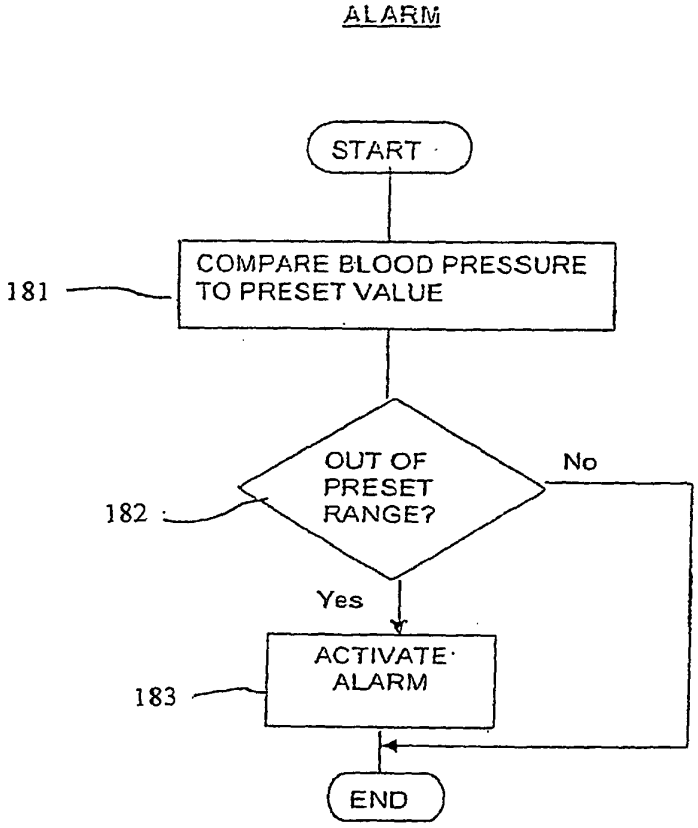
ALARM
START
COMPARE BLOOD PRESSURE TO PRESET VALUE
181
OUT OF PRESET RANGE?
182
No
Yes
ACTIVATE ALARM
183
END

FIG. 18

INTERNATIONAL SEARCH REPORT

Inte nal Application No
PCT/SG 03/00159

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B5/021

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 968 681 A (SEIKO EPSON CORP) 5 January 2000 (2000-01-05) paragraph '0034!; figure 37 paragraph '0199! paragraph '0283! paragraph '0284! paragraph '0033! paragraph '0056! paragraph '0066! claim 37	1-3
A	EP 1 074 216 A (SEIKO EPSON CORP) 7 February 2001 (2001-02-07) abstract paragraph '0082!	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 October 2003	14/10/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Papone, F

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

national application No.
PCT/SG 03/00159

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 17-21
because they relate to subject matter not required to be searched by this Authority, namely:
Rule 39.1(iv) PCT - Diagnostic method practised on the human or animal body

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter nal Application No
PCT/SG 03/00159

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0968681 A	05-01-2000	EP 0968681 A1	05-01-2000
		US 6293915 B1	25-09-2001
		CN 1251027 T	19-04-2000
		WO 9926529 A1	03-06-1999
		TW 425278 B	11-03-2001
EP 1074216 A	07-02-2001	EP 1074216 A1	07-02-2001
		US 6432060 B1	13-08-2002
		WO 0049943 A1	31-08-2000

Form PCT/ISA/210 (patent family annex) (July 1992)

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 September 2006 (08.09.2006)

PCT

(10) International Publication Number
WO 2006/094107 A1

(51) International Patent Classification:
A61B 5/00 (2006.01)

(21) International Application Number:
PCT/US2006/007387

(22) International Filing Date: 1 March 2006 (01.03.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

60/657,596	1 March 2005 (01.03.2005)	US
60/657,759	1 March 2005 (01.03.2005)	US
60/657,268	1 March 2005 (01.03.2005)	US
60/657,281	1 March 2005 (01.03.2005)	US

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(75) Inventors/Applicants *(for US only)*: **DIAB, Mohamed. LAMEGO, Marcelo. AL-ALI, Ammar.**

(74) Agent: **DELANEY, Karoline, A.**; Knobbe, Martens, Olson & Bear, LLP, 2040 Main Street, 14th Floor, Irvine, California 92614 (US).

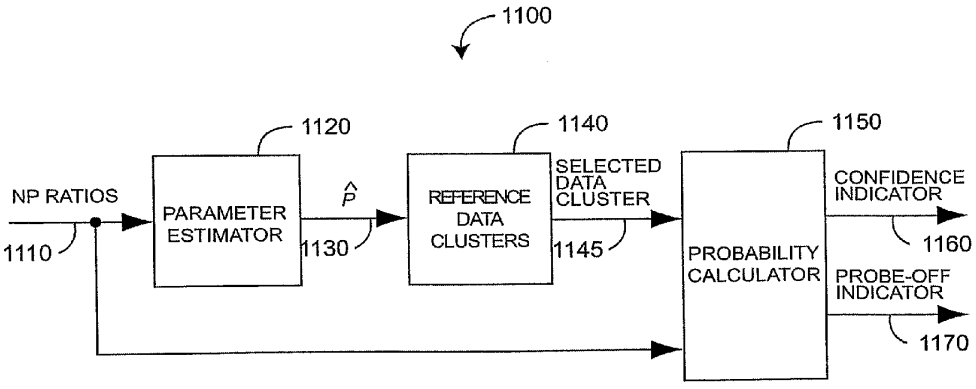
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: PHYSIOLOGICAL PARAMETER CONFIDENCE MEASURE



(57) Abstract: Confidence in a physiological parameter is measured from physiological data responsive to the intensity of multiple wavelengths of optical radiation after tissue attenuation. The physiological parameter is estimated based upon the physiological data. Reference data clusters are stored according to known values of the physiological parameter. At least one of the data clusters is selected according to the estimated physiological parameter. The confidence measure is determined from a comparison of the selected data clusters and the physiological data

WO 2006/094107 A1

PHYSIOLOGICAL PARAMETER CONFIDENCE MEASURE

PRIORITY CLAIM TO RELATED PROVISIONAL APPLICATIONS

[0001] The present application claims priority benefit under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application Serial No. 60/657,596, filed March 1, 2005, entitled "*Multiple Wavelength Sensor,*" No. 60/657,281, filed March 1, 2005, entitled "*Physiological Parameter Confidence Measure,*" No. 60/657,268, filed March 1, 2005, entitled "*Configurable Physiological Measurement System,*" and No. 60/657,759, filed March 1, 2005, entitled "*Noninvasive Multi-Parameter Patient Monitor.*" The present application incorporates the foregoing disclosures herein by reference.

INCORPORATION BY REFERENCE OF COPENDING RELATED APPLICATIONS

[0002] The present application is related to the following copending U.S. utility applications:

	App. Sr. No.	Filing Date	Title	Atty Dock.
1	11/###,###	March 1, 2006	Multiple Wavelength Sensor Emitters	MLR.002A
2	11/###,###	March 1, 2006	Multiple Wavelength Sensor Equalization	MLR.003A
3	11/###,###	March 1, 2006	Multiple Wavelength Sensor Substrate	MLR.004A
4	11/###,###	March 1, 2006	Multiple Wavelength Sensor Interconnect	MLR.005A
5	11/###,###	March 1, 2006	Multiple Wavelength Sensor Attachment	MLR.006A
6	11/###,###	March 1, 2006	Multiple Wavelength Sensor Drivers	MLR.009A
7	11/###,###	March 1, 2006	Physiological Parameter Confidence Measure	MLR.010A
8	11/###,###	March 1, 2006	Configurable Physiological Measurement System	MLR.011A
9	11/###,###	March 1, 2006	Noninvasive Multi-Parameter Patient Monitor	MLR.012A
10	11/###,###	March 1, 2006	Noninvasive Multi-Parameter Patient Monitor	MLR.013A
11	11/###,###	March 1, 2006	Noninvasive Multi-Parameter Patient Monitor	MLR.014A

The present application incorporates the foregoing disclosures herein by reference.

BACKGROUND OF THE INVENTION

[0003] Spectroscopy is a common technique for measuring the concentration of organic and some inorganic constituents of a solution. The theoretical basis of this technique is the Beer-Lambert law, which states that the concentration c_i of an absorbent in solution can be determined by the intensity of light transmitted through the solution, knowing the pathlength d_λ, the intensity of the incident light $I_{0,\lambda}$, and the extinction coefficient $\varepsilon_{i,\lambda}$ at a particular wavelength λ. In generalized form, the Beer-Lambert law is expressed as:

$$I_\lambda = I_{0,\lambda} e^{-d_\lambda \cdot \mu_{a,\lambda}} \quad (1)$$

$$\mu_{a,\lambda} = \sum_{i=1}^{n} \varepsilon_{i,\lambda} \cdot c_i \quad (2)$$

where $\mu_{a,\lambda}$ is the bulk absorption coefficient and represents the probability of absorption per unit length. The minimum number of discrete wavelengths that are required to solve EQS. **1-2** are the number of significant absorbers that are present in the solution.

[0004] A practical application of this technique is pulse oximetry, which utilizes a noninvasive sensor to measure oxygen saturation (SpO_2) and pulse rate. In general, the sensor has light emitting diodes (LEDs) that transmit optical radiation of red and infrared wavelengths into a tissue site and a detector that responds to the intensity of the optical radiation after absorption (e.g., by transmission or transreflectance) by pulsatile arterial blood flowing within the tissue site. Based on this response, a processor determines measurements for SpO_2, pulse rate, and can output representative plethysmographic waveforms. Thus, "pulse oximetry" as used herein encompasses its broad ordinary meaning known to one of skill in the art, which includes at least those noninvasive procedures for measuring parameters of circulating blood through spectroscopy. Moreover, "plethysmograph" as used herein (commonly referred to as "photoplethysmograph"), encompasses its broad ordinary meaning known to one of skill in the art, which includes at least data representative of a change in the

absorption of particular wavelengths of light as a function of the changes in body tissue resulting from pulsing blood.

[0005] Pulse oximeters capable of reading through motion induced noise are available from Masimo Corporation ("Masimo") of Irvine, California. Moreover, portable and other oximeters capable of reading through motion induced noise are disclosed in at least U.S. Pat. Nos. 6,770,028, 6,658,276, 6,157,850, 6,002,952 5,769,785, and 5,758,644, which are owned by Masimo and are incorporated by reference herein. Such reading through motion oximeters have gained rapid acceptance in a wide variety of medical applications, including surgical wards, intensive care and neonatal units, general wards, home care, physical training, and virtually all types of monitoring scenarios.

[0006] FIG. **1** illustrates HbO_2 and Hb absorption μ_a versus wavelength. At red and near IR wavelengths below 970 nm, where water has a significant peak, Hb and HbO_2 are the only significant absorbers normally present in the blood. Thus, typically only two wavelengths are needed to resolve the concentrations of Hb and HbO_2, e.g. a red (RD) wavelength at 660 nm and an infrared (IR) wavelength at 940 nm. In particular, SpO_2 is computed based upon a red ratio Red_{AC}/Red_{DC} and an IR ratio IR_{AC}/IR_{DC}, which are the AC detector response magnitude at a particular wavelength normalized by the DC detector response at that wavelength. The normalization by the DC detector response reduces measurement sensitivity to variations in tissue thickness, emitter intensity and detector sensitivity, for example. The AC detector response is a plethysmograph, as described above. Thus, the red and IR ratios can be denoted as NP_{RD} and NP_{IR} respectively, where NP stands for "normalized plethysmograph." In pulse oximetry, oxygen saturation is calculated from the ratio NP_{RD}/NP_{IR}.

SUMMARY OF THE INVENTION

[0007] A multiple wavelength sensor and a noninvasive multi-parameter patient monitor, such as referenced above, make blood absorption measurements at more than a red wavelength and an IR wavelength. In one embodiment, described below, blood absorption measurements are made at eight wavelengths. Advantageously, this rich wavelength data, compared with

conventional pulse oximetry, allows a determination of a tissue profile or tissue characterization over a wavelength spectrum.

[0008] FIG. **2** illustrates an example of a "tissue profile" **200** for SpO2 = 97%. For this example, including FIGS. 3-4, below, the sensor emits eight wavelengths (610, 620, 630, 655, 700, 720, 800 and 905 nm). The graph is a plot of NP ratios **210** versus wavelength **220**, where the NP ratios are of the form $NP_{\lambda 1}/ NP_{\lambda 2}$. This is a generalization to multiple wavelengths of the ratio NP_{RD}/NP_{IR} described above for two (red and IR) wavelengths. In order to provide a common scale for these NP ratios, the ratios are calculated with respect to a reference wavelength, λr, which may be any of the available wavelengths. Thus, the plotted NP ratios are denoted $NP_{\lambda n}/ NP_{\lambda r}$ over the n available wavelengths, including λr. Note that the NP ratio at the reference wavelength is $NP_{\lambda r}/ NP_{\lambda r} = 1$, which is 800 nm in FIG. **2**.

[0009] As shown in FIG. **2**, when a sensor is properly positioned on a tissue site, the detector only receives LED emitted light that has propagated through the tissue site after tissue scattering and absorption. Thus, a tissue profile **200** should reflect the blood constituent absorption characteristics illustrated in FIG. **1**, above. For this high oxygen saturation (97%) example, HbO_2 is the only significantly absorbing blood constituent and, indeed, the resulting tissue profile **200** is shaped like the HbO_2 absorption curve **110** (FIG. **1**).

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a graph of oxyhemoglobin and reduced hemoglobin light absorption versus wavelength across portions of the red and IR spectrum;

[0011] FIG. **2** is a graph of NP ratios versus wavelength illustrating a tissue profile;

[0012] FIG. **3** is a graph of NP ratios versus wavelength illustrating a probe-off profile;

[0013] FIG. **4** is a graph of NP ratios versus wavelength illustrating a penumbra profile;

[0014] FIG. **5** is a general block diagram of a confidence measurement system;

[0015] FIG. **6** is a graph of normalized plethysmograph (NP) ratios versus wavelength for low and high SpO_2 illustrating a NP envelope;

[0016] FIG. **7** is a block diagram of a multiple wavelength probe off detector utilizing an NP envelope;

[0017] FIG. **8** is a graph of NP ratios versus wavelength illustrating a family of parametric NP curves;

[0018] FIG. **9** is a block diagram of a multiple wavelength confidence measurement system utilizing parametric NP curves;

[0019] FIG. **10** is an NP ratio graph illustrating a family of NP data clusters; and

[0020] FIG. **11** is a block diagram of a multiple wavelength confidence measurement system utilizing NP data clusters.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] In this application, reference is made to many blood parameters. Some references that have common shorthand designations are referenced through such shorthand designations. For example, as used herein, HbCO designates carboxyhemoglobin, HbMet designates methemoglobin, and Hbt designates total hemoglobin. Other shorthand designations such as COHb, MetHb, and tHb are also common in the art for these same constituents. These constituents are generally reported in terms of a percentage, often referred to as saturation, relative concentration or fractional saturation. Total hemoglobin is generally reported as a concentration in g/dL. The use of the particular shorthand designators presented in this application does not restrict the term to any particular manner in which the designated constituent is reported.

[0022] FIG. **3** illustrates an example of a probe-off profile **300**. When a sensor is completely dislodged from a patient, a so-called "probe off" condition occurs. Despite a probe off condition, an optical sensor may continue to detect an AC signal, which can be induced at the detector by other than pulsatile arterial absorption of LED emitted light. For example, small patient movements, vibrations, air flow or other perturbations may cause the pathlength between the LEDs and the detector to vary, resulting in an AC detector signal that can be mistakenly interpreted by the monitor as due to pulsatile arterial blood. Further, ambient light may reach the detector, and any modulation of the ambient light due to AC power, power fluctuations, moving objects, such as a fan, among other perturbations can be also mistaken as a pulsatile arterial signal. Probe off errors

are serious because a blood constituent monitor may display normal results, such as oxygen saturation, when, in fact, the sensor is not properly attached to the patient, potentially leading to missed severe desaturation events. As shown in FIG. **3**, a probe-off profile **300** is readily apparent as it does not have a shape related to the absorption characteristics of hemoglobin constituents.

[0023] FIG. **4** illustrates an example of a penumbra profile **400**. When a sensor is not properly positioned or becomes partially dislodged, a penumbra condition may occur, where the detector is "shadowed" by a tissue site, such as a finger, but also receives some light directly from the emitters or indirectly reflected off the sensor housing, or both. As a result, the DC signal at the detector rises significantly, which lowers the AC/DC ratio (NP). Because red wavelengths are more significantly absorbed by Hb and HbO2, the penumbra condition is most noticeable at the red portion **405** of the $NP_{\lambda n}$/ $NP_{\lambda r}$. This effect is readily seen in the penumbra profile **400** as compared to a normal tissue profile **200** (FIG. **2**).

[0024] Advantageously, a physiological parameter confidence measurement system, as described below, can distinguish a tissue profile **200** (FIG. **2**) from a probe-off profile **300** (FIG. **3**) or penumbra profile **400** (FIG. **4**), as examples. Further, a physiological parameter confidence measurement system can provide indications that the detector signal is degraded as the result of various physiological and non-physiological phenomenon.

[0025] FIG. **5** illustrates a physiological parameter confidence measurement system **500** having a physiological data **510** input, a confidence indicator **560** output and a probe-off indicator **570** output. In one embodiment, physiological data **510**, such as the NP ratios described above, is derived from a sensor **501** generating a sensor signal **502** responsive to multiple wavelengths of optical radiation transmitted into and attenuated by a tissue site. The confidence indicator **560** provides an observer with some measure of "goodness" for the physiological data **510**. That is, if confidence is high, it is likely the physiological data **510** is representative of a physiological condition or state. If confidence is low, the physiological data **510** may be less representative of a physiological condition or state. If the confidence is very low, a probe-off indicator **570** may be generated to alert an observer to the possibility that a sensor from which the

physiological data **510** is derived is not properly positioned on a tissue site and may not be generating physiologically significant data. In one embodiment, a confidence measure may be provided as a percentage, such as 0-100%. In various embodiments, a confidence indicator **560** corresponding to a confidence measure may be visual or audible or both. For example, a confidence indicator **560** may be a number display, a display message, a bar display, a color indicator or display, such as green (high confidence), yellow (average confidence), red (low confidence). Also, a confidence indicator **560** may be any of various alarm sounds, tones or patterns of sounds or tones, such as a double beep at less than high confidence. In one embodiment, the physiological parameter confidence measurement system **500** is incorporated within a physiological monitor **503** having a display **580** or alarm **590** for outputting the confidence indicator **560** or probe-off indicator **570**.

[0026] As shown in FIG. **5**, the physiological parameter confidence measurement system **500** also has a parameter estimator **520**, a physiological data reference **540** and a confidence measurer **550**. The parameter estimator **520** derives one or more physiological parameter estimates, $\hat{P}$, **530** based upon the physiological data **510**. The parameter estimate or estimates **530** are used to select one or more data clusters **545** from the physiological data reference **540**. In one embodiment, the physiological data reference **540** is a collection of predetermined physiological data organized in data clusters. For example the physiological data reference **540** may contain clinically-derived physiological data organized according to corresponding values of a physiological parameter determined by a "gold standard" instrument. In a particular embodiment, the physiological data are NP ratios obtained for various physiological parameters, such as SpO_2, HbCO, HbMet, Hbt, fractional oxygen saturation, bilirubin or glucose to name a few, as measured with a standardized cooximeter, for example. In one embodiment, the physiological data reference **540** is a non-volatile memory or other data storage device containing predetermined physiological data. The confidence measurer **550** uses the physiological data **510** and the selected data cluster or data clusters **545** to generate the confidence indicator **560**, the probe-off indicator **570** or both.

[0027] A confidence measurement and confidence indicator, as described herein, may be combined with other signal quality and data confidence measurements and indicators, such as those described in U.S. Patent No. 6,996,427 titled *Pulse Oximetry Data Confidence Indicator* and U.S. Patent No. 6,606,511 titled *Pulse Oximetry Pulse Indicator*, both patents assigned to Masimo Corporation, Irvine, CA and incorporated by reference herein. A probe off measurement and probe off indicator as described herein may be combined with other probe off measurements and indicators, such as those described in U.S. Patent No. 6,654,624 titled *Pulse Oximeter Probe-Off Detector* and U.S. Patent No. 6,771,994 titled *Pulse Oximeter Probe-Off Detection System*, both patents assigned to Masimo Corporation, Irvine, CA and incorporated by reference herein.

[0028] FIG. **6** illustrates NP ratio versus wavelength curves computed from a multiple wavelength sensor, such as described in the U.S. Patent Application titled Multiple Wavelength Sensor, referenced above. In this example, the sensor emits eight wavelengths (620, 630, 660, 700, 730, 805, 905 and 960nm). Shown is a low oxygen saturation curve **610**, e.g. SpO_2 = 70% and a high oxygen saturation curve **620**, e.g. $SpO_2 \approx 100\%$. By comparison, a conventional two wavelength pulse oximetry sensor, as described above, results in a single point on a particular curve. Advantageously, the NP ratio curves **610**, **620** represent a tissue profile that can be compared to a particular sensor response to determine if a physiologically significant measurement has been made. In one embodiment, the NP ratio curves **610**, **620** delineate the boundaries of a physiologically significant NP ratio region **630**. Although described above with respect to SpO_2, such regions or boundaries can be derived for other physiological parameters such as HbCO, HbMet, Hbt, fractional oxygen saturation, bilirubin or glucose to name a few.

[0029] FIG. **7** illustrates one embodiment of a physiological parameter confidence measurement system **700** utilizing a NP ratio region such as described with respect to FIG. **6**, above. The confidence measurement system **700** has input NP ratios **710** measured in response to a multiple wavelength sensor, reference NP ratio region **740** that delineates physiologically significant NP ratios **630** (FIG. **6**), and a comparator **750**. In one particular embodiment, the

NP ratio region **740** is predetermined from clinically-derived data for one or more parameters of interest, such as SpO_2, HbCO, HbMet, Hbt, fractional oxygen saturation, bilirubin or glucose, to name a few. In another particular embodiment, the NP ratio region **740** is theoretically calculated. The comparator **750** compares the input NP ratios **710** with the NP ratio region **740** and generates a probe-off indicator **770** if any, or more than a predetermine number, of the input NP ratios **710** fall outside of an NP ratio region **740**.

[0030] FIG. **8** illustrates a family of parametric NP ratio versus wavelength curves **800** computed from a multiple wavelength sensor, such as referenced above. Each curve represents a different value of a measured parameter, such as SpO_2. For example, there may be a curve for each of SpO_2 = 70%, 75%, 80%, . . . 100%. Advantageously, such curves more precisely indicate physiologically significant multiple wavelength sensor measurements as compared to a bounded NP ratio region **630** (FIG. **6**) such as described with respect to FIGS. **6-7**, above.

[0031] FIG. **9** illustrates another embodiment of a physiological parameter confidence measurement system **900** utilizing parametric NP ratio curves, such as described with respect to FIG. **8**, above. The confidence measurement system **900** has input NP ratios **910** measured in response to a multiple wavelength sensor, a parameter estimator **920**, reference parametric curves **940** and a difference calculator **950**. The parameter estimator **920** inputs the NP ratios **910** so as to generate a parameter estimate **930**, such as SpO_2, HbCO, HbMet, Hbt, fractional oxygen saturation, bilirubin or glucose, to name a few. The estimated parameter **930** selects one or more of the reference parametric curves **940**, which are predetermined from clinically-derived data that is stored in memory or data that is mathematically pre-calculated or calculated in real time and stored in memory. The difference calculator **950** measures the difference between the NP ratios **910** and the selected parametric curve **940**. For example, a mean-squared error calculation can be made between the input NP ratios **910** and the selected parametric curve **945**. The resulting difference calculation is used as a confidence measure or translated into a confidence measure and a confidence indicator output **960** is generated accordingly. Alternatively, or in addition to a confidence measure, a probe off condition can be indicated if the

difference calculation is larger than a predetermined value or the confidence measure is less than a predetermined value. In another embodiment, a correlation calculator is used in place of the difference calculation.

[0032] FIG. **10** illustrates a family of data clusters **1000** shown in two dimensions by way of example. Each data cluster **1000** represents NP ratios clinically measured across a population for specific values **1020** of a selected parameter *P,* such as P_1, P_2, P_3 and P_4 as shown. Each data cluster **1000** defines a region **1010** of NP ratios measured for a particular parameter value **1020** and has a probability distribution, such as a normal distribution, over the indicated region **1010**.

[0033] For example, the clinical data can be organized as a table of known values of P, corresponding NP ratios measured over a population, and the relative number of occurrences of particular NP ratio values for each value of P. The relative number of occurrences of particular NP ratio values for a particular value of P yields an NP ratio probability distribution for that value of P. Thus, each P value **1020** in the table has a corresponding data cluster **1000** of measured NP ratios and an associated probability distribution for those NP ratios.

[0034] FIG. **11** illustrates yet another embodiment of a physiological parameter confidence measurement system **1100** utilizing NP data clusters and corresponding probability distributions, such as described with respect to FIG. **10**, above. The confidence measurement system **1100** has input NP ratios **1110** measured in response to a multiple wavelength sensor, a parameter estimator **1120**, reference data clusters **1140** and a probability calculator **1150**. The parameter estimator **1120** inputs the NP ratios **1110** so as to generate a parameter estimate **1130**, such as described with respect to other embodiments, above. In one embodiment, the reference data clusters **1140**, such as described with respect to FIG. **10**, are stored in a memory device, such as an EPROM. The estimated parameter **1130** is compared with the reference data clusters **1140** so as to determine the closest region **1010** (FIG. **10**) or closest overlapping portion of two regions **1010** (FIG. **10**). The probability calculator **1150** computes a probability based upon the distribution above the selected region **1010** (FIG. **10**). A confidence measure is also derived based upon the calculated probability

1150. In a particular embodiment, the confidence measure is the calculated probability. A confidence indicator **1160** is generated in response to the confidence measure. In one embodiment, if the confidence probability or the calculated confidence measure is below a predetermined threshold, a probe-off indicator **1170** is generated. In particular embodiments, the confidence indicator **1160** or probe-off indicator **1170** or both may be alphanumeric or digital displays, optical indicators or alarms or similar audible indicators, to name a few.

[0035] A physiological parameter confidence measurement system has been disclosed in detail in connection with various embodiments. These embodiments are disclosed by way of examples only and are not to limit the scope of the claims that follow. One of ordinary skill in art will appreciate many variations and modifications.

WHAT IS CLAIMED IS:

1. A method of determining a measure of confidence in a physiological parameter, the physiological parameter determined by transmitting multiple wavelengths of optical radiation into a tissue site and detecting the optical radiation after tissue attenuation, the method comprising:

deriving physiological data responsive to the intensity of multiple wavelengths of optical radiation transmitted into a tissue site and detected after tissue attenuation;

estimating a physiological parameter based upon the physiological data;

providing a physiological data reference;

obtaining at least one data cluster from the physiological data reference; and

determining a measure of confidence in the estimated physiological parameter based upon the at least one data cluster and the derived physiological data.

2. The method according to claim 1 wherein the providing step comprises:

predetermining the physiological data for known values of the physiological parameter across a sample population;

clustering the data according to the physiological parameter values; and

storing the data clusters so as to be retrievable according to the physiological parameter values.

3. The method according to claim 2 wherein the obtaining step comprises selecting the at least one data cluster according to the estimated physiological parameter.

4. The method according to claim 3 wherein the selecting step comprises:

determining at least one data cluster having a corresponding physiological parameter value closest to the estimated physiological parameter; and

reading the determined at least one data cluster from the memory.

5. The method according to claim 4 wherein the physiological data are ratios of normalized plethysmographs (NP ratios).

6. The method according to claim 5 wherein the physiological parameter is at least one of SpO_2, MetHb and HbCO.

7. The method according to claim 6 wherein the data clusters are a plurality of parameteric curves of NP ratio versus wavelength.

8. The method according to claim 6 wherein the data clusters are probability distributions of NP ratios.

9. A physiological parameter confidence measurement method comprising:

deriving physiological data responsive to the intensity of multiple wavelengths of optical radiation transmitted into a tissue site and detected after tissue attenuation;

estimating a physiological parameter based upon the physiological data;

providing a physiological data reference having a plurality of data clusters each corresponding to a particular value of the physiological parameter,;

comparing at least one of the data clusters to the physiological data; and

indicating confidence in the estimated physiological parameter based upon the comparison.

10. The physiological parameter confidence measurement method according to claim 9 further comprising associating a probability function with each of the data clusters.

11. The physiological parameter confidence measurement method according to claim 10 wherein the comparing step comprises determining a probability that the derived physiological data corresponds to the estimated physiological parameter.

12. The physiological parameter confidence measurement method according to claim 11 wherein the indicating step comprises generating at least one of a visual indication and an audible indication corresponding to the determined probability.

13. The physiological parameter confidence measurement method according to claim 12 further comprising triggering an alarm that a probe-off condition exists when the determined probability is below a predetermined threshold.

14. A confidence measurement system comprising:

a plurality of physiological data responsive to the intensity of multiple wavelengths of optical radiation transmitted into a tissue site and detected after tissue attenuation;

a parameter estimator configured to input the physiological data and output an estimate of a physiological parameter;

a physiological data reference having a plurality of data clusters corresponding to known values of the physiological parameter; and

a confidence measurer adapted to compare the physiological data with the data clusters so as to calculate a measure of confidence in the physiological parameter estimate.

15. The confidence measurement system according to claim 14 wherein the physiological data comprises a plurality of ratios of normalized plethysmographs corresponding to the multiple wavelengths of optical radiation.

16. The confidence measurement system according to claim 15 wherein the parameter estimator comprises a value calculation corresponding to at least one of SpO_2, HbCO, HbMet, Hbt, fractional oxygen saturation, bilirubin and glucose.

17. The confidence measurement system according to claim 16 wherein the physiological data reference comprises a plurality of known values of the physiological parameter, corresponding predetermined values of ratios of normalized plethysmographs and probabilities associated with the predetermined values.

18. The confidence measurement system according to claim 17 wherein the confidence measurer comprises a probability calculation that the input physiological data corresponds to the estimated physiological parameter.

19. The confidence measurement system according to claim 18 further comprising a confidence indicator responsive to the probability calculation.

20. The confidence measurement system according to claim 19 further comprising a probe-off indicator responsive to the probability calculation and a predetermined probability threshold.

21. A confidence measurement system comprising:

a plurality of physiological data responsive to the intensity of multiple wavelengths of optical radiation transmitted into a tissue site and detected after tissue attenuation;

a parameter estimator configured to input the physiological data and output a corresponding physiological parameter estimate;

a physiological data reference means for providing data clusters according to known values of the physiological parameter; and

a confidence measurement means for determining confidence in physiological parameter estimate based upon the physiological data and the data clusters.

22. The confidence measurement system according to claim 21 further comprising an output means for indicating confidence in the physiological parameter estimate.

23. The confidence measurement system according to claim 21 further comprising an alarm means for indicating a probe-off condition in response to low confidence in the physiological parameter estimate.

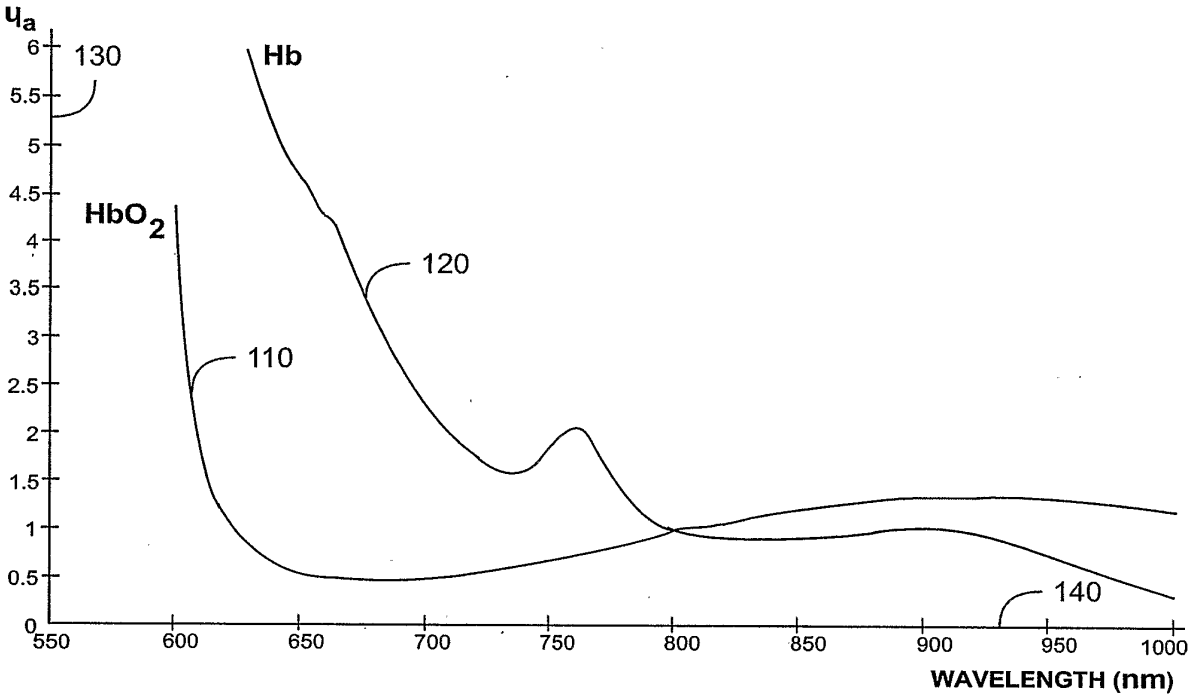

μ_a
130
Hb
HbO_2
120
110
140
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
550
600
650
700
750
800
850
900
950
1000
WAVELENGTH (nm)

FIG. 1

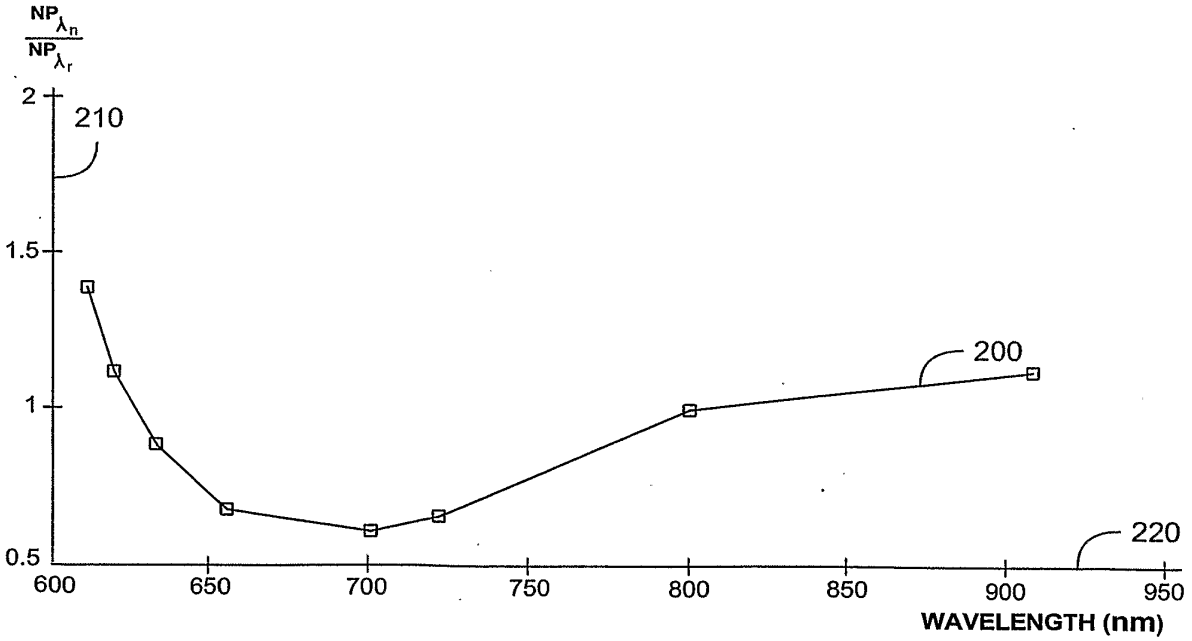

$\frac{NP_{\lambda_n}}{NP_{\lambda_r}}$
210
200
220
2
1.5
1
0.5
600
650
700
750
800
850
900
950
WAVELENGTH (nm)

FIG. 2

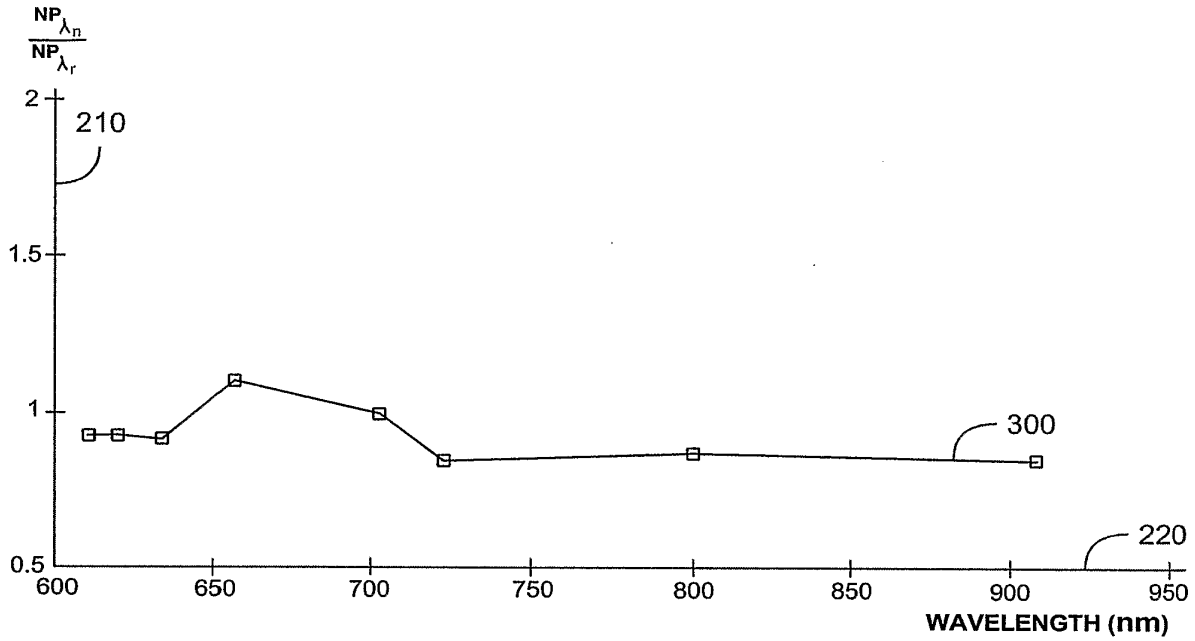

$\frac{NP_{\lambda_n}}{NP_{\lambda_r}}$
2
1.5
1
0.5
210
300
220
600
650
700
750
800
850
900
950
WAVELENGTH (nm)

FIG. 3

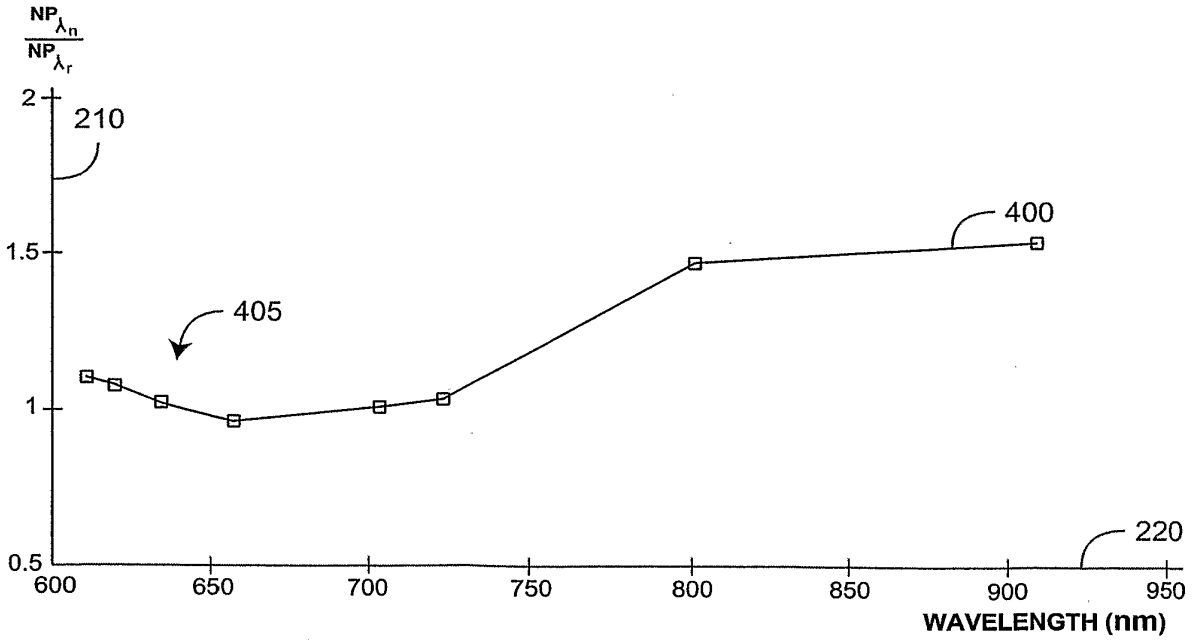

$\frac{NP_{\lambda_n}}{NP_{\lambda_r}}$
2
1.5
1
0.5
210
400
405
220
600
650
700
750
800
850
900
950
WAVELENGTH (nm)

FIG. 4

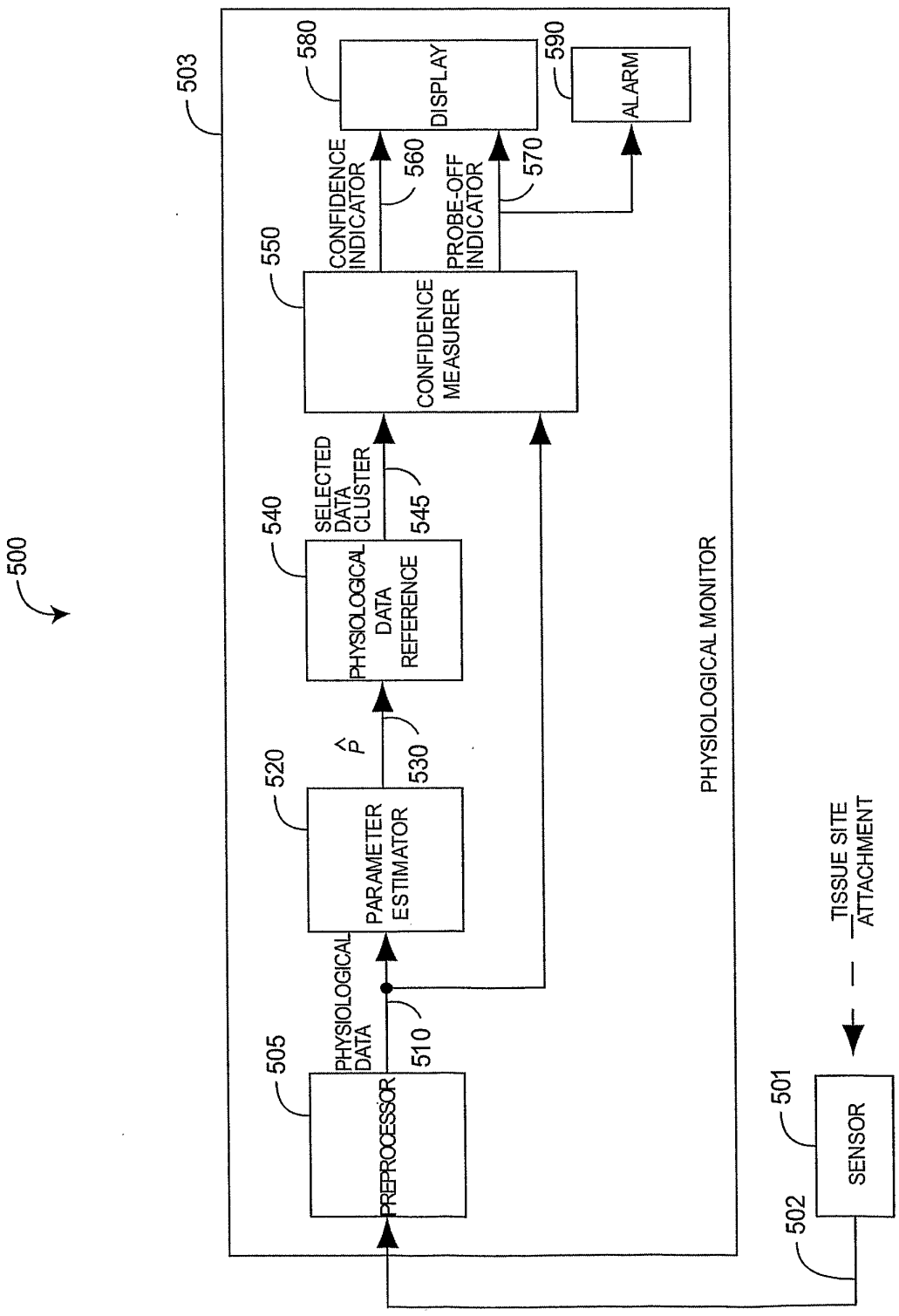

500
503
PHYSIOLOGICAL MONITOR
505
PREPROCESSOR
PHYSIOLOGICAL DATA
510
520
PARAMETER ESTIMATOR
$\hat{P}$
530
540
PHYSIOLOGICAL DATA REFERENCE
SELECTED DATA CLUSTER
545
550
CONFIDENCE MEASURER
CONFIDENCE INDICATOR
560
PROBE-OFF INDICATOR
570
580
DISPLAY
590
ALARM
501
SENSOR
502
TISSUE SITE ATTACHMENT

FIG. 5

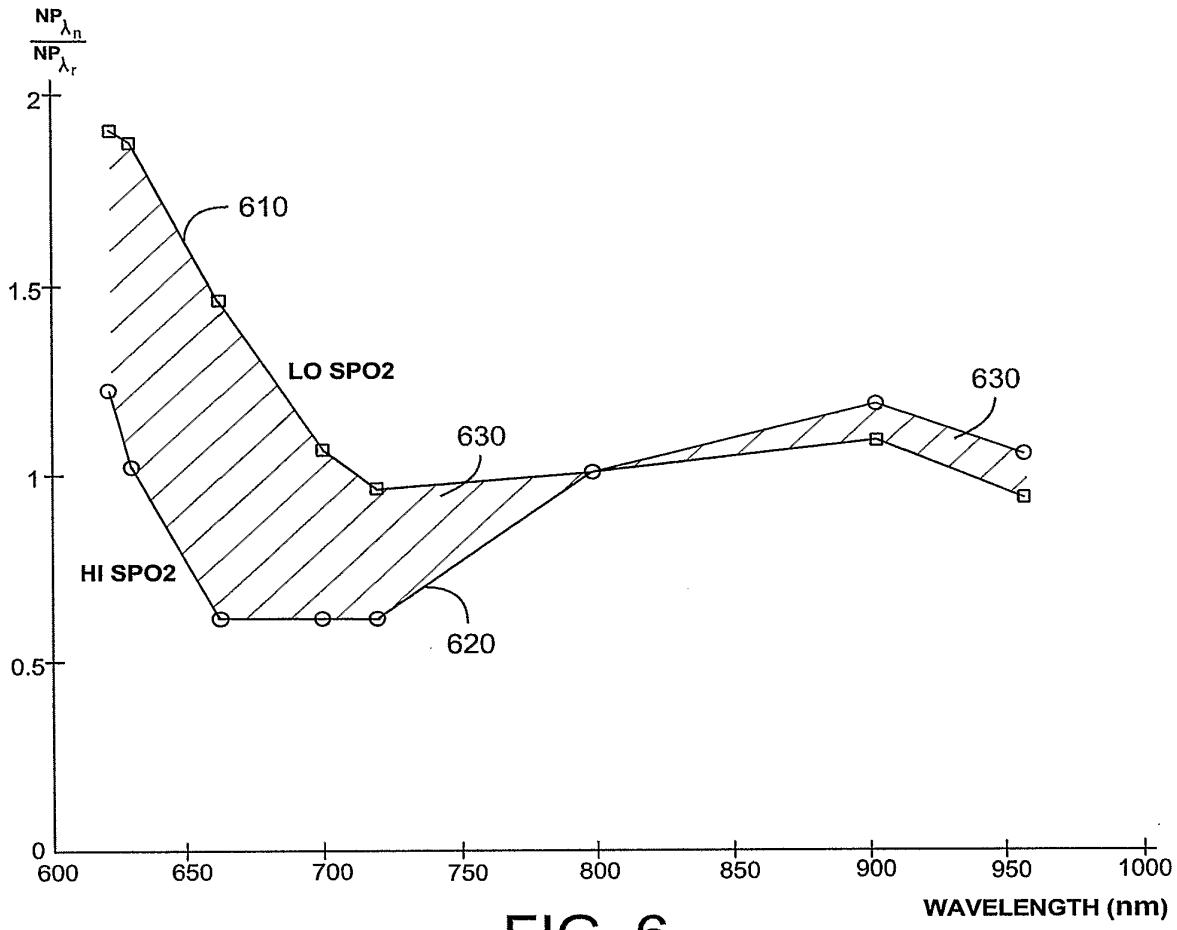

NP λn / NP λr
2
1.5
1
0.5
0
610
LO SPO2
630
630
HI SPO2
620
600
650
700
750
800
850
900
950
1000
WAVELENGTH (nm)

FIG. 6

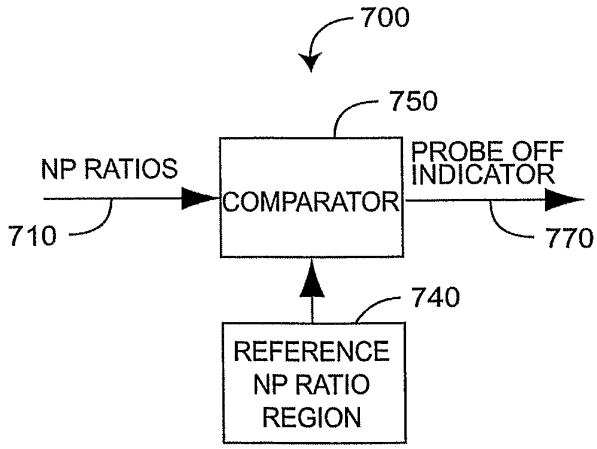

700
750
NP RATIOS
COMPARATOR
PROBE OFF INDICATOR
710
770
740
REFERENCE NP RATIO REGION

FIG. 7

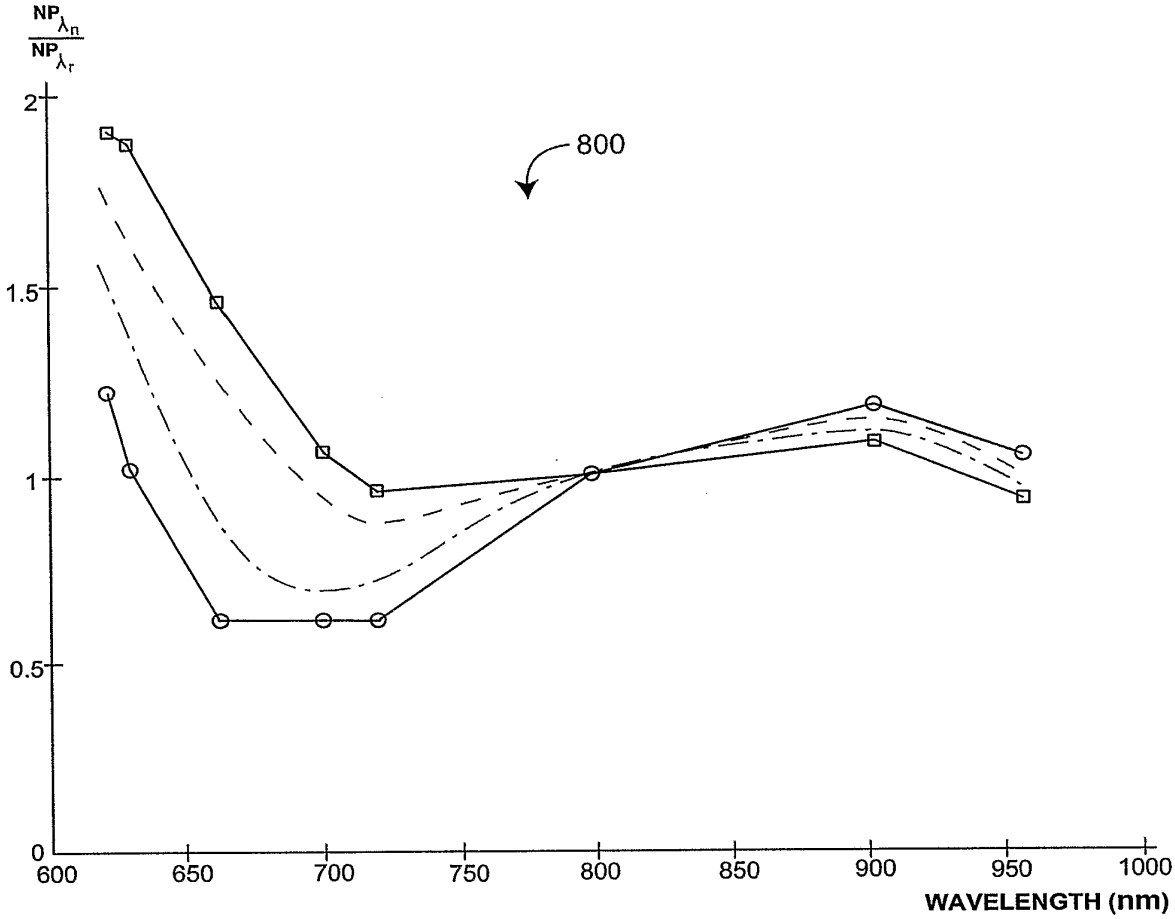

NP λn / NP λr
2
1.5
1
0.5
0
800
600
650
700
750
800
850
900
950
1000
WAVELENGTH (nm)

FIG. 8

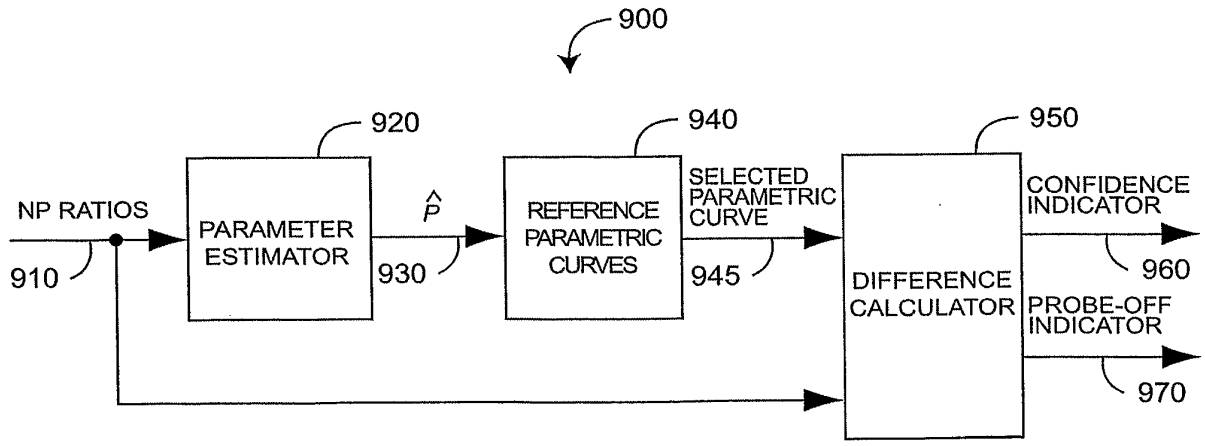

900
920
940
950
NP RATIOS
910
PARAMETER ESTIMATOR
P̂
930
REFERENCE PARAMETRIC CURVES
SELECTED PARAMETRIC CURVE
945
DIFFERENCE CALCULATOR
CONFIDENCE INDICATOR
960
PROBE-OFF INDICATOR
970

FIG. 9

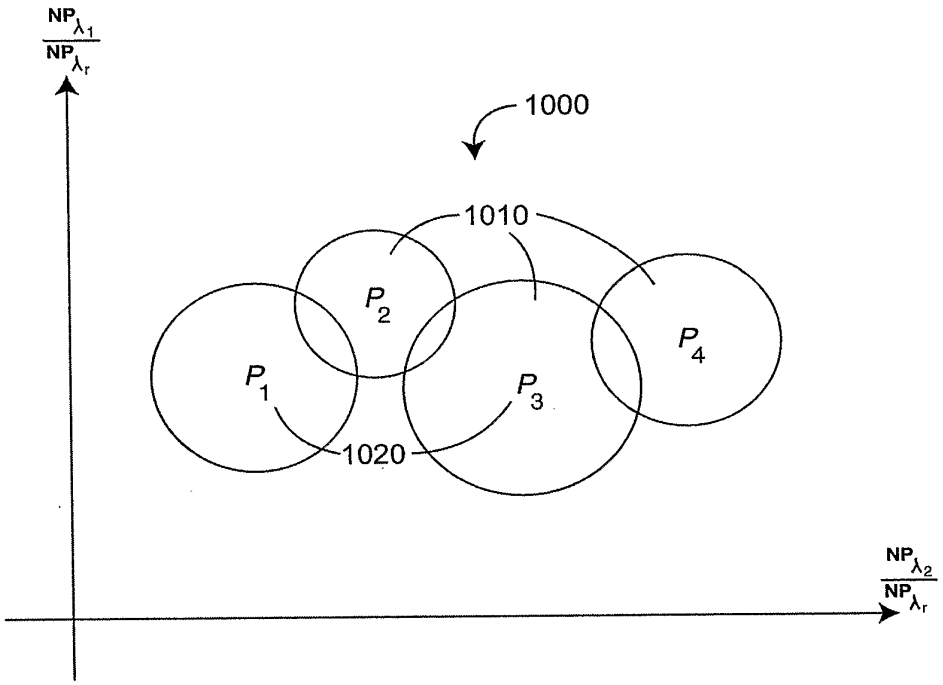

NP λ1 / NP λr
1000
1010
P2
P4
P1
P3
1020
NP λ2 / NP λr

FIG. 10

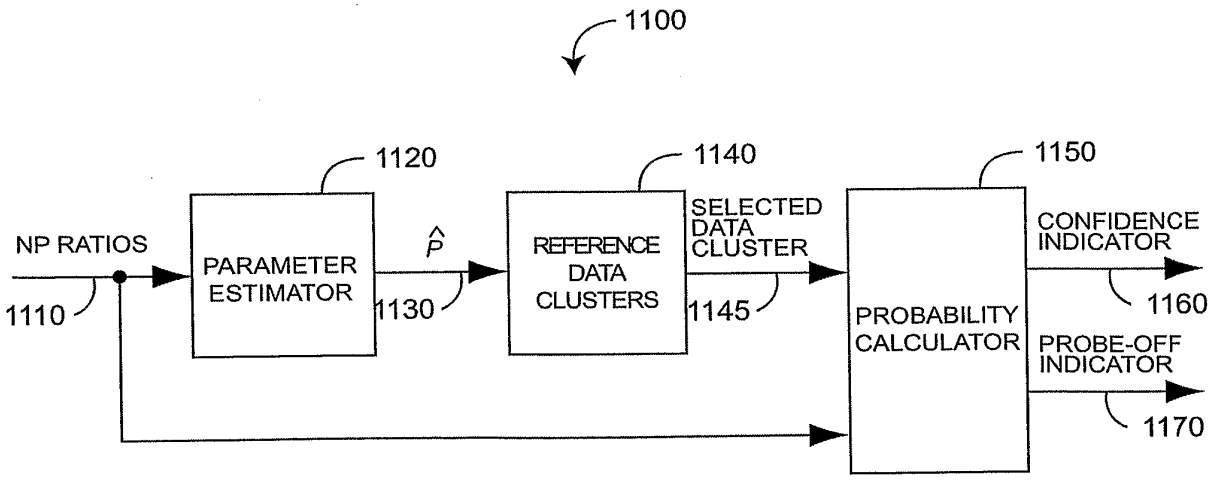

1100
1120
1140
1150
NP RATIOS
1110
PARAMETER ESTIMATOR
P̂
1130
REFERENCE DATA CLUSTERS
SELECTED DATA CLUSTER
1145
PROBABILITY CALCULATOR
CONFIDENCE INDICATOR
1160
PROBE-OFF INDICATOR
1170

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/007387

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 653 498 A (NEW, JR. ET AL) 31 March 1987 (1987-03-31) column 2, line 39 - line 55 column 16, line 5 - column 17, line 26 figure 19 -----	1-4, 9-14, 21-23
A	US 2004/133087 A1 (ALI AMMAR AL ET AL) 8 July 2004 (2004-07-08) paragraph [0008] - paragraph [0023] paragraph [0097] - paragraph [0105] figures 17,18 -----	1,9,14, 21
A	US 2004/158134 A1 (DIAB MOHAMED K ET AL) 12 August 2004 (2004-08-12) paragraph [0005] - paragraph [0012] figures 3-6 ----- -/--	1,9,14, 21

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 July 2006	17/07/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Abraham, V

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/007387

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98/43071 A (NELLCOR PURITAN BENNETT INC) 1 October 1998 (1998-10-01) abstract	1,9,14, 21

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2006/007387

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4653498 A	31-03-1987	NONE	
US 2004133087 A1	08-07-2004	NONE	
US 2004158134 A1	12-08-2004	NONE	
WO 9843071 A	01-10-1998	AU 736060 B2	26-07-2001
		AU 2105297 A	20-10-1998
		CA 2283860 A1	01-10-1998
		EP 0966665 A1	29-12-1999
		JP 2001517128 T	02-10-2001

Form PCT/ISA/210 (patent family annex) (April 2005)

Espacenet

Bibliographic data: EP1880666 (A1) — 2008-01-23

Method and wrist worn device for pulse rate detection

Inventor(s): KLOPFENSTEIN FRANCOIS [CH]; VETTER ROLF [CH]; RENEVEY PHILIPPE [CH]; NEUMAN VICTOR [CH]; VERJUS CHRITOPHE [CH] ± (KLOPFENSTEIN, FRANCOIS, ; VETTER, ROLF, ; RENEVEY, PHILIPPE, ; NEUMAN, VICTOR, ; VERJUS, CHRITOPHE)

Applicant(s): ETA SA MFT HORLOGERE SUISSE [CH] ± (ETA SA MANUFACTURE HORLOGERE SUISSE)

Classification: **- international:** ***A61B5/024***
- cooperative: **A61B5/02416 (EP); A61B5/02438 (EP); A61B5/0245 (EP)**

Application number: EP20060117653 20060721 Global Dossier

Priority number(s): EP20060117653 20060721

Also published as: EP1880666 (B1) AT434972 (T) CN101108126 (A) CN101108126 (B) HK1114321 (A1) more

Abstract of EP1880666 (A1)

The pulsometer (10) has an electronic optical measurement device (18) measuring a pulse of a wearer and comprising light sources (E1-E3) and receivers (R1-R3). The sources are formed by a diode emitting light in infrared range, and the receivers are formed by photodiodes. The sources and the receivers are arranged in the form of a matrix including rows and columns (C1-C3). The rows are oriented along a direction orthogonal to a direction of a wrist, and the columns are oriented parallel to the direction of the wrist. Each row and column alternately contains one light source and one receiver. An independent claim is also included for a method for controlling a pulsometer.

Notice

CLAIMS EP1880666

1.

Portable wrist pulse sensor (12) having a housing (14) which contains an optical optical measuring device (18) of the pulsometer carrier pulse (10) and an electronic circuit (20) for processing the measurements in view calculating the pulse (P), a wristband (16) which holds the bottom (24) of the casing (14) against the wrist (12), in which the electronic optical measuring device (18) has at least one light source (E1, E2, E3) and a plurality of light receivers (R1, R2, R3) which are arranged in the bottom (24) of the housing (14) and which are directed towards the wrist (12), characterized in that the optical electronic measuring device (18) comprises at least two light sources (E1, E2, E3) and at least two receivers (R1, R2, R3), in that the light sources (E1, E2, E3) and the receivers (R1, R2, R3) are arranged in the form of a matrix comprising two lines (L1, L2), each oriented in a direct direction orthogonal ion to the direction (D1) of the wrist (12), and at least two columns (C1, C2, C3), oriented parallel to the direction (D1) of the wrist (12), in that each line (L1, L2) of the matrix alternately contains a light source (E1, E2, E3) and a receiver (R1, R2, R3), and each column (C1, C2, C3) of the matrix alternately contains a light source (E1, E2, E3) and a receptor (R1, R2, R3).

2.

Pulsometer (10) according to the preceding claim, characterized in that the distance between each light source (E1, E2, E3) and the adjacent receiver (R1, R2, R3) in a line (L1, L2) of the matrix is substantially equal to the distance between each light source (E1, E2, E3) and the adjacent receiver (R1, R2, R3) in a column (C1, C2, C3) of the matrix.

3.

Pulsometer (10) according to claim 1 or 2, characterized in that the matrix comprises three columns (C1, C2, C3), and in that the first line (L1) contains a light source (E2) surrounded by two receivers (R1, R3), and the second line (L2) contains a receiver (R2) surrounded by two light sources (E1, E3).

4.
Pulsometer (10) according to any one of the preceding claims, characterized in that each light source (E1, E2, E3) is constituted by a diode which emits light in the infrared range, and each receiver (R1 , R2, R3) is constituted by a photodiode.

5.
Pulsometer (10) according to any one of the preceding claims, characterized in that the electronic circuit (20) comprises a pulse calculation unit (28) which calculates a pulse value (P1, P2, P3) respectively corresponding to each receiving signal (SR1, SR2, SR3) produced by a receiver (R1, R2, R3), and a selection unit (30) which determines an optimum pulse value (PO) among the pulse values (P1, P2, P3) obtained by the pulse calculation unit (28).

6.
Pulsometer (10) according to any one of claims 1 to 4, characterized in that the electronic circuit (20) comprises a computing unit (26) of a virtual signal (SV) corresponding to an addition of the reception signals (SR1, SR2, SR3) produced by each of the receivers (R1, R2, R3), a pulse calculation unit (28) which calculates a pulse value (P1, P2, P3, PV) respectively corresponding to each reception signal (SR1, SR2, SR3) produced by a receiver (R1, R2, R3) and the virtual signal (SV), and a selection unit (30) which determines an optimum pulse value (PO) among the pulse values (P1, P2, P3, PV) obtained by the pulse calculation unit (28).

7.
Pulsometer (10) according to claim 5 or 6, characterized in that the electronic circuit (20) comprises a calculation unit (32) of a reliability index (IF) of the measurements which is a function of the pulse values (P1, P2, P3, PV) obtained by the pulse calculation unit (28).

8.
A method of controlling a pulsometer (10) according to any one of the preceding claims, comprising a measuring step in which each light source (E1, E2, E3) emits a light beam (FL) and each receiver (R1 , R2, R3) produces a receive signal (SR1, SR2, SR3) as a function of the received light, and a pulse calculation step in which a pulse value (P1, P2, P3) is calculated from

of the reception signal (SR1, SR2, SR3) produced by each receiver (R1, R2, R3) during the measuring step, characterized in that the step of calculating the pulse (P1, P2, P3) is followed by a selection step in which an optimum pulse value (PO) is selected from the pulse values (P1, P2, P3) obtained in the pulse calculation step.

9.

A method of controlling a pulsometer (10) according to any one of claims 1 to 7, comprising a measuring step in which each light source (E1, E2, E3) emits a light beam (FL) and each receiver (R1, R2, R3) produces a reception signal (SR1, SR2, SR3) as a function of the received light, and a pulse calculation step in which a pulse value (P1, P2, P3) is calculated from the reception signal (SR1, SR2, SR3) produced by each receiver (R1, R2, R3) during the measurement step, characterized in that a step of calculating a virtual signal (SV) corresponding to an addition of the reception signals (SR1, SR2, SR3) produced by each of the receivers (R1, R2, R3) is interposed between the measuring step and the step of calculating the pulse, in that a value pulse rate (PV) is calculated from the virtual signal (SV) during the pulse calculation step, and that, during the selection step, the The optimum heart rate (OP) is selected from the pulse values (P1, P2, P3, PV) obtained in the pulse calculation step.

10.

Control method according to claim 8 or 9, characterized in that the step of calculating the pulse is followed by a step of calculating a reliability index (IF) of the measurements during which a comparison is made between the values of pulses (P1, P2, P3, PV) obtained in the pulse calculation step.

11.

Control method according to the preceding claim, characterized in that the step of calculating the reliability index (IF) of the measurements is followed by a step of detecting the positioning state of the housing (14) during which , depending on the value of the reliability index (IF), is determined whether the pulse sensor (10) is worn or if the housing (14) is incorrectly positioned on the wrist (12).

DESCRIPTION EP1880666

[0001]
The invention relates to a portable wrist pulse and its control method.

[0002]
The invention more particularly relates to a portable wrist pulse comprising a housing which contains an electronic device for optical measurement of the pulsometer wearer's pulse and an electronic circuit for the processing of measurements for calculating the pulse, a clamping strap which maintains the bottom of the case pressed against the wrist, wherein the optical electronic measuring device comprises at least one light source and a plurality of light receivers which are arranged in the bottom of the housing and which are oriented towards the wrist.

[0003]

Such a type of pulsometer is described in particular in the document US 2003/0065269.

In this document, the optical electronic measuring device comprises an emitting diode which is arranged in the center of a square defined by four photodiodes, so that each photodiode is located equidistant from the emitter diode.

[0004]

Although this arrangement of the diode and photodiodes generally gives good results, there are sometimes problems of reliability of the pulse measurements, in particular because of physiological differences between the different carriers, for example in terms of vascularization of the wrist. These measurement reliability problems may also arise due to poor positioning of the case on the wrist.

[0005]
The invention aims in particular to remedy these disadvantages by proposing a simple and economical solution.

[0006]
For this purpose, the invention proposes a pulsometer of the type described above, characterized in that the optical measurement electronic device comprises at least two light sources and at least two receivers, in that the light sources and the receivers are arranged under the shape of a matrix comprising two lines, each oriented in a direction orthogonal to the direction of the wrist, and at least two columns, oriented parallel to the direction of the wrist, in that each line of the matrix alternately contains a light source and a receiver, and each column of the matrix contains a light source and a receiver.

[0007]

Thanks to the arrangement according to the invention, there has been an increase in the reliability of measurements despite the fact that the receivers are not distributed symmetrically around each light source.

In particular, shifting the columns of light sources and receivers in a direction orthogonal to the wrist direction makes it possible to cover a wide variety of different physiological characteristics among the carriers, which makes it possible to compensate for the differences in vascularization.

[0008]
The arrangement according to the invention also makes it possible to detect more easily a bad positioning of the pulsometer casing on the wrist, which makes it easier for the wearer to detect the origin of the measurement errors of the pulse.

[0009]

Preferably, the distance between each light source and the adjacent receiver in a row of the array is substantially equal to the distance between each light source and the adjacent receiver in a column of the array.

Such an arrangement facilitates the processing of the signal produced by each receiver by homogenizing the intensity of the signals.

[0010]

According to an advantageous embodiment, the matrix comprises three columns, and the first line contains a light source surrounded by two receivers, and the second line contains a receiver surrounded by two light sources.

This arrangement offers a particularly effective compromise by covering a greater number of different carrier physiologies while allowing to realize a compact and economical optical electronic measuring device. In particular, this arrangement minimizes the area occupied on the bottom of the housing, particularly in the direction of the wrist, with respect to a device according to the prior art.

[0011]

In the context of the present invention, it has unexpectedly been found that the non-symmetrical arrangement of the receivers with respect to the light sources has not decreased the reliability of the signals produced by the receivers. On the contrary, this arrangement makes it possible to obtain at least one reliable reception signal in the majority of cases, whatever the morphology of the wearer and its vascularization characteristics.

[0012]

Preferably, each light source is constituted by a diode which emits light in the infrared range, and each receiver is constituted by a photodiode. This optical measurement system is the one that offers the best results in terms of reliability and quality of measurements, while being economical and easy to implement.

[0013]

According to an advantageous embodiment, the electronic circuit comprises a pulse calculation unit which calculates a pulse value respectively corresponding to each reception signal produced by a receiver and to a virtual signal obtained by a calculating unit of a virtual signal. which corresponds to an addition of the reception signals produced by each of the receivers. A selection unit determines an optimum pulse value among the pulse values obtained by the pulse calculation unit. This solution further increases the diversity of usable signals and makes it possible to compensate measurement errors between the different receivers.

[0014]

Advantageously, the electronic circuit comprises a unit for calculating a reliability index of the measurements which is a function of the pulse values obtained by the pulse calculation unit. This reliability index makes it possible to make the most of the diversity of the signals produced by the receivers by making it possible to avoid displaying unrealistic pulse values and by making it possible to inform the user of the quality of the measurements made. In addition, when this reliability index reaches a determined value, the electronic circuit can detect a bad positioning of the housing on the wrist or an unworn state of the pulsometer.

[0015]

The invention also proposes a method for controlling a pulsometer according to one of the preceding characteristics, comprising a measurement step during which each light source emits a light beam and each receiver produces a reception signal according to the light. received, and a step of calculating the pulse rate during which a pulse value is calculated from the reception signal produced by each receiver during the measurement step, characterized in that a step of calculating a virtual signal corresponding to an addition of the reception signals produced by each of the receivers is interposed between the measurement step and the step of calculating the pulse, in that a pulse value is calculated from the virtual signal during the step of calculating the pulse, and in that, during the selection step, the optimum pulse value is selected from the pulse values

obtained in the pulse calculation step.

[0016]
According to other characteristics of this method: the step of calculating the pulse is followed by a step of calculating a reliability index of the measurements during which a comparison is made between the pulse values obtained in the step of pulse calculation; the step of calculating the reliability index of the measurements is followed by a step of detecting the positioning state of the housing during which, as a function of the value of the reliability index, is determined whether the pulsometer is worn or if the case is positioned incorrectly on the wrist.

[0017]
Other characteristics and advantages of the present invention will appear more clearly on reading the detailed description which follows, made with reference to the accompanying drawings given by way of non-limiting example and in which: FIG. 1 is a view from above which schematically represents the pulsometer according to the invention worn on the wrist of a wearer; FIG. 2 is a bottom view diagrammatically showing the bottom of the pulsometer casing of FIG. 1 and its electronic device for optical pulse measurement; Figure 3 is a sectional view along the plane 3-3 which schematically shows the pulsometer of Figure 1 and the light beam emitted by a light source of the electronic optical measuring device; FIG. 4 is a block diagram which represents the pulsometer of FIG. 1 and the electronic circuit which equips it.

[0018]

In Figures 1 to 4, there is shown a portable pulse wrist 12 of a carrier.

The pulsometer 10 comprises a casing 14 attached to the wrist 12 by means of a wristband 16.

[0019]
In the remainder of the description, the direction D1 of the wrist 12 will be referred to as the general direction of the forearm associated with the wrist 12 of the wearer.

[0020]
The housing 14 contains an optical electronic device 18 for measuring the carrier's pulse and an electronic circuit 20 for processing the measurements in order to calculate the carrier's pulse P

and to display it by means of a display device 22 such as as a liquid crystal display.

[0021]

The optical electronic measuring device 18 is arranged in the bottom 24 of the casing 14, on the opposite side to the display device 22.

The bracelet 16 is provided to hold the bottom 24 of the casing 14 against the wrist 12, so as to optimize the operation of the optical electronic measuring device 18.

[0022]

According to the teachings of the invention, the optical electronic measuring device 18 comprises at least two light sources E1, E2, E3 and at least two light receivers R1, R2, R3 which are oriented towards the wrist 12 of the wearer and which are arranged in the form of a matrix comprising two lines L1, L2, oriented in a direction orthogonal to the direction D1 of the wrist 12, and at least two columns C1, C2, C3, oriented parallel to the direction D1 of the wrist.

In addition, each line L1, L2 of the matrix alternately contains a light source E1, E2, E3 and a receiver R1, R2, R3, and each column C1, C2, C3 of the matrix contains a light source E1, E2, E3 and a receiver R1, R2, R3.

[0023]
According to a preferred embodiment, which is shown in the figures, the optical electronic measurement device 18 comprises three light sources E1, E2, E3, constituted by three diodes emitting in the infrared range, and three receivers R1, R2 , R3, constituted by three photodiodes provided to each produce a reception signal SR1, SR2, SR3 which is a function of the amount of light received.

[0024]
The matrix therefore comprises here three columns C1, C2, C3 with, considering FIG. 2, a first column C1 comprising a first receiver R1 in the first line L1 and a first light source E1 in the second line L2, a second column C2 having a second light source E2 in the first line L1 and a

second receiver R2 in the second line L2, and a third column C3 having a third receiver R3 in the first line L1 and a third light source E3 in the second line L2.

[0025]

In the first line L1, the second light source E2 is substantially aligned with the first and third receivers R1, R3.

In the second line L2, the first and third light sources E1, E3 are therefore substantially aligned with the second receiver R2.

[0026]
Preferably, the distance between each light source E1, E2, E3 and the adjacent receiver R1, R2, R3 in a line L1, L2 of the matrix is substantially equal to the distance between each light source E1, E2, E3 and the receiver R1, R2, R3 adjacent in a C1, C2 column of the matrix.

[0027]
According to the embodiment shown in the figures, lines L1, L2 are rectilinear but they could also be curved and describe two arcs of circles substantially parallel, secant.

[0028]
FIG. 4 shows in greater detail the electronic circuit 20 of the pulsometer 10 according to the invention.

[0029]

According to the preferred embodiment, the electronic circuit 20 comprises a first computing unit 26 which determines, from the reception signals SR1, SR2, SR3 produced by the three receivers R1, R2, R3 during each pulse measurement, a associated virtual reception signal SV.

The virtual reception signal SV is preferably constituted by an addition of the three reception signals SR1, SR2, SR3.

[0030]

The electronic circuit 20 comprises a second computing unit 28 which determines, from the reception signals SR1, SR2, SR3 produced by the receivers R1, R2, R3 and from the virtual signal SV, the pulse values P1, P2, P3, corresponding PV.

The second computing unit 28 is designed to process the signals SR1, SR2, SR3, SV by eliminating the noise, for example by means of filters (not shown), this noise being due mainly to the micro-movements of the housing 14 by compared to the wrist 12 of the wearer.

[0031]
The electronic circuit 20 comprises a selection unit 30 which selects, from the pulse values P1, P2, P3, PV obtained by the second calculation unit 28, an optimum pulse value PO. This optimum pulse value PO is selected on the basis of criteria defined by design, for example the pulse value P1, P2, P3, PV having the smallest variance is selected as the optimum value PO.

[0032]
The optimum pulse value PO selected by the selection unit 30 is transmitted to the display device 22 to allow the wearer to view it.

[0033]
Of course, from the optimum pulse value PO, other parameters related to the pulse value PO can also be calculated and displayed, for example the amount of calories consumed, or other information related to the history of the pulse. pulse measurements.

[0034]

According to the preferred embodiment, the electronic circuit 20 comprises a third calculation unit 32 which determines the value of a reliability index IF of the pulse measurements from the pulse values P1, P2, P3, PV obtained by the second computing unit 28.

The third computing unit 32 assigns a reliability index value IF which is, for example, a function of the frequency of the signals corresponding to the pulse values P1, P2, P3, PV, of the correlation between these signals, of the amplitude of these signals, and history of pulse values P1, P2, P3, PV.

[0035]
Regarding the frequency, it is necessary that the signals are included in a determined spectral band.

[0036]
When several signals are correlated, that is to say that several signals give the same information, in particular having similar variations at the same time, this indicates that this information is reliable since the spatial diversity of the receivers R1, R2, R3 makes that they are influenced differently when the housing 14 is incorrectly positioned.

[0037]
The amplitude of these signals must be within defined limits, so that a too large amplitude makes it possible to detect a problem of reliability of the measurement due to movements of the wearer.

[0038]
The determination of the reliability index IF exploits for example the result of calculations of variance and dispersion of the pulse values P1, P2, P3, PV.

[0039]
According to an alternative embodiment of the invention, the third computing unit 32 can also use the reception signals SR1, SR2, SR3 and the virtual signal SV to determine the value of the reliability index IF.

[0040]

The third computing unit 32 can transmit the value of the reliability index IF to the display device 22 to enable the wearer to know the reliability of the pulse values P that are displayed.

Depending on the value of the reliability index IF, when this is representative of insufficient reliability of the measurements, the electronic circuit 20 can also control the suspension of the display of the pulse P, so as not to display erroneous P-pulse values.

[0041]
Advantageously, depending on the value of the reliability index IF, the electronic circuit 20 can detect a poor positioning of the housing 14 on the wrist 12, which results in a greater amount of ambient light that reaches at least the one of the receivers R1, R2, R3.

[0042]

In the context of the present invention, after numerous experiments and tests, it has been found that the configuration according to the preferred embodiment with three light sources E1, E2, E3 and three receivers R1, R2, R3 is that which offers the best compromise for improving the reliability of pulse measurements by covering a large number of carriers with different physiological characteristics, while limiting the size and complexity of the optical electronic measuring device 18.

In addition, this configuration is the one that gives the best results to detect problems of misplacement of the housing 14 on the wrist 12.

[0043]

It should be noted that, in the preferred embodiment, the second receiver R2, which is located in the center of the second line L2 and is therefore surrounded by three light sources E1, E2, E3, receives light from these three sources. E1, E2, E3, while each of the two other receivers R1, R3 receive substantially light from the two adjacent light sources, respectively E1, E2 and E2, E3.

To compensate for this imbalance in light reception, it is planned to reduce the gain in the channel of the analog electronic circuit processing the reception signal SR2 produced by the second receiver R2.

Alternatively, the aforesaid imbalance of the signal SR2 can be corrected numerically by the

calculation unit 26.

[0044]
The method of controlling the pulsometer according to the invention is now described.

[0045]

This method comprises a measurement step, implemented by the optical measurement electronic device 18, during which each light source E1, E2, E3 emits a light beam FL directed towards the wrist 12 of the wearer.

This light beam FL propagates in the wrist 12 and part of this light beam FL is backscattered and detected by the receivers R1, R2, R3.

Depending on the amount of light received, each receiver produces a reception signal SR1, SR2, SR3 which enables the heartbeat of the wearer to be measured by detecting periodic variations in the light energy absorbed by the wearer's tissues.

[0046]
The principle of this pulse measurement step P is described in particular in document US 2003/0065269 to which reference may be made for details, in particular in the preamble of the description of this document.

[0047]
According to the teachings of the invention, the step of measuring the pulse P is followed by a step of calculating the virtual signal SV, implemented by the first calculation unit 26, during which the corresponding virtual signal SV is produced. an addition of the reception signals SR1, SR2, SR3.

[0048]
The step of calculating the virtual signal SV is followed by a step of calculating the pulse P1, P2, P3, PV, implemented by the second calculation unit 28, during which the reception signals SR1, SR2, SR3 and the virtual signal SV are processed to determine the corresponding pulse values P1, P2, P3, PV.

[0049]

The step of calculating the pulse is followed by a selection step, carried out by the selection unit 30, during which the optimum pulse value PO is selected from the pulse values P1, P2, P3, PV. obtained during the pulse calculation step.

It is this optimum pulse value PO that is intended to be displayed.

[0050]
Preferably, the step of calculating the pulse is followed by a step of calculating the reliability index IF of the measurements, implemented by the third calculation unit 32, during which the pulse values P1, P2, P3 corresponding to the reception signals SR1, SR2, SR3 and the pulse value PV corresponding to the virtual signal SV are compared with each other so as to determine the value of the reliability index IF representative of the confidence that can be placed in the measurements performed and in the optimum pulse value PO obtained by the selection unit 30.

[0051]
It is noted that the step of calculating the reliability index IF can provide for comparing the pulse values P1, P2, P3, PV obtained by the step of calculating the current pulse with the previous values that were obtained during the calculation steps corresponding to the previous measurements and which have been memorized, which makes it possible to determine whether the evolution of the value of the pulse PO over time is realistic.

[0052]

The reliability index IF can be calculated taking into account the amplitude values of the DC and AC components of each pulse value P1, P2, P3, PV due to ambient light, and amplitude values of the DC and DC components. alternative of each signal P1, P2, P3, PV due to the light emitted by the sources E1, E2, E3, and taking into account values derived from these signals P1, P2, P3, PV, such as for example the variance or the frequency spectrum.

Taking into account these parameters, it is thus possible to distinguish the case where the pulse

10 is incorrectly positioned on the wrist 12 of the case where the pulse 10 is not worn, for example when it is placed on a table.

[0053]
Advantageously, the step of calculating the reliability index IF is followed by a step of detecting a bad positioning of the casing 14 on the wrist 12 or of an unworn state of the pulsometer 10 during which, according to of the value of the reliability index IF, the electronic circuit 20 signals to the carrier the incorrect positioning, for example by means of the display device 22, or the electronic circuit 20 interrupts the display of the pulse in the case of a detection of an unworn state.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 880 666 A1

(12) DEMANDE DE BREVET EUROPEEN

(43) Date de publication:
23.01.2008 Bulletin 2008/04

(51) Int Cl.:
A61B 5/024 *(2006.01)*

(21) Numéro de dépôt: **06117653.3**

(22) Date de dépôt: **21.07.2006**

(84) Etats contractants désignés:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Etats d'extension désignés:
AL BA HR MK YU

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(54) Pulsomètre portable au poignet et procédé de commande associé

(57) L'invention propose un pulsomètre (10) comportant un boîtier (14) qui contient un dispositif électronique de mesure optique (18) du pouls et un circuit électronique un bracelet (16) de serrage qui maintient le fond (24) du boîtier (14) plaqué contre le poignet (12), caractérisé en ce que le dispositif électronique de mesure optique (18) comporte au moins deux sources lumineuses (E1, E2, E3) et au moins deux récepteurs (R1, R2, R3), en ce que les sources lumineuses (E1, E2, E3) et les récepteurs (R1, R2, R3) sont agencés sous la forme d'une matrice comportant deux lignes (L1, L2), orientées chacune suivant une direction orthogonale à la direction (D1) du poignet (12), et au moins deux colonnes (C1, C2, C3), orientées parallèlement à la direction (D1) du poignet (12), en ce que chaque ligne (L1, L2) de la matrice contient alternativement une source lumineuse (E1, E2, E3) et un récepteur (R1, R2, R3), et chaque colonne (C1, C2, C3) de la matrice contient une source lumineuse (E1, E2, E3) et un récepteur (R1, R2, R3).

L'invention propose aussi un procédé de commande de ce pulsomètre (10).

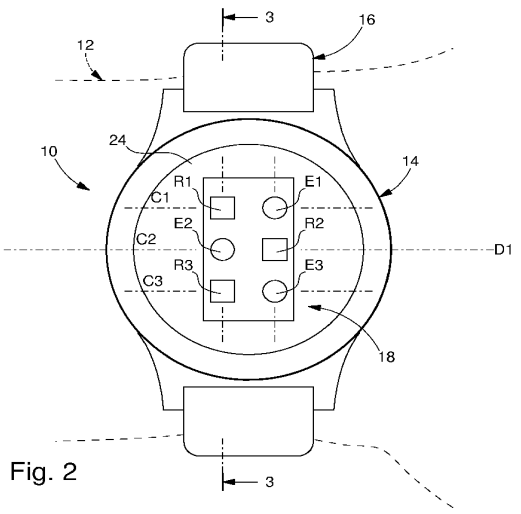

Fig. 2

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Printed by Jouve, 75001 PARIS (FR)

Description

[0001] L'invention concerne un pulsomètre portable au poignet et son procédé de commande.

[0002] L'invention concerne plus particulièrement un pulsomètre portable au poignet comportant un boîtier qui contient un dispositif électronique de mesure optique du pouls du porteur du pulsomètre et un circuit électronique pour le traitement des mesures en vue de calculer le pouls, un bracelet de serrage qui maintient le fond du boîtier plaqué contre le poignet, dans lequel le dispositif électronique de mesure optique comporte au moins une source lumineuse et plusieurs récepteurs de lumière qui sont agencés dans le fond du boîtier et qui sont orientés vers le poignet.

[0003] Un tel type de pulsomètre est décrit notamment dans le document US 2003/0065269. Dans ce document, le dispositif électronique de mesure optique comporte une diode émettrice qui est agencée au centre d'un carré défini par quatre photodiodes, de manière que chaque photodiode soit située à égale distance de la diode émettrice.

[0004] Bien que cette disposition de la diode et des photodiodes donne généralement de bons résultats, on constate parfois des problèmes de fiabilité des mesures de pouls, notamment en raison de différences physiologiques entre les différents porteurs, par exemple en matière de vascularisation du poignet. Ces problèmes de fiabilité des mesures peuvent aussi apparaître en raison de mauvais positionnements du boîtier sur le poignet.

[0005] L'invention vise notamment à remédier à ces inconvénients en proposant une solution simple et économique.

[0006] Dans ce but, l'invention propose un pulsomètre du type décrit précédemment, caractérisé en ce que le dispositif électronique de mesure optique comporte au moins deux sources lumineuses et au moins deux récepteurs, en ce que les sources lumineuses et les récepteurs sont agencés sous la forme d'une matrice comportant deux lignes, orientées chacune suivant une direction orthogonale à la direction du poignet, et au moins deux colonnes, orientées parallèlement à la direction du poignet, en ce que chaque ligne de la matrice contient alternativement une source lumineuse et un récepteur, et chaque colonne de la matrice contient une source lumineuse et un récepteur.

[0007] Grâce à l'agencement selon l'invention, on a constaté une augmentation de la fiabilité des mesures malgré le fait que les récepteurs ne sont pas répartis de manière symétrique autour de chaque source lumineuse. En particulier, le décalage des colonnes de sources lumineuses et de récepteurs selon une direction orthogonale à la direction du poignet permet de couvrir une grande variété de caractéristiques physiologies différentes parmi les porteurs, ce qui permet de compenser les différences de vascularisation.

[0008] L'agencement selon l'invention permet aussi de détecter plus facilement un mauvais positionnement du boîtier du pulsomètre sur le poignet, ce qui permet au porteur de détecter plus facilement l'origine des erreurs de mesure du pouls.

[0009] De préférence, la distance entre chaque source lumineuse et le récepteur adjacent dans une ligne de la matrice est sensiblement égale à la distance entre chaque source lumineuse et le récepteur adjacent dans une colonne de la matrice. Un tel agencement facilite le traitement du signal produit par chaque récepteur en homogénéisant l'intensité des signaux.

[0010] Selon un mode de réalisation avantageux, la matrice comporte trois colonnes, et la première ligne contient une source lumineuse entourée par deux récepteurs, et la seconde ligne contient un récepteur entouré par deux sources lumineuses. Cette disposition offre un compromis particulièrement efficace en couvrant un plus grand nombre de physiologies des porteurs différentes tout en permettant de réaliser un dispositif électronique de mesure optique compact et économique. En particulier, cette disposition minimise la surface occupée sur le fond du boîtier, notamment dans la direction du poignet, par rapport à un dispositif selon l'art antérieur.

[0011] Dans le cadre de la présente invention, il a été constaté de manière inattendue que l'agencement non symétrique des récepteurs par rapport aux sources lumineuses n'a pas diminué la fiabilité des signaux produits par les récepteurs. Au contraire, cet agencement permet d'obtenir au moins un signal de réception fiable dans la majorité des cas, quel que soit la morphologie du porteur et ses caractéristiques de vascularisation.

[0012] De préférence, chaque source lumineuse est constituée par une diode qui émet de la lumière dans le domaine de l'infrarouge, et chaque récepteur est constitué par une photodiode. Ce système de mesure optique est celui qui offre les meilleurs résultats en matière de fiabilité et de qualité des mesures, tout en étant économique et simple de mise en oeuvre.

[0013] Selon un mode de réalisation avantageux, le circuit électronique comprend une unité de calcul du pouls qui calcule une valeur de pouls correspondant respectivement à chaque signal de réception produit par un récepteur et à un signal virtuel obtenu par une unité de calcul d'un signal virtuel qui correspond à une addition des signaux de réception produits par chacun des récepteurs. Une unité de sélection détermine une valeur de pouls optimale parmi les valeurs de pouls obtenues par l'unité de calcul du pouls. Cette solution augmente encore la diversité des signaux exploitables et permet de compenser les erreurs de mesures entre les différents récepteurs.

[0014] Avantageusement, le circuit électronique comprend une unité de calcul d'un indice de fiabilité des mesures qui est fonction des valeurs de pouls obtenues par l'unité de calcul du pouls. Cet indice de fiabilité permet d'exploiter au mieux la diversité des signaux produits par les récepteurs en permettant d'éviter d'afficher des valeurs de pouls irréalistes et en permettant d'informer l'utilisateur sur la qualité des mesures effectuées. De plus,

lorsque cet indice de fiabilité atteint une valeur déterminée, le circuit électronique peut détecter un mauvais positionnement du boîtier sur le poignet ou un état non porté du pulsomètre.

[0015] L'invention propose aussi un procédé de commande d'un pulsomètre selon l'une des caractéristiques précédentes, comportant une étape de mesure au cours de laquelle chaque source lumineuse émet un faisceau lumineux et chaque récepteur produit un signal de réception en fonction de la lumière reçue, et une étape de calcul du pouls au cours de laquelle une valeur de pouls est calculée à partir du signal de réception produit par chaque récepteur au cours de l'étape de mesure, caractérisé en ce qu'une étape de calcul d'un signal virtuel correspondant à une addition des signaux de réception produits par chacun des récepteurs est intercalée entre l'étape de mesure et l'étape de calcul du pouls, en ce qu'une valeur de pouls est calculée à partir du signal virtuel au cours de l'étape de calcul du pouls, et en ce que, au cours de l'étape de sélection, la valeur de pouls optimale est sélectionnée parmi les valeurs de pouls obtenues à l'étape de calcul du pouls.

[0016] Selon d'autres caractéristiques de ce procédé :

- l'étape de calcul du pouls est suivie par une étape de calcul d'un indice de fiabilité des mesures au cours de laquelle une comparaison est effectuée entre les valeurs de pouls obtenues à l'étape de calcul du pouls;
- l'étape de calcul de l'indice de fiabilité des mesures est suivie par une étape de détection de l'état de positionnement du boîtier au cours de laquelle, en fonction de la valeur de l'indice de fiabilité, est déterminé si le pulsomètre est porté ou si le boîtier est mal positionné sur le poignet.

[0017] D'autres caractéristiques et avantages de la présente invention apparaîtront plus clairement à la lecture de la description détaillée qui suit, faite en référence aux dessins annexés donnés à titre d'exemple non limitatifs et dans lesquels :

- la figure 1 est une vue de dessus qui représente schématiquement le pulsomètre selon l'invention porté au poignet d'un porteur;
- la figure 2 est une vue de dessous qui représente schématiquement le fond du boîtier du pulsomètre de la figure 1 et son dispositif électronique de mesure optique du pouls;
- la figure 3 est une vue en coupe selon le plan 3-3 qui représente schématiquement le pulsomètre de la figure 1 et le faisceau lumineux émis par une source lumineuse du dispositif électronique de mesure optique;
- la figure 4 est un schéma fonctionnel qui représente le pulsomètre de la figure 1 et le circuit électronique qui l'équipe.

[0018] Sur les figures 1 à 4, on a représenté un pulsomètre 10 portable au poignet 12 d'un porteur. Le pulsomètre 10 comporte un boîtier 14 attaché au poignet 12 par l'intermédiaire d'un bracelet 16 de serrage.

[0019] Dans la suite de la description, on désignera par direction D1 du poignet 12 la direction générale de l'avant-bras associé au poignet 12 du porteur.

[0020] Le boîtier 14 contient un dispositif électronique de mesure optique 18 du pouls du porteur et un circuit électronique 20 pour le traitement des mesures en vue de calculer le pouls P du porteur et de l'afficher au moyen d'un dispositif d'affichage 22 tel qu'un écran à cristaux liquides.

[0021] Le dispositif électronique de mesure optique 18 est agencé dans le fond 24 du boîtier 14, du côté opposé au dispositif d'affichage 22. Le bracelet 16 est prévu pour maintenir le fond 24 du boîtier 14 plaqué contre le poignet 12, de manière à optimiser le fonctionnement du dispositif électronique de mesure optique 18.

[0022] Conformément aux enseignements de l'invention, le dispositif électronique de mesure optique 18 comporte au moins deux sources lumineuses E1, E2, E3 et au moins deux récepteurs R1, R2, R3 de lumière qui sont orientés vers le poignet 12 du porteur et qui sont agencés sous la forme d'une matrice comportant deux lignes L1, L2, orientées suivant une direction orthogonale à la direction D1 du poignet 12, et au moins deux colonnes C1, C2, C3, orientées parallèlement à la direction D1 du poignet. De plus, chaque ligne L1, L2 de la matrice contient alternativement une source lumineuse E1, E2, E3 et un récepteur R1, R2, R3, et chaque colonne C1, C2, C3 de la matrice contient une source lumineuse E1, E2, E3 et un récepteur R1, R2, R3.

[0023] Selon un mode de réalisation préféré, qui est représenté sur les figures, le dispositif électronique de mesure optique 18 comporte trois sources lumineuses E1, E2, E3, constituées par trois diodes émettant dans le domaine de l'infrarouge, et trois récepteurs R1, R2, R3, constitués par trois photodiodes prévues pour produire chacune un signal de réception SR1, SR2, SR3 qui est fonction de la quantité de lumière reçue.

[0024] La matrice comporte donc ici trois colonnes C1, C2, C3 avec, en considérant la figure 2, une première colonne C1 comportant un premier récepteur R1 dans la première ligne L1 et une première source lumineuse E1 dans la seconde ligne L2, une deuxième colonne C2 comportant une deuxième source lumineuse E2 dans la première ligne L1 et un deuxième récepteur R2 dans la seconde ligne L2, et une troisième colonne C3 comportant un troisième récepteur R3 dans la première ligne L1 et une troisième source lumineuse E3 dans la seconde ligne L2.

[0025] Dans la première ligne L1, la deuxième source lumineuse E2 est donc sensiblement alignée avec le premier et le troisième récepteurs R1, R3. Dans la seconde ligne L2, la première et la troisième sources lumineuses E1, E3 sont donc sensiblement alignées avec le deuxième récepteur R2.

[0026] De préférence, la distance entre chaque source lumineuse E1, E2, E3 et le récepteur R1, R2, R3 adjacent dans une ligne L1, L2 de la matrice est sensiblement égale à la distance entre chaque source lumineuse E1, E2, E3 et le récepteur R1, R2, R3 adjacent dans une colonne C1, C2 de la matrice.

[0027] Selon le mode de réalisation représenté sur les figures, les lignes L1, L2 sont rectilignes mais elles pourraient aussi être courbées et décrire deux arcs de cercles sensiblement parallèles, on sécants.

[0028] Sur la figure 4, on a représenté plus en détail le circuit électronique 20 du pulsomètre 10 selon l'invention.

[0029] Selon le mode de réalisation préféré, le circuit électronique 20 comprend une première unité de calcul 26 qui détermine, à partir des signaux de réception SR1, SR2, SR3 produits par les trois récepteurs R1, R2, R3 lors de chaque mesure de pouls, un signal de réception virtuel SV associé. Le signal de réception virtuel SV est de préférence constitué par une addition des trois signaux de réception SR1, SR2, SR3.

[0030] Le circuit électronique 20 comporte une deuxième unité de calcul 28 qui détermine, à partir des signaux de réception SR1, SR2, SR3 produits par les récepteurs R1, R2, R3 et à partir du signal virtuel SV, les valeurs de pouls P1, P2, P3, PV correspondantes. La deuxième unité de calcul 28 est prévue pour traiter les signaux SR1, SR2, SR3, SV en éliminant le bruit, par exemple à l'aide de filtres (non représentés), ce bruit étant dû principalement aux micro-mouvements du boîtier 14 par rapport au poignet 12 du porteur.

[0031] Le circuit électronique 20 comporte une unité de sélection 30 qui sélectionne, parmi les valeurs de pouls P1, P2, P3, PV obtenues par la deuxième unité de calcul 28, une valeur de pouls optimale PO. Cette valeur de pouls optimale PO est sélectionnée sur la base de critères définis par conception, par exemple la valeur de pouls P1, P2, P3, PV possédant la plus petite variance est sélectionnée comme valeur optimale PO.

[0032] La valeur de pouls optimale PO sélectionnée par l'unité de sélection 30 est transmise au dispositif d'affichage 22 pour permettre au porteur de la visualiser.

[0033] Bien entendu, à partir de la valeur de pouls optimale PO, d'autres paramètres liés à la valeur du pouls PO peuvent aussi être calculés et affichés, par exemple la quantité de calories consommées, ou d'autres informations liées à l'historique des mesures de pouls.

[0034] Selon le mode de réalisation préféré, le circuit électronique 20 comprend une troisième unité de calcul 32 qui détermine la valeur d'un indice de fiabilité IF des mesures de pouls à partir des valeurs de pouls P1, P2, P3, PV obtenues par la deuxième unité de calcul 28. La troisième unité de calcul 32 affecte une valeur d'indice de fiabilité IF qui est, par exemple, fonction de la fréquence des signaux correspondant aux valeurs de pouls P1, P2, P3, PV, de la corrélation entre ces signaux, de l'amplitude de ces signaux, et de l'historique des valeurs de pouls P1, P2, P3, PV.

[0035] Concernant la fréquence, il faut que les signaux soient compris dans une bande spectrale déterminée.

[0036] Lorsque plusieurs signaux sont corrélés, c'est-à-dire que plusieurs signaux donnent la même information, notamment en ayant des variations similaires au même moment, cela indique que cette information est fiable puisque la diversité spatiale des récepteurs R1, R2, R3 fait qu'ils sont influencés différemment lorsque le boîtier 14 est mal positionné.

[0037] L'amplitude de ces signaux doit être comprise dans des limites déterminées, de sorte qu'une amplitude trop importante permet de détecter un problème de fiabilité de la mesure dû à des mouvements du porteur.

[0038] La détermination de l'indice de fiabilité IF exploite par exemple le résultat des calculs de variance et de dispersion des valeurs de pouls P1, P2, P3, PV.

[0039] Selon une variante de réalisation de l'invention, la troisième unité de calcul 32 peut aussi utiliser les signaux de réception SR1, SR2, SR3 et le signal virtuel SV pour déterminer la valeur de l'indice de fiabilité IF.

[0040] La troisième unité de calcul 32 peut transmettre la valeur de l'indice de fiabilité IF au dispositif d'affichage 22 pour permettre au porteur de connaître la fiabilité des valeurs de pouls P qui sont affichées. En fonction de la valeur de l'indice de fiabilité IF, lorsque celle-ci est représentative d'une fiabilité insuffisante des mesures, le circuit électronique 20 peut aussi commander la suspension de l'affichage du pouls P, de manière à ne pas afficher de valeurs de pouls P erronées.

[0041] Avantageusement, en fonction de la valeur de l'indice de fiabilité IF, le circuit électronique 20 peut détecter un mauvais positionnement du boîtier 14 sur le poignet 12, ce qui se traduit par une plus grande quantité de lumière ambiante qui atteint au moins l'un des récepteurs R1, R2, R3.

[0042] Dans le cadre de la présente invention, après de nombreuses expérimentations et essais, il a été constaté que la configuration selon le mode de réalisation préféré avec trois sources lumineuses E1, E2, E3 et trois récepteurs R1, R2, R3 est celle qui offre le meilleur compromis pour l'amélioration de la fiabilité des mesures de pouls en couvrant un nombre important de porteurs avec des caractéristiques physiologiques différentes, tout en limitant l'encombrement et la complexité du dispositif électronique de mesure optique 18. De plus, cette configuration est celle qui donne les meilleurs résultats pour détecter des problèmes de mauvais positionnement du boîtier 14 sur le poignet 12.

[0043] On note que, dans le mode de réalisation préféré, le deuxième récepteur R2, qui est situé au centre de la seconde ligne L2 et qui est donc entouré par trois sources lumineuses E1, E2, E3, reçoit de la lumière provenant de ces trois sources lumineuses E1, E2, E3, alors que chacun des deux autres récepteurs R1, R3 reçoivent essentiellement de la lumière provenant des deux sources lumineuses adjacentes, respectivement E1, E2 et E2, E3. Pour compenser ce déséquilibre dans la réception de lumière, il est prévu de diminuer le gain dans le

canal du circuit électronique analogique traitant le signal de réception SR2 produit par le deuxième récepteur R2. Alternativement, le susdit déséquilibre du signal SR2 peut être corrigé numériquement par l'unité de calcul 26.

[0044] On décrit maintenant le procédé de commande du pulsomètre selon l'invention.

[0045] Ce procédé comporte une étape de mesure, mise en oeuvre par le dispositif électronique de mesure optique 18, au cours de laquelle chaque source lumineuse E1, E2, E3 émet un faisceau lumineux FL dirigé vers le poignet 12 du porteur. Ce faisceau lumineux FL se propage dans le poignet 12 et une partie de ce faisceau lumineux FL est rétro-diffusée et détectée par les récepteurs R1, R2, R3. En fonction de la quantité de lumière reçue, chaque récepteur produit un signal de réception SR1, SR2, SR3 qui permet la mesure des pulsations cardiaques du porteur en détectant des variations périodiques de l'énergie lumineuse absorbée par les tissus du porteur.

[0046] Le principe de cette étape de mesure du pouls P est décrit notamment dans le document US 2003/0065269 auquel on pourra se reporter pour plus de détails, en particulier dans le préambule de la description de ce document.

[0047] Conformément aux enseignements de l'invention, l'étape de mesure du pouls P est suivie par une étape de calcul du signal virtuel SV, mise en oeuvre par la première unité de calcul 26, au cours de laquelle est produit le signal virtuel SV correspondant à une addition des signaux de réception SR1, SR2, SR3.

[0048] L'étape de calcul du signal virtuel SV est suivie par une étape de calcul du pouls P1, P2, P3, PV, mise en oeuvre par la deuxième unité de calcul 28, au cours de laquelle les signaux de réception SR1, SR2, SR3 et le signal virtuel SV sont traités de manière à déterminer les valeurs de pouls P1, P2, P3, PV correspondantes.

[0049] L'étape de calcul du pouls est suivie par une étape de sélection, mise en oeuvre par l'unité de sélection 30, au cours de laquelle la valeur de pouls optimale PO est sélectionnée parmi les valeurs de pouls P1, P2, P3, PV obtenues au cours de l'étape de calcul du pouls. C'est cette valeur de pouls optimale PO qui est prévue pour être affichée.

[0050] De préférence, l'étape de calcul du pouls est suivie par une étape de calcul de l'indice de fiabilité IF des mesures, mise en oeuvre par la troisième unité de calcul 32, au cours de laquelle les valeurs de pouls P1, P2, P3 correspondant aux signaux de réception SR1, SR2, SR3 et la valeur de pouls PV correspondant au signal virtuel SV sont comparées entre elles de manière à déterminer la valeur de l'indice de fiabilité IF représentatif de la confiance qui peut être placée dans les mesures effectuées et dans la valeur de pouls optimale PO obtenue par l'unité de sélection 30.

[0051] On note que l'étape de calcul de l'indice de fiabilité IF peut prévoir de comparer les valeurs de pouls P1, P2, P3, PV obtenues par l'étape de calcul du pouls en cours aux valeurs antérieures qui ont été obtenues lors des étapes de calcul correspondant aux mesures précédentes et qui ont été mémorisés, ce qui permet de déterminer si l'évolution de la valeur du pouls PO au cours du temps est réaliste.

[0052] L'indice de fiabilité IF peut être calculé en tenant compte des valeurs d'amplitude des composantes continue et alternative de chaque valeur de pouls P1, P2, P3, PV dues à la lumière ambiante, et des valeurs d'amplitude des composantes continue et alternative de chaque signal P1, P2, P3, PV dues à la lumière émise par les sources E1, E2, E3, et en tenant compte de valeurs dérivées de ces signaux P1, P2, P3, PV, comme par exemple la variance ou le spectre de fréquences. En tenant compte de ces paramètres, il est ainsi possible de distinguer le cas où le pulsomètre 10 est mal positionné sur le poignet 12 du cas où le pulsomètre 10 est non porté, par exemple lorsqu'il est posé sur une table.

[0053] Avantageusement, l'étape de calcul de l'indice de fiabilité IF est suivie par une étape de détection d'un mauvais positionnement du boîtier 14 sur le poignet 12 ou d'un état non porté du pulsomètre 10 au cours de laquelle, en fonction de la valeur de l'indice de fiabilité IF, le circuit électronique 20 signale au porteur le mauvais positionnement, par exemple au moyen du dispositif d'affichage 22, ou le circuit électronique 20 interrompt l'affichage du pouls dans le cas d'une détection d'un état non porté.

Revendications

1. Pulsomètre (10) portable au poignet (12) comportant un boîtier (14) qui contient un dispositif électronique de mesure optique (18) du pouls du porteur du pulsomètre (10) et un circuit électronique (20) pour le traitement des mesures en vue de calculer le pouls (P), un bracelet (16) de serrage qui maintient le fond (24) du boîtier (14) plaqué contre le poignet (12), dans lequel le dispositif électronique de mesure optique (18) comporte au moins une source lumineuse (E1, E2, E3) et plusieurs récepteurs (R1, R2, R3) de lumière qui sont agencés dans le fond (24) du boîtier (14) et qui sont orientés vers le poignet (12),
caractérisé en ce que le dispositif électronique de mesure optique (18) comporte au moins deux sources lumineuses (E1, E2, E3) et au moins deux récepteurs (R1, R2, R3), **en ce que** les sources lumineuses (E1, E2, E3) et les récepteurs (R1, R2, R3) sont agencés sous la forme d'une matrice comportant deux lignes (L1, L2), orientées chacune suivant une direction orthogonale à la direction (D1) du poignet (12), et au moins deux colonnes (C1, C2, C3), orientées parallèlement à la direction (D1) du poignet (12), **en ce que** chaque ligne (L1, L2) de la matrice contient alternativement une source lumineuse (E1, E2, E3) et un récepteur (R1, R2, R3), et chaque colonne (C1, C2, C3) de la matrice contient alternativement une source lumineuse (E1, E2, E3) et un

récepteur (R1, R2, R3).

2. Pulsomètre (10) selon la revendication précédente, **caractérisé en ce que** la distance entre chaque source lumineuse (E1, E2, E3) et le récepteur (R1, R2, R3) adjacent dans une ligne (L1, L2) de la matrice est sensiblement égale à la distance entre chaque source lumineuse (E1, E2, E3) et le récepteur (R1, R2, R3) adjacent dans une colonne (C1, C2, C3) de la matrice.

3. Pulsomètre (10) selon la revendication 1 ou 2, **caractérisé en ce que** la matrice comporte trois colonnes (C1, C2, C3), et **en ce que** la première ligne (L1) contient une source lumineuse (E2) entourée par deux récepteurs (R1, R3), et la seconde ligne (L2) contient un récepteur (R2) entouré par deux sources lumineuses (E1, E3).

4. Pulsomètre (10) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** chaque source lumineuse (E1, E2, E3) est constituée par une diode qui émet de la lumière dans le domaine de l'infrarouge, et chaque récepteur (R1, R2, R3) est constitué par une photodiode.

5. Pulsomètre (10) selon l'une quelconque des revendications précédente, **caractérisé en ce que** le circuit électronique (20) comprend une unité de calcul du pouls (28) qui calcule une valeur de pouls (P1, P2, P3) correspondant respectivement à chaque signal de réception (SR1, SR2, SR3) produit par un récepteur (R1, R2, R3), et une unité de sélection (30) qui détermine une valeur de pouls optimale (PO) parmi les valeurs de pouls (P1, P2, P3) obtenues par l'unité de calcul du pouls (28).

6. Pulsomètre (10) selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** le circuit électronique (20) comprend une unité de calcul (26) d'un signal virtuel (SV) correspondant à une addition des signaux de réception (SR1, SR2, SR3) produits par chacun des récepteurs (R1, R2, R3), une unité de calcul du pouls (28) qui calcule une valeur de pouls (P1, P2, P3, PV) correspondant respectivement à chaque signal de réception (SR1, SR2, SR3) produit par un récepteur (R1, R2, R3) et au signal virtuel (SV), et une unité de sélection (30) qui détermine une valeur de pouls optimale (PO) parmi les valeurs de pouls (P1, P2, P3, PV) obtenues par l'unité de calcul du pouls (28).

7. Pulsomètre (10) selon la revendication 5 ou 6, **caractérisé en ce que** le circuit électronique (20) comprend une unité de calcul (32) d'un indice de fiabilité (IF) des mesures qui est fonction des valeurs de pouls (P1, P2, P3, PV) obtenues par l'unité de calcul du pouls (28).

8. Procédé de commande d'un pulsomètre (10) selon l'une quelconque des revendications précédentes, comportant une étape de mesure au cours de laquelle chaque source lumineuse (E1, E2, E3) émet un faisceau lumineux (FL) et chaque récepteur (R1, R2, R3) produit un signal de réception (SR1, SR2, SR3) en fonction de la lumière reçue, et une étape de calcul du pouls au cours de laquelle une valeur de pouls (P1, P2, P3) est calculée à partir du signal de réception (SR1, SR2, SR3) produit par chaque récepteur (R1, R2, R3) au cours de l'étape de mesure, **caractérisé en ce que** l'étape de calcul du pouls (P1, P2, P3) est suivie par une étape de sélection au cours de laquelle une valeur de pouls optimale (PO) est sélectionnée parmi les valeurs de pouls (P1, P2, P3) obtenues à l'étape de calcul du pouls.

9. Procédé de commande d'un pulsomètre (10) selon l'une quelconque des revendications 1 à 7, comportant une étape de mesure au cours de laquelle chaque source lumineuse (E1, E2, E3) émet un faisceau lumineux (FL) et chaque récepteur (R1, R2, R3) produit un signal de réception (SR1, SR2, SR3) en fonction de la lumière reçue, et une étape de calcul du pouls au cours de laquelle une valeur de pouls (P1, P2, P3) est calculée à partir du signal de réception (SR1, SR2, SR3) produit par chaque récepteur (R1, R2, R3) au cours de l'étape de mesure, **caractérisé en ce qu'**une étape de calcul d'un signal virtuel (SV) correspondant à une addition des signaux de réception (SR1, SR2, SR3) produits par chacun des récepteurs (R1, R2, R3) est intercalée entre l'étape de mesure et l'étape de calcul du pouls, **en ce qu'**une valeur de pouls (PV) est calculée à partir du signal virtuel (SV) au cours de l'étape de calcul du pouls, et **en ce que**, au cours de l'étape de sélection, la valeur de pouls optimale (PO) est sélectionnée parmi les valeurs de pouls (P1, P2, P3, PV) obtenues à l'étape de calcul du pouls.

10. Procédé de commande selon la revendication 8 ou 9, **caractérisé en ce que** l'étape de calcul du pouls est suivie par une étape de calcul d'un indice de fiabilité (IF) des mesures au cours de laquelle une comparaison est effectuée entre les valeurs de pouls (P1, P2, P3, PV) obtenues à l'étape de calcul du pouls.

11. Procédé de commande selon la revendication précédente, **caractérisé en ce que** l'étape de calcul de l'indice de fiabilité (IF) des mesures est suivie par une étape de détection de l'état de positionnement du boîtier (14) au cours de laquelle, en fonction de la valeur de l'indice de fiabilité (IF), est déterminé si le pulsomètre (10) est porté ou si le boîtier (14) est mal positionné sur le poignet (12).

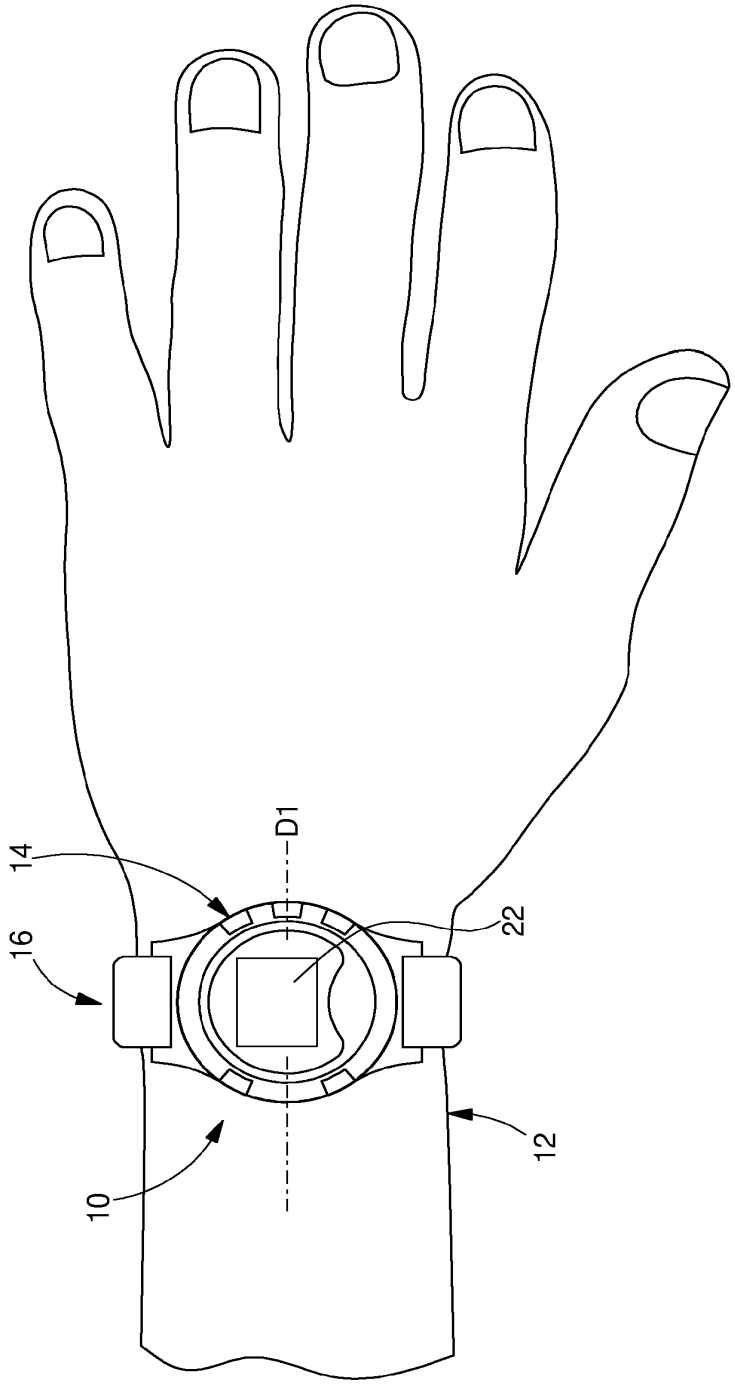

Fig. 1

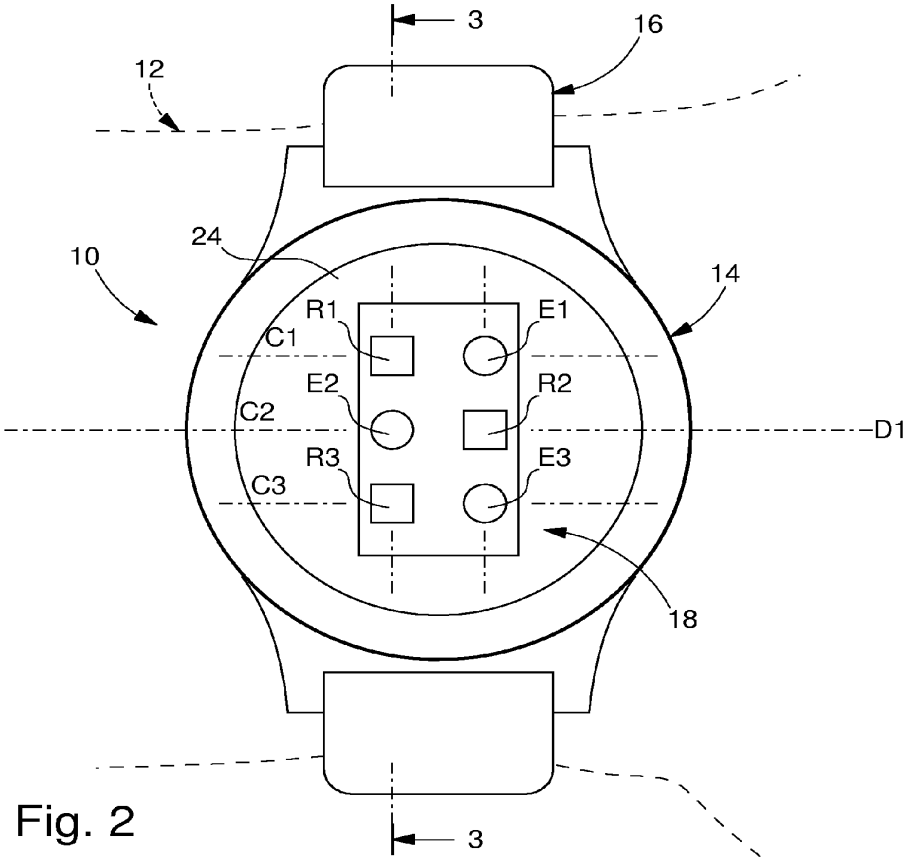
3
16
12
24
10
14
R1
E1
C1
E2
R2
C2
D1
R3
E3
C3
18
3

Fig. 2

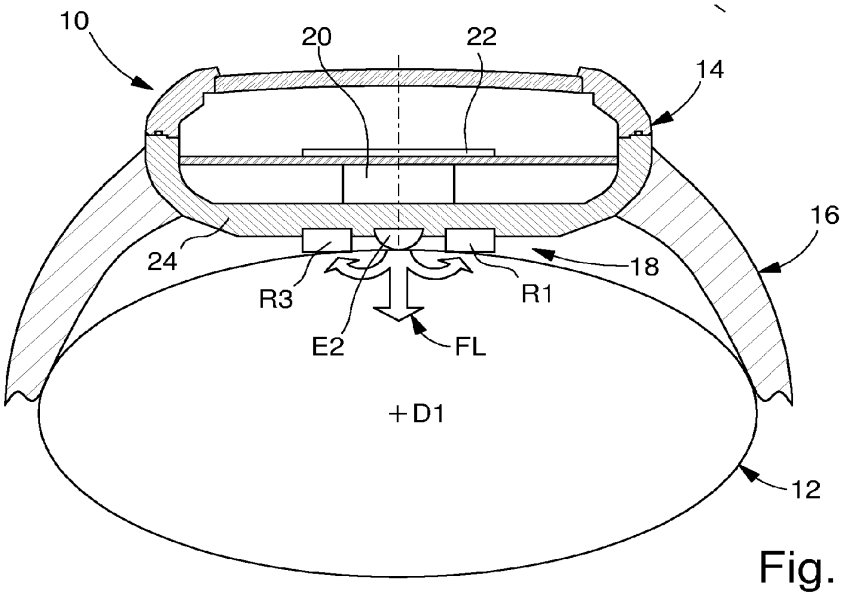
10
20
22
14
16
24
18
R3
R1
E2
FL
+D1
12

Fig. 3

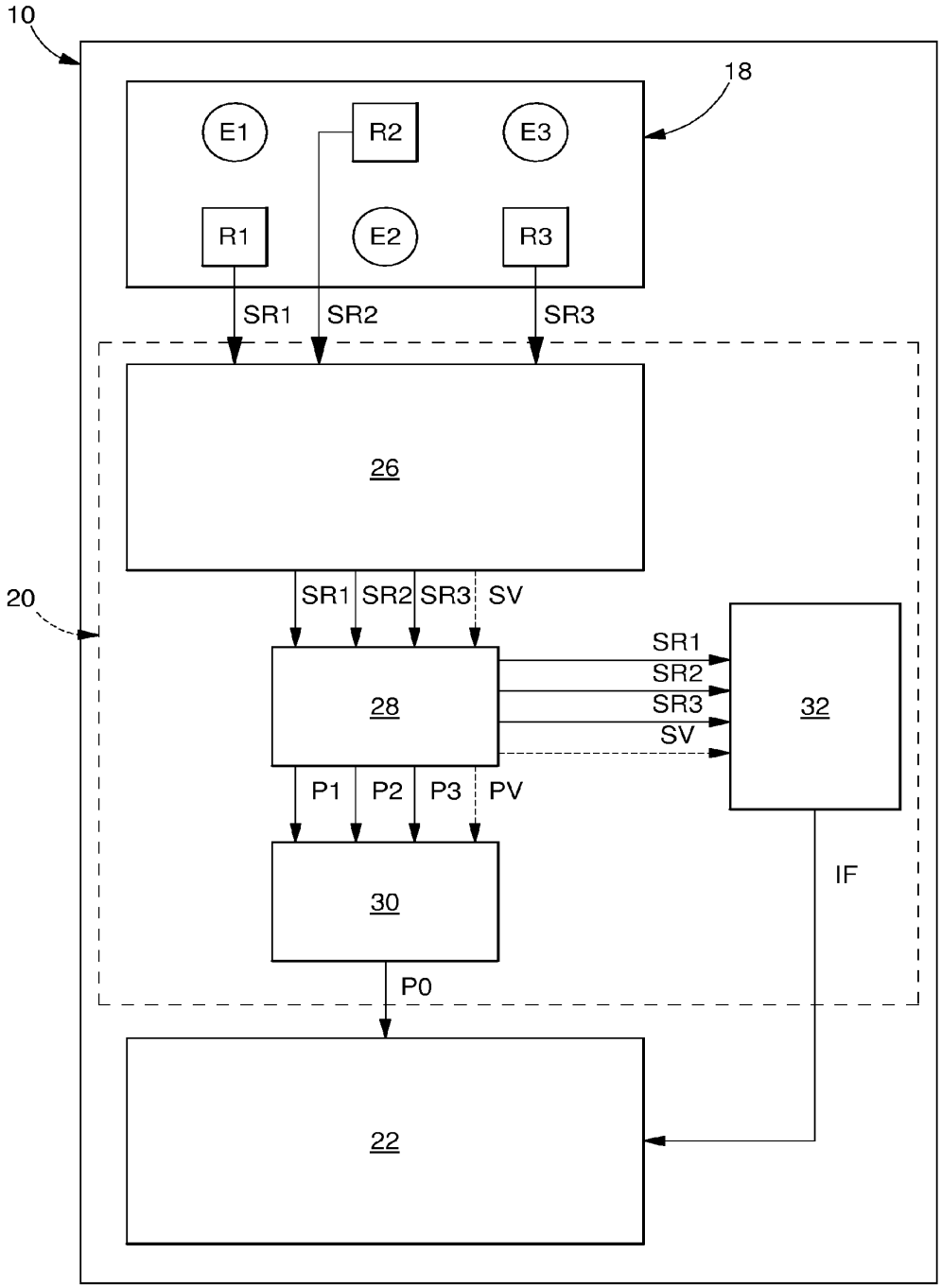
10
18
E1
R2
E3
R1
E2
R3
SR1
SR2
SR3
26
20
SR1
SR2
SR3
SV
28
SR1
SR2
SR3
SV
32
P1
P2
P3
PV
30
IF
P0
22

Fig. 4

Office européen des brevets

RAPPORT DE RECHERCHE EUROPEENNE

Numéro de la demande
EP 06 11 7653

DOCUMENTS CONSIDERES COMME PERTINENTS

Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes	Revendication concernée	CLASSEMENT DE LA DEMANDE (IPC)
A	US 2003/065269 A1 (VETTER ROLF [CH] ET AL) 3 avril 2003 (2003-04-03) * le document en entier *	1-11	INV. A61B5/024
A	US 4 063 551 A (SWEENEY JAMES STEVENS) 20 décembre 1977 (1977-12-20) * le document en entier *	1-11	
A	FR 2 669 819 A1 (IVAC CORP [US]) 5 juin 1992 (1992-06-05) * le document en entier *	1-11	
A	WO 01/95796 A (KONINKL PHILIPS ELECTRONICS NV [NL]) 20 décembre 2001 (2001-12-20) * le document en entier *	1-11	
A	US 4 706 072 A (IKEYAMA TAKESHI [JP]) 10 novembre 1987 (1987-11-10) * le document en entier *	1-11	
A	US 2004/236227 A1 (GUEISSAZ FRANCOIS [CH]) 25 novembre 2004 (2004-11-25) * le document en entier *	1-11	DOMAINES TECHNIQUES RECHERCHES (IPC) A61B

Le présent rapport a été établi pour toutes les revendications

Lieu de la recherche	Date d'achèvement de la recherche	Examinateur
Munich	30 janvier 2007	Gentil, Cédric

CATEGORIE DES DOCUMENTS CITES

X : particulièrement pertinent à lui seul
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A : arrière-plan technologique
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T : théorie ou principe à la base de l'invention
E : document de brevet antérieur, mais publié à la date de dépôt ou après cette date
D : cité dans la demande
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ANNEXE AU RAPPORT DE RECHERCHE EUROPEENNE RELATIF A LA DEMANDE DE BREVET EUROPEEN NO. EP 06 11 7653

La présente annexe indique les membres de la famille de brevets relatifs aux documents brevets cités dans le rapport de recherche européenne visé ci-dessus.
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30-01-2007

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Pour tout renseignement concernant cette annexe : voir Journal Officiel de l'Office européen des brevets, No.12/82

RÉFÉRENCES CITÉES DANS LA DESCRIPTION

Cette liste de références citées par le demandeur vise uniquement à aider le lecteur et ne fait pas partie du document de brevet européen. Même si le plus grand soin a été accordé à sa conception, des erreurs ou des omissions ne peuvent être exclues et l'OEB décline toute responsabilité à cet égard.

Documents brevets cités dans la description

- US 20030065269 A **[0003] [0046]**

Espacenet

Bibliographic data: JPH11235320 (A) — 1999-08-31

BIOLOGICAL INFORMATION MEASURING DEVICE

Inventor(s): KONDO YUTAKA ± (KONDO YUTAKA)

Applicant(s): SEIKO EPSON CORP ± (SEIKO EPSON CORP)

Classification: **- international:** ***A61B5/0245;*** (IPC1-7): A61B5/0245
- cooperative:

Application number: JP19980040675 19980223

Priority number(s): JP19980040675 19980223

Abstract of JPH11235320 (A)

PROBLEM TO BE SOLVED: To enhance measuring accuracy while minimizing the pressure applied to a living body. SOLUTION: A biological information measuring device having a pulse wave sensor unit 100 comprising a reflecting optical sensor and detecting pulse rate, a housing 10 incorporating the sensor unit, and a wrist band 20 (21) for securing the housing 10 to a living body is improved. Ground terminals 140, 141 are movably mounted on a projecting part 130 formed on the back lid of the housing 10. The ground terminals 140, 141 are connected to the necessary parts of the circuit board 101 of the pulse wave sensor unit 100 via a spring 152 made of a conductor. When the device is attached to the living body, the ground terminals 140, 141 are held in contact with the living body by the spring 152 to keep the necessary parts of the circuit board 101 grounded.

CLAIMS JPH11235320

1.

A light emitting means for irradiating light to a detection part of the living body, a biological information detecting means for receiving a reflected light from the living body related to the light irradiated by the light emitting means and generating a biological information signal corresponding to the amount of received light; A circuit that amplifies or converts the biological information signal generated by the biological information detection means, the light emitting means, the biological information detection means, and a support that supports the circuit; and the support that is connected to the support. A fixing means for fixing to a living body, and is electrically connected to at least one of the light emitting means, the biological information detecting means, and the circuit, and is movably supported by the support so as to face the living body. A grounding terminal; and a biasing means for constantly biasing the grounding terminal toward the living body when the support is fixed to the living body by the fixing means. The biological information measuring device for.

2.

The support has a convex portion formed on a surface directed to the living body when fixed to the living body, and the convex portion protects the light emitting means and the biological information detecting means, and A translucent body that secures the progress of light from the light emitting unit through the living body to the biometric information detecting unit and the grounding terminal are attached, and the translucent body and the grounding terminal are more than the convex portion. The biological information measuring device according to claim 1, wherein the biological information measuring device is protruded toward the living body.

3.

A light emitter that emits light to a detection site of a living body; a light receiver that receives reflected light from the living body according to light emitted by the light emitter and generates a biological information signal corresponding to the amount of received light; and the light receiving means A circuit that amplifies or converts the biological information signal generated by the device, a light-emitting body, a light-receiving body and a support that supports the circuit; A wound body that is wound to fix the support to the living body, and is electrically connected to at least one of the light emitter, the light receiver, and the circuit, and is movable to the support A grounding terminal supported and opposed to the living body, and a spring that constantly biases the grounding terminal toward the living body when the supporting body is fixed to the living body by the wound body; Characterized by comprising The biological information measuring device for.

4.

The support has a convex portion formed on a surface directed to the living body when fixed to the living body, and the convex portion protects the light emitter and the light receiver, and the light emitter. A translucent body that secures the progression of light from the living body to the light receiving body and the grounding terminal, and the translucent body and the grounding terminal are located on the living body side of the convex portion. The living body information measuring device according to claim 3, wherein the living body information measuring device is protruded into the body.

5.

The living body side end face of the grounding terminal and the living body side end face of the translucent body are positioned on substantially the same plane when pressed toward the living body. The biological information measuring device according to claim 2 or 4.

6.

A light emitting means for irradiating light to a detection part of the living body, a biological information detecting means for receiving a reflected light from the living body related to the light irradiated by the light emitting means and generating a biological information signal corresponding to the amount of received light; A circuit that amplifies or converts the biological information signal generated by the biological information detection means, the light emitting means, the biological information detection means, and a support that supports the circuit; and the support that is connected to the support. A grounding means that is electrically connected to at least one of the fixing means for fixing to the living body, the light emitting means, the biological information detecting means, and the circuit, and is supported by the support and opposed to the living body. A terminal is attached to the support to protect the light emitting

means and the biological information detecting means, and the light travels from the light emitting means through the living body to the biological information detecting means. The grounding terminal and the translucent body project toward the living body side than the support body, the living body side end surface of the grounding terminal, and the translucent body The living body side end face is located on substantially the same plane, the grounding terminal has a loop shape, and is disposed so as to surround the translucent body. Measuring device.

7.

A light emitter that emits light to a detection site of a living body; a light receiver that receives reflected light from the living body according to light emitted by the light emitter and generates a biological information signal corresponding to the amount of received light; and the light receiving means A circuit that amplifies or converts the biological information signal generated by the device, a light-emitting body, a light-receiving body and a support that supports the circuit; A wound body that is wound to fix the support to the living body, and is electrically connected to at least one of the light emitter, the light receiver, and the circuit, and is supported by the support. A grounding terminal opposed to the living body and light attached to the support to protect the light emitting means and the biological information detecting means and from the light emitting means through the living body to the biological information detecting means Progress The grounding terminal and the translucent body protrude from the support body toward the living body side, the living body side end surface of the grounding terminal, and the translucent body The living body side end surface of the living body is located on substantially the same plane, the grounding terminal has a loop shape, and is disposed so as to surround the translucent body. Measuring device.

DESCRIPTION JPH11235320

[0001]

BACKGROUND OF THE INVENTION 1. Field of the Invention The present invention relates to a biological information measuring apparatus capable of optically measuring biological information such as a pulse rate.

[0002]

2. Description of the Related Art In order to obtain information such as the pulse rate of a living body, the light from the illuminant is irradiated on the living body, and the reflected light from the living body is received by a photosensor, thereby changing the reflected light corresponding to the pulse. Measurement technology has already been implemented. In such a technique, a light emitter, a photosensor, or a circuit that converts and amplifies an electric signal output from the photosensor is grounded. This grounding can be performed by bringing a grounding terminal into contact with the living body.

[0003]

It is desirable that the floating capacitance between the portion to be grounded and the living body is low and stable. However, in the past, since it was difficult to always bring the ground terminal into close contact with the living body during the measurement, the floating capacitance sometimes increased or fluctuated. In particular, when measurement is performed on a site

where muscle is developed, there is a high possibility that the ground terminal and the living body are separated when the living body is exercising. In particular, when the fluctuation of the reflected light from the living body is small due to a thick skin layer, the level of the output signal of the photosensor is small, so the influence of the floating capacitance is relatively large. As a result, the measurement accuracy was lowered.

[0004]

In order to always keep the grounding terminal in close contact with the living body, it is possible to take a measure by pressing the device attached to it with a band or the like with a strong holding force against the living body, but in that case, the band inevitably presses the living body. It becomes difficult to use for a long time because the strength becomes strong and the living body feels a high pressure feeling over a wide range. In particular, when the measurement is performed on a portion having a lot of unevenness on the skin surface, it must be pressed with a considerable force.

[0005]

The present invention has been made in view of the above circumstances, and an object thereof is to provide a biological information measuring apparatus capable of improving measurement accuracy while minimizing a feeling of pressure applied to a living body.

[0006]

In order to solve the above problems, a living body information measuring apparatus according to the present invention comprises a light emitting means for irradiating light to a detection site of a living body, and the living body relating to light emitted by the light emitting means. A living body information detecting means for receiving a reflected light from the living body and generating a living body information signal corresponding to the amount of received light, a circuit for amplifying or converting the living body information signal generated by the living body information detecting means, the light emitting means, Biological information detection means and a support body for supporting the circuit; Fixing means connected to the support body for fixing the support body to the living body; At least one of the light emitting means, the biological information detection means, and the circuit And the grounding terminal that is movably supported by the support and is opposed to the living body, and the fixing means fixes the support to the living body. Occasionally, characterized in that it comprises a biasing means for constantly urged toward the ground terminal to the living body.

[0007]
In another aspect, the biological information measuring apparatus according to the present invention receives a light emitting body that irradiates light on a detection portion of a living body and reflected light from the living body related to the light emitted by the light emitting body. A light receiving body that generates a biological information signal according to the amount of received light, a circuit that amplifies or converts the biological information signal generated by the light receiving means, the light emitting body, the light receiving body, and a support that supports the circuit; At least one of a wound body coupled to the support and wound around the living body in the vicinity of the detection site to fix the support to the living body, the light emitter, the light receiver, and the circuit. And the grounding terminal that is movably supported by the support and is opposed to the living body, and the support is fixed to the living body by the wound body. The grounding terminal Characterized in that it comprises a spring which constantly urged toward the body.

[0008]

According to the above configuration, when the support is fixed to the living body, the grounding terminal supported so as to be movable is always biased toward the living body by the biasing means or the spring.

In other words, since the necessary part is always grounded, the influence of the stray capacitance is always minimized.

Accordingly, the measurement accuracy is improved as compared with the conventional case.

The grounding is ensured by the biasing means or spring supported by the support, so that the range of pressure on the living body is narrow, the feeling of pressure felt by the living body is minimized, and the living body can withstand long-term measurements. It is possible.

[0009]

The support has a convex portion formed on a surface directed to the living body when fixed to the living body, and the convex portion protects the light emitting means and the biological information detecting means, and A translucent body that ensures the progress of light from the

light emitting unit through the living body to the biometric information detecting unit and the grounding terminal are attached, and the translucent body and the grounding terminal are more than the convex portion. You may make it protrude on the said biological body side. According to this, the grounding terminal protrudes to the living body side from the convex portion of the support. Therefore, the adhesion between the ground terminal and the living body is improved, and the measurement accuracy is further improved. In addition, since the translucent body protrudes more toward the living body than the convex portion of the support body, the adhesion between the translucent body and the living body can be improved, and the influence of external light on the biometric information detecting means can be reduced.

[0010]

Further, the biological information measuring apparatus according to the present invention includes a light emitting unit that irradiates light to a detection site of a living body, and a living body that receives reflected light from the living body related to the light irradiated by the light emitting unit and that corresponds to the amount of light received. Biological information detection means for generating an information signal, a circuit for amplifying or converting the biological information signal generated by the biological information detection means, the light emitting means, the biological information detection means, and a support for supporting the circuit, The fixing means coupled to the support body and electrically connected to at least one of a fixing means for fixing the support body to the living body, the light emitting means, the biological information detection means, and the circuit. A grounding terminal supported and opposed to the living body, and attached to the supporting body to protect the light emitting means and the biological information detecting means, and from the light emitting means to the living body. A translucent body that ensures the progress of light reaching the biological information detecting means, and the grounding terminal and the translucent body protrude toward the living body from the support, and the grounding terminal The living body side end face and the living body side end face of the translucent body are located on substantially the same plane, and the grounding terminal has a loop shape so as to surround the translucent body. It may be characterized by being arranged.

[0011]

Furthermore, in another aspect, the biological information measuring apparatus according to the present invention receives a light emitting body that irradiates light on a detection site of the living body and reflected light from the living body that is related to the light emitted by the light emitting body. A light receiving body that generates a biological information signal according to the amount, a circuit that amplifies or converts the biological information signal generated by the light receiving means, the light emitting body, the light receiving body, and a support that supports the circuit; At least one of a wound body coupled to a support body and wound around the living body in the vicinity of the detection site, and fixing the support body to the living body,

the light emitter, the light receiver, and the circuit And a grounding terminal supported by the support and opposed to the living body, and attached to the support to protect the light emitting means and the biological information detection means. The light emission A translucent body that ensures the progress of light from the stage through the living body to the biometric information detecting means, and the grounding terminal and the translucent body protrude toward the living body from the support, The living body side end surface of the grounding terminal and the living body side end surface of the translucent body are located on substantially the same plane, and the grounding terminal has a loop shape, It is arranged so as to surround the body.

[0012]

As described above, the end face of the grounding terminal and the end face of the translucent body are positioned on substantially the same plane, and the grounding terminal is arranged around the translucent body in a loop shape, so that the end face of the grounding terminal and the translucent body The pressure applied to the living body by the end surface of the body is made uniform.

Therefore, compared with the case where pressure concentrates, the feeling of pressure on the living body can be reduced.

Further, since the grounding terminal has a loop shape, for example, even if there is a relative movement between the living body and the support, the grounding terminal and the living body are not separated. In other words, since the necessary part is always grounded, the influence of the stray capacitance is always minimized. Accordingly, the measurement accuracy is improved as compared with the conventional case. Further, since the loop-shaped grounding terminal surrounds the light transmitting body, the influence of external light on the measurement can be prevented.

[0013]

DESCRIPTION OF THE PREFERRED EMBODIMENTS Various embodiments of the present invention will be described below with reference to the drawings. 1 . First Embodiment (1) Schematic Structure As shown in FIG. 1 and FIG. 2, the biological information measuring device according to the embodiment of the present invention is a wristwatch type, and a housing (with

various electric parts or electronic parts built in ((Support body) 10 and a wristband (fixing means, wound body) 20 which is connected to the housing 10 and wound around a human arm to fix the housing 10 to the arm.

[0014]

The wristband 20 in this embodiment has two band pieces 21 and 22. One end of the band piece 21 is connected to the lower end of the housing 10. The lower end of the band piece 22 is connected to the upper end of the housing 10. A method of connecting the band pieces 21 and 22 to the housing 10 is a known method using a spring bar 25 (see FIG. 3). As a material of the band pieces 21 and 22, a material that does not transmit light is selected in order to suppress a measurement error of a pulse wave sensor unit described later.

[0015]

As shown in FIG. 1, a buckle 26 and a tongue 27 are attached to the end of the band piece 22 far from the housing 10 in a known manner. On the other hand, a plurality of small holes 28 are formed in the band piece 22 at equal intervals along the longitudinal direction. The band piece 22 is inserted into the buckle 26, and the tongue 27 is passed through one of the small holes 28, whereby the biological information measuring device is fixed to the human arm, and the back surface of the housing 10 is in close contact with the back of the wrist. Then, by selecting the small hole 28 through which the tongue 27 is passed, the peripheral length of the device is adjusted.

[0016]

FIG. 3 shows a cross section of the housing 10. As shown in the figure, the housing 10 has an outer case 11 disposed on the front side and a back cover 12 disposed on the back side. The outer case 11 and the back cover 12 are fixed in combination with each other to form a space for accommodating various electric parts or electronic parts. As a material for the outer case 11 and the back cover 12, a material that does not transmit light is selected.

[0017]

A pulse wave sensor unit 100 is supported on the housing 10. The pulse wave sensor unit 100 is a reflective optical sensor, and includes a circuit board 101 disposed on the back cover 12 and an LED (Light Emitting Unit) mounted on the back surface of the circuit board 101. (Emitting Diode) 102 and a photodiode 103 (see FIG. 4) which is a photoreceptor (biological information detection means). The light emitted from the LED 102 travels downward in the figure and irradiates the wearer's wrist. Irradiation light is absorbed by wrist tissues, blood vessels, and the like, and the irradiation light that has escaped absorption is reflected. The reflected light is received by the photodiode 103, and the photodiode 103 generates an electric signal corresponding to the intensity of the received light.

[0018]

A through hole is formed in the center of the back cover 12, and a transparent glass 104 is fixed so as to cover the through hole. The transparent glass 104 allows light transmission for the LED 102 and the photodiode 103 and at the same time protects them.

[0019]
Although not shown in FIG. 3, an OP amplifier 106 and resistors 107a and 107b (see FIG. 5), which will be described later, are mounted on the circuit board 101. These electric components amplify and output the output signal of the photodiode 103. It is supposed to be converted.

[0020]

A main board 110 is disposed in the internal space of the housing 10.

The main board 110 is provided with a data processing circuit 111 including an IC component such as a CPU (Central Processing Unit) described later. On the back side of the main board 110, a battery 112 serving as a power source of the biological information measuring apparatus is disposed. The battery 112 is connected to a circuit on the main board 110. Further, a liquid crystal display device 113 is disposed on the front side of the main substrate 110. On the front side of the liquid crystal display device 113, a transparent glass 114 that allows the liquid crystal display device 113 to be visible and protects the liquid crystal display device 113 is disposed. The transparent glass 114 is supported by the outer case 11 of the housing 10. The liquid crystal display device 113 displays the pulse rate (biological information) that is the measurement result

of the pulse wave sensor unit 100.

[0021]

In this embodiment, the circuit provided on the main board 110 has a function of counting time and date as in a normal digital clock. The liquid crystal display device 113 can display time and date in addition to the above pulse rate. In the liquid crystal display device 113 shown in FIG. 1, "10:08" represents time, and "127" represents pulse rate. As shown in FIG. 1, the outer case 11 of the housing 10 is provided with button switches 116 and 117 for performing time adjustment, display mode switching, and the like.

[0022]

The main board 110 and the pulse wave sensor unit 100 are connected to each other by a connector (not shown). Thus, power is supplied from the main board 110 to the pulse wave sensor unit 100, and a pulse wave signal is supplied from the pulse wave sensor unit 100 to the main board 110.

[0023]

(2) Pulse Detection FIG. 5 shows details of the pulse wave sensor unit 100. As shown in the figure, a positive voltage + V is applied to the anode of the LED 102, and its cathode is grounded via a resistor 107a and a conducting wire 108a. The grounding is performed by bringing a grounding terminal 140 described later into contact with the wrist surface of the subject. Since the resistor 107a acts as a current limiting resistor, a desired current flows through the LED 102.

[0024]

A positive voltage + V is applied to the cathode of the photodiode 103, and an anode is connected to the negative input terminal of the OP amplifier 106. The output signal of the OP amplifier 106 is fed back to the negative input terminal via the resistor 107b. The input impedance of the OP amplifier 106 is extremely high and the gain is also large.

[0025]

Further, the positive input terminal of the OP amplifier 106 is grounded via a conducting wire 108b. This grounding is performed by bringing a grounding terminal 141 described later into contact with the wrist surface of the subject. Thus, since the positive input terminal of the OP amplifier 106 is grounded, the anode of the photodiode 103 is imaginarily shorted to the ground. Therefore, the photodiode 103 is reverse-biased, and when light is incident thereon, a current corresponding to the amount of light flows. This current is larger as the incident light is stronger. The OP amplifier 106 and the resistor 107b convert the current from the photodiode 103 into a voltage and amplify it. That is, the output signal Vm of the OP amplifier 106 varies according to the amount of incident light.

[0026]

The principle of the pulse wave sensor unit 100 will be described with reference to FIG. In the figure, T is the epidermis of the living body to be detected, and C is capillaries and arterioles. A living tissue is formed between the epidermis T and the blood vessel C. And blood flows inside the blood vessel C. Part of the light emitted from the LED 102 is absorbed by the biological tissue and hemoglobin in the blood, and the other part is reflected by the biological tissue, and the reflected light is received by the photodiode 103. The photodiode 103 outputs an electrical signal according to the amount of received light. Therefore, the output signal of the photodiode 103 reflects absorption by living tissue and absorption by hemoglobin in blood.

[0027]

FIG. 7 is a diagram showing fluctuations in absorbance when light is externally applied to a human blood vessel, where I2 is a light absorption component due to tissue, I3 is a light absorption component due to venous blood, and I4 is a light absorption component due to arterial blood. The tissue absorption component I2 is constant because the tissue concentration does not change. The light absorption component I3 due to venous blood is also constant. This is because there is no pulsation in the vein and no change in concentration.

[0028]

As shown in FIG. 8, the blood pressure related to the pulsation of blood pumped out from the heart is generally higher and more fluctuating as the blood vessel is closer to the heart, and lower and not fluctuating in the vein. Therefore, the output current of the photodiode 103 varies according to the pulsation of the artery. Therefore, the output signal Vm of the OP amplifier 106 obtained by amplifying the output of the photodiode 103 can be regarded as a pulse wave signal.

[0029]

FIG. 9 is a functional block diagram of the data processing circuit 111 of the main board 110. The pulse wave signal Vm generated by the pulse wave sensor unit 100 is supplied to the pulse wave signal converter 120, and the pulse wave signal converter 120 converts the pulse wave signal Vm from an analog signal to a digital signal (pulse wave data MD). . The pulse wave data MD is transferred to a storage unit 121 configured by a RAM (Random Access Memory) or the like, and the storage unit 121 stores pulse wave data MD for a predetermined period.

[0030]

The pulse wave data MD is read from the storage unit 121 at a constant cycle, and the read pulse wave data MD is transferred to the frequency analysis unit 122. The frequency analyzing unit 122 performs frequency analysis on the pulse wave data MD to generate pulse wave analysis data MKD. There are various frequency analysis methods. In this example, FFT (Fast Fourier Transform) is used so that analysis can be performed in a short calculation time.

[0031]

Next, the pulse wave analysis data MKD is supplied to the pulse rate calculation unit 123, and the pulse rate calculation unit 123 calculates the pulse rate HR based on the pulse wave analysis data MKD. In this calculation, the pulse rate calculation unit 123 specifies the peak of the spectrum intensity of the pulse wave analysis data MKD, and calculates the frequency Fh based on the time between the peaks. Since the frequency Fh is the fundamental frequency of the pulse wave signal Vm, the pulse rate calculator 58 calculates the pulse rate HR, which is the number of pulses per minute, using the following equation. $HR = 60Fh$

[0032]
When the S / N ratio of the pulse wave signal Vm is sufficiently high, the pulse wave signal Vm is simply shaped and converted into a rectangular wave without using frequency analysis, the period of the rectangular wave is obtained, and the pulse rate HR May be displayed.

[0033]

The pulse rate HR calculated in this way is displayed on the liquid crystal display device 13.

The pulse of the subject can be known in this way.

[0034]

(3) Details of Earth Terminals Returning to FIGS. 3 and 4, details of the earth terminals 140 and 141 for grounding shown in FIG. 5 will be described. A convex portion 130 is formed on the back side surface of the back cover 12 of the housing 10, that is, the surface facing the wrist surface of the subject. The convex portion 130 has a truncated cone shape, and the surface on the back side is a flat surface 131. A portion corresponding to the convex portion 130 is thickened, and a housing concave portion into which the circuit board 101 is fitted is formed on the front surface thereof. Two holes 132 having a circular cross section opening toward the housing recess are formed in the thick portion.

[0035]

In addition, two through holes 133 having a circular cross section are formed in the thick portion, and the through holes 133 are coaxially connected to the holes 132, respectively. The body portions of the ground terminals 140 and 141 are inserted into the through holes 133, respectively.

[0036]

Each of the grounding terminals 140 and 141 is made of a conductor, and has a head portion 142, a trunk portion 143, an engaging portion 144, and an end flange 145 as shown in FIG. Each of these portions has a circular cross section and is connected coaxially. The head 142 has a diameter larger than the diameter of the through hole 133, and the body 143 has a diameter slightly smaller than the diameter of the through hole 133. A circumferential groove 146 is formed at the center of the body portion 143, and a rubber waterproof packing 150 shown in FIG. The waterproof packing 150 seals between the through hole 133 and the grounding terminal, and prevents water from entering the circuit board 101.

[0037]

The engaging portion 144 of each of the ground terminals 140 and 141 has a diameter smaller than the diameters of the end flange 145 and the trunk portion 143. A C-shaped ring 151 made of a conductor shown in FIG. 3 is fitted therein. The C-shaped ring 151 and the head 142 prevent the grounding terminals 140 and 141 from dropping from the through hole 133. However, since the length of the body portion 143 is longer than the length of the through hole 133, each of the ground terminals 140 and 141 can slide through the through hole 133 along the axial direction thereof.

[0038]

Further, conductor coil springs (biasing means) 152 are arranged in the holes 132 so as to be coaxial with the grounding terminals 140 and 141, respectively. Each spring 152 is compressed in the axial direction by the circuit board 101 and the C-shaped ring 151. Therefore, the C-shaped ring 151 and the grounding terminals 140 and 141 are always urged downward in the drawing by the reaction force generated by the spring 152. As shown in FIG. 3, the C-shaped ring 151 contacts the bottom surface of the hole 132 unless a force is applied to the grounding terminals 140 and 141 from below.

[0039]

As is clear from the above, the spring 152 is always in contact with the circuit board 101. In the circuit board 101, both springs 152 are in contact with each other at the positions of the conductor 108 a connected to the resistor 107 a shown in FIG. 3 and the conductor 108 b

connected to the positive input terminal of the OP amplifier 106. Thereby, the grounding terminal 140 is electrically connected to the conducting wire 108a through the corresponding C-shaped ring 151 and the spring 152, and the grounding terminal 141 is similarly electrically connected to the conducting wire 108b.

[0040]

When the wristband 20 is wound around the wrist W of the subject and the biological information measuring device is fixed to the wrist W as shown in FIG. 11, the ground terminals 140 and 141 are always in contact with the skin surface of the wrist W. This is because the grounding terminals 140 and 141 can move along the normal direction of the skin surface of the wrist W and are biased toward the wrist W by the spring 152. Due to the biasing force of the spring 152, this contact state is maintained even if a movement such as twisting the wrist W is performed. This measurement is particularly effective because there is a possibility of movement of the subject in the measurement at a site where the muscle has developed like the wrist W.

[0041]

Accordingly, the necessary portions (the conductive wires 108a and 108b) are always grounded. For this reason, the influence of the floating capacitance between the place to be grounded and the body of the subject is always minimized, and the measurement accuracy is improved. In the measurement site where the skin surface layer is thick like the wrist W, the fluctuation of the reflected light is small and the level of the output signal of the photodiode 103 is small. However, since the influence of the floating capacitance is reduced in this way, the measurement accuracy can be greatly improved.

[0042]

It is the spring 152 supported by the housing 10 that ensures this grounding. Accordingly, it is not necessary to strongly tighten the wrist W with the wristband 20, and the range in which the wrist W is pressed is narrow. For this reason, the feeling of pressure felt by the subject is minimized, and the subject can withstand long-term measurement.

[0043]

Further, the grounding terminals 140 and 141 are attached to the convex portion 130 of the wrist W directed to the wrist W, and the grounding terminals 140 and 141 are projected to the wrist W side from the convex portion 130. The adhesion between the ground terminals 140 and 141 and the skin surface of the subject is improved, and the measurement accuracy is further improved. Similarly, since the transparent glass 104 is attached to the convex portion 130 and the transparent glass 104 is protruded to the wrist W side from the convex portion 130, the adhesion between the transparent glass 104 and the skin surface of the subject is improved. It is possible to improve and reduce the influence of external light on the photodiode 103.

[0044]

Further, as shown in FIG. 11, the wrist W side end surface of the ground terminals 140 and 141 and the wrist W side end surface of the transparent glass 104 are substantially the same when pressed against the skin surface of the wrist W. The force of the spring 152 is set so as to lie on the plane. For this reason, the pressure applied to the wrist W by the end surfaces of the ground terminals 140 and 141 and the end surface of the transparent glass 104 is made uniform. Therefore, it is possible to reduce the feeling of pressure on the subject as compared with the case where pressure is concentrated.

[0045]

Further, a necessary portion of the circuit board 101 and the ground terminals 140 and 141 are electrically connected by a conductor C-shaped ring 151 attached to the ground terminals 140 and 141 and a spring 152. In this way, by using the conductor spring 152 for connection, a dedicated wiring can be eliminated. That is, since the number of parts can be reduced, the manufacturing cost can be reduced.

[0046]

In the above embodiment, the conductive wire 108a of FIG. 5 is connected to the grounding terminal 140 and the conductive wire 108b is connected to the grounding terminal 141. You may make it connect.

[0047]

2.

Second Embodiment Next, a second embodiment according to the present invention will be described with reference to FIGS. In addition, the same code | symbol is attached | subjected to the component in 1st Embodiment, and the description is abbreviate | omitted. Since the schematic structure and pulse detection of the biological information measuring device of the second embodiment are the same as those of the first embodiment, details of the ground terminal will be described below.

[0048]

The back cover 12 of the housing 10 is provided with a convex portion 130 similar to that of the first embodiment, and a ring-shaped (loop-shaped) ground terminal 160 is attached to the flat surface 131. The grounding terminal 160 is disposed so as to surround the transparent glass 104.

[0049]

As shown in FIG. 13, the grounding terminal 160 is fixed to the flat surface 131 of the convex portion 130 at two locations (positions of the screws 165). Details of the attachment are shown in FIG. A through hole 162 having a circular cross section is formed in the convex portion 130, and a cylindrical pin 163 made of a conductor is inserted into the through hole 162. Female screws are formed at upper and lower ends of the inner peripheral surface of the pin 163. Screws 164 whose body part penetrates the circuit board 101 and screws 165 whose body part penetrates the grounding terminal 160 are respectively screwed into these female screws.

[0050]

In this way, the ground terminal 160 is fixed to the convex portion 130. Further, the screws 164 and 165 and the pin 163 are made of a conductor, so that the circuit board 101 is electrically connected to the grounding terminal 160. In the circuit board 101, the two screws 164 are in contact with each other at the positions of the conductive wires 108 a and 108 b shown in FIG. 5,

whereby the conductive wires 108 a and 108 b are electrically connected to the ground terminal 160.

[0051]

As shown in FIG. 12, the grounding terminal 160 and the transparent glass 104 protrude toward the subject's wrist W from the flat surface 131 of the convex portion 130, the wrist W side end surface of the grounding terminal 160, and the transparent glass 104. The end surface on the wrist W side is located on substantially the same plane. Therefore, when the wristband 20 is wound around the wrist W of the subject and the biological information measuring device is fixed to the wrist W, the grounding terminal 160 contacts the skin surface of the wrist W. Accordingly, the necessary portions (conductive wires 108a and 108b) are grounded.

[0052]

As shown in FIG. 14, a circumferential groove is formed on the outer periphery of the pin 163, and a rubber waterproof packing 167 is provided here. The waterproof packing 167 seals between the through hole 162 and the grounding terminal, and prevents water from entering the circuit board 101.

[0053]

In this embodiment, the end face of the grounding terminal 160 and the end face of the transparent glass 104 are positioned on substantially the same plane, and the grounding terminal 160 is arranged around the transparent glass 104 as a loop shape. The pressure applied to the subject by the end face 160 and the end face of the transparent glass 104 is made uniform. Therefore, it is possible to reduce the feeling of pressure on the subject as compared with the case where pressure is concentrated.

[0054]

Further, since the ground terminal 160 has a loop shape, the ground terminal 160 and the wrist W are not separated even if there is a relative movement between the wrist W and the housing

10. For this reason, the influence of the floating capacitance between the place to be grounded and the body of the subject is always minimized, and the measurement accuracy is improved. In the measurement site where the skin surface layer is thick like the wrist W, the fluctuation of the reflected light is small and the level of the output signal of the photodiode 103 is small. However, since the influence of the floating capacitance is reduced in this way, the measurement accuracy can be greatly improved. Moreover, in the measurement in the site ¦ part where the muscle developed like the wrist W, since there exists a possibility of a test subject's exercise ¦ movement, this advantage is especially effective. Furthermore, since the loop-shaped grounding terminal surrounds the transparent body, the influence of external light on the measurement can be prevented.

[0055]

3、 In the above-described embodiment, the buckle 26, the tongue 27, and the small hole 28 are provided with the circumference adjusting mechanism. However, the circumference adjusting mechanism is not limited to this example. For example, a Velcro tape, A button or the like may be used. For example, if a medical supporter belt made of a highly stretchable material is used, the circumference adjustment mechanism may not be provided.

[0056]

Various circuits other than the circuit illustrated in FIG. 5 can be used as the pulse wave sensor unit using the reflective optical sensor. The present invention can be applied to the grounding of various pulse wave sensor unit circuits in addition to the grounding of the circuit shown in FIG.

[0057]

The biological information measuring device of the above embodiment is a wristwatch type wound around the wrist W. However, the present invention is not limited to this, and the present invention can also be applied to detection of other parts such as fingers and ankles.

[0058]

The locations of the ground terminals 140, 141, 160 and the transparent glass 104 are not limited to those shown in the figure, and may be at other positions as long as contact with a living body is possible.

[0059]
As described above, according to the present invention, the measurement accuracy can be improved while minimizing the feeling of pressure applied to the living body.

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報（Ａ）**　(11)特許出願公開番号

特開平11－235320

(43)公開日　平成11年(1999)８月31日

(51)Int.Cl.[6]	識別記号	ＦＩ	
Ａ６１Ｂ　5/0245		Ａ６１Ｂ　5/02	３２０Ｂ
			３２１Ｂ

審査請求　未請求　請求項の数７　ＯＬ　（全 12 頁）

(21)出願番号　特願平10－40675

(22)出願日　平成10年(1998)２月23日

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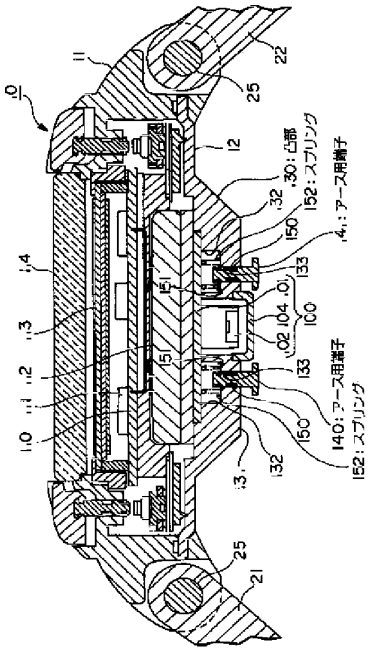
(54)【発明の名称】　生体情報計測装置

(57)【要約】
【課題】生体へ与える圧迫感を最小限としながらも、測定精度を向上させる。
【解決手段】反射型光学センサであって脈拍数を検出する脈波センサユニット１００と、このセンサユニットを内蔵するハウジング１０と、ハウジング１０を生体に固定するリストバンド２０とを有する生体情報計測装置を改良する。ハウジング１０の裏蓋１２に形成された凸部１３０には、移動可能にアース用端子１４０，１４１が取り付けられている。アース用端子１４０，１４１は、導体製のスプリング１５２を介して、脈波センサユニット１００の回路基板１０１の必要箇所に接続されている。装置を生体に装着すると、アース用端子１４０，１４１はスプリング１５２により常に生体に接触し、回路基板１０１の必要箇所の接地が維持される。



【特許請求の範囲】
【請求項１】　生体の検出部位に光を照射する発光手段と、
前記発光手段が照射した光に係る前記生体からの反射光を受光して受光量に応じた生体情報信号を生成する生体情報検出手段と、
前記生体情報検出手段の生成した前記生体情報信号を増幅または変換する回路と、
前記発光手段、前記生体情報検出手段および前記回路を支持する支持体と、
前記支持体に連結され、前記支持体を前記生体に固定する固定手段と、
前記発光手段、前記生体情報検出手段および前記回路の少なくとも一つに電気的に接続されていると共に、前記支持体に移動可能に支持されて前記生体に対向させられたアース用端子と、
前記固定手段により前記支持体が前記生体に固定されているときに、前記アース用端子を前記生体に向けて常に付勢する付勢手段とを備えることを特徴とする生体情報計測装置。
【請求項２】　前記支持体には、前記生体に固定されるときに、前記生体に向けられる面に凸部が形成されており、
前記凸部には前記発光手段および前記生体情報検出手段を保護すると共に、前記発光手段から前記生体を経て前記生体情報検出手段に至る光の進行を確保する透光体と、前記アース用端子が取り付けられており、前記透光体と前記アース用端子は前記凸部よりも前記生体側に突出させられていることを特徴とする請求項１に記載の生体情報計測装置。
【請求項３】　生体の検出部位に光を照射する発光体と、
前記発光体が照射した光に係る前記生体からの反射光を受光して受光量に応じた生体情報信号を生成する受光体と、
前記受光手段の生成した前記生体情報信号を増幅または変換する回路と、
前記発光体、前記受光体および前記回路を支持する支持体と、
前記支持体に連結され、前記検出部位の付近の前記生体の周囲に巻回されて、
前記支持体を前記生体に固定する巻回体と、
前記発光体、前記受光体および前記回路の少なくとも一つに電気的に接続されていると共に、前記支持体に移動可能に支持されて前記生体に対向させられたアース用端子と、
前記巻回体により前記支持体が前記生体に固定されているときに、前記アース用端子を前記生体に向けて常に付勢するスプリングとを備えることを特徴とする生体情報計測装置。
【請求項４】　前記支持体には、前記生体に固定されるときに、前記生体に向けられる面に凸部が形成されており、
前記凸部には前記発光体および前記受光体を保護すると共に、前記発光体から前記生体を経て前記受光体に至る光の進行を確保する透光体と、前記アース用端子とが取り付けられており、前記透光体と前記アース用端子は前記凸部よりも前記生体側に突出させられていることを特徴とする請求項３に記載の生体情報計測装置。
【請求項５】　前記アース用端子の前記生体側の端面と、前記透光体の前記生体側の端面は、前記生体に向けて押し付けられたときに、ほぼ同一の平面上に位置するようにされたことを特徴とする請求項２または４に記載の生体情報計測装置。
【請求項６】　生体の検出部位に光を照射する発光手段と、
前記発光手段が照射した光に係る前記生体からの反射光を受光して受光量に応じた生体情報信号を生成する生体情報検出手段と、
前記生体情報検出手段の生成した前記生体情報信号を増幅または変換する回路と、
前記発光手段、前記生体情報検出手段および前記回路を支持する支持体と、
前記支持体に連結され、前記支持体を前記生体に固定する固定手段と、
前記発光手段、前記生体情報検出手段および前記回路の少なくとも一つに電気的に接続されていると共に、前記支持体に支持されて前記生体に対向させられたアース用端子と、
前記支持体に取り付けられて、前記発光手段および前記生体情報検出手段を保護すると共に、前記発光手段から前記生体を経て前記生体情報検出手段に至る光の進行を確保する透光体とを備え、
前記アース用端子および前記透光体は前記支持体よりも前記生体側に突出していると共に、前記アース用端子の前記生体側の端面と、前記透光体の前記生体側の端面はほぼ同一の平面上に位置しており、
前記アース用端子はループ形状を有しており、前記透光体を取り囲むように配置されていることを特徴とする生体情報計測装置。
【請求項７】　生体の検出部位に光を照射する発光体と、
前記発光体が照射した光に係る前記生体からの反射光を受光して受光量に応じた生体情報信号を生成する受光体と、
前記受光手段の生成した前記生体情報信号を増幅または変換する回路と、
前記発光体、前記受光体および前記回路を支持する支持体と、
前記支持体に連結され、前記検出部位の付近の前記生体

の周囲に巻回されて、前記支持体を前記生体に固定する巻回体と、
前記発光体、前記受光体および前記回路の少なくとも一つに電気的に接続されていると共に、前記支持体に支持されて前記生体に対向させられたアース用端子と、
前記支持体に取り付けられて、前記発光手段および前記生体情報検出手段を保護すると共に、前記発光手段から前記生体を経て前記生体情報検出手段に至る光の進行を確保する透光体とを備え、
前記アース用端子および前記透光体は前記支持体よりも前記生体側に突出していると共に、前記アース用端子の前記生体側の端面と、前記透光体の前記生体側の端面はほぼ同一の平面上に位置しており、
前記アース用端子はループ形状を有しており、前記透光体を取り囲むように配置されていることを特徴とする生体情報計測装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、光学的に脈拍数等の生体情報を計測することができる生体情報計測装置に関する。
【０００２】
【従来の技術】生体の脈拍数等の情報を得るため、発光体からの光を生体に照射し、生体からの反射光をフォトセンサで受光することにより、脈拍に対応する反射光の変動を計測する技術がすでに実施されている。かかる技術においては、発光体、フォトセンサ、またはそのフォトセンサの出力した電気信号を変換および増幅する回路を接地させている。この接地は、生体にアース用端子を接触させることにより行うことができる。
【０００３】
【発明が解決しようとする課題】上記の接地されるべき箇所と生体との間の浮遊静電容量は低く、かつ安定しているのが望ましい。しかし、従来は、測定の間、常にアース用端子を生体に密着させることが難しかったため、浮遊静電容量が高くなったり、変動したりすることがあった。特に、筋肉が発達している部位に対して測定を行う場合に、生体が運動している時には、アース用端子と生体とが離れる可能性が大きかった。また、特に、皮膚表面の層が厚いなどの理由により、生体からの反射光の変動が小さい場合には、フォトセンサの出力信号のレベルが小さいため、相対的に浮遊静電容量の影響が大きくなり、測定精度の低下をもたらしていた。
【０００４】アース用端子を常に生体に密着させるには、これが付属している装置を生体に強い保持力でバンドなどにより押し付けるという方策も採りうるが、その場合には、必然的にバンドが生体を圧迫する力が強くなり、生体が広い範囲にわたって高い圧迫感を感じ取るため、長時間の使用が難しい。特に、皮膚表面の凹凸が多い部位に対して測定を行う場合には、かなりの力で押圧しなければならない。
【０００５】本発明は上記の事情を考慮してなされたものであり、生体へ与える圧迫感を最小限としながらも、測定精度を向上させることができる生体情報計測装置を提供することを目的とする。
【０００６】
【課題を解決するための手段】上記課題を解決するため、本発明に係る生体情報計測装置は、生体の検出部位に光を照射する発光手段と、前記発光手段が照射した光に係る前記生体からの反射光を受光して受光量に応じた生体情報信号を生成する生体情報検出手段と、前記生体情報検出手段の生成した前記生体情報信号を増幅または変換する回路と、前記発光手段、前記生体情報検出手段および前記回路を支持する支持体と、前記支持体に連結され、前記支持体を前記生体に固定する固定手段と、前記発光手段、前記生体情報検出手段および前記回路の少なくとも一つに電気的に接続されていると共に、前記支持体に移動可能に支持されて前記生体に対向させられたアース用端子と、前記固定手段により前記支持体が前記生体に固定されているときに、前記アース用端子を前記生体に向けて常に付勢する付勢手段とを備えることを特徴とする。
【０００７】また、本発明の生体情報計測装置は、別の観点からいえば、生体の検出部位に光を照射する発光体と、前記発光体が照射した光に係る前記生体からの反射光を受光して受光量に応じた生体情報信号を生成する受光体と、前記受光手段の生成した前記生体情報信号を増幅または変換する回路と、前記発光体、前記受光体および前記回路を支持する支持体と、前記支持体に連結され、前記検出部位の付近の前記生体の周囲に巻回されて、前記支持体を前記生体に固定する巻回体と、前記発光体、前記受光体および前記回路の少なくとも一つに電気的に接続されていると共に、前記支持体に移動可能に支持されて前記生体に対向させられたアース用端子と、前記巻回体により前記支持体が前記生体に固定されているときに、前記アース用端子を前記生体に向けて常に付勢するスプリングとを備えることを特徴とする。
【０００８】上記構成によれば、支持体が生体に固定されているときに、移動可能に支持されたアース用端子は常に付勢手段またはスプリングにより生体に向けて付勢される。つまり必要な箇所が常に接地されるので、浮遊静電容量の影響は常に最小限になる。従って、従来よりも測定精度が向上する。この接地を確保するのは、支持体に支持された付勢手段またはスプリングであるので、生体を圧迫する範囲は狭く、生体が感じ取る圧迫感も最小限となり、長期間の測定にも生体が耐えることが可能である。
【０００９】前記支持体には、前記生体に固定されるときに、前記生体に向けられる面に凸部が形成されており、前記凸部には前記発光手段および前記生体情報検出

手段を保護すると共に、前記発光手段から前記生体を経て前記生体情報検出手段に至る光の進行を確保する透光体と、前記アース用端子が取り付けられており、前記透光体と前記アース用端子は前記凸部よりも前記生体側に突出させられているようにしてもよい。これによれば、アース用端子が支持体の凸部よりも生体側に突出する。従って、アース用端子と生体との密着性が向上し、測定精度がさらに向上する。しかも、透光体が支持体の凸部よりも生体側に突出するので、透光体と生体との密着性も向上し、外光が生体情報検出手段に影響を与えるのも削減できる。

【００１０】また、本発明に係る生体情報計測装置は、生体の検出部位に光を照射する発光手段と、前記発光手段が照射した光に係る前記生体からの反射光を受光して受光量に応じた生体情報信号を生成する生体情報検出手段と、前記生体情報検出手段の生成した前記生体情報信号を増幅または変換する回路と、前記発光手段、前記生体情報検出手段および前記回路を支持する支持体と、前記支持体に連結され、前記支持体を前記生体に固定する固定手段と、前記発光手段、前記生体情報検出手段および前記回路の少なくとも一つに電気的に接続されていると共に、前記支持体に支持されて前記生体に対向させられたアース用端子と、前記支持体に取り付けられて、前記発光手段および前記生体情報検出手段を保護すると共に、前記発光手段から前記生体を経て前記生体情報検出手段に至る光の進行を確保する透光体とを備え、前記アース用端子および前記透光体は前記支持体よりも前記生体側に突出していると共に、前記アース用端子の前記生体側の端面と、前記透光体の前記生体側の端面はほぼ同一の平面上に位置しており、前記アース用端子はループ形状を有しており、前記透光体を取り囲むように配置されていることを特徴とするものでもよい。

【００１１】さらに、本発明に係る生体情報計測装置は、別の観点では、生体の検出部位に光を照射する発光体と、前記発光体が照射した光に係る前記生体からの反射光を受光して受光量に応じた生体情報信号を生成する受光体と、前記受光手段の生成した前記生体情報信号を増幅または変換する回路と、前記発光体、前記受光体および前記回路を支持する支持体と、前記支持体に連結され、前記検出部位の付近の前記生体の周囲に巻回されて、前記支持体を前記生体に固定する巻回体と、前記発光体、前記受光体および前記回路の少なくとも一つに電気的に接続されていると共に、前記支持体に支持されて前記生体に対向させられたアース用端子と、前記支持体に取り付けられて、前記発光手段および前記生体情報検出手段を保護すると共に、前記発光手段から前記生体を経て前記生体情報検出手段に至る光の進行を確保する透光体とを備え、前記アース用端子および前記透光体は前記支持体よりも前記生体側に突出していると共に、前記アース用端子の前記生体側の端面と、前記透光体の前記生体側の端面はほぼ同一の平面上に位置しており、前記アース用端子はループ形状を有しており、前記透光体を取り囲むように配置されていることを特徴とする。

【００１２】このようにアース用端子の端面と透光体の端面をほぼ同一の平面上に位置させ、アース用端子をループ形状として透光体の周囲に配置したことにより、アース用端子の端面と透光体の端面が生体に与える圧力が均一化される。従って、圧力が集中する場合に比べて、生体への圧迫感をやわらげることができる。また、アース用端子がループ形状となることにより、例えば生体と支持体との間で相対移動があっても、アース用端子と生体とが離れることがない。つまり必要な箇所が常に接地されるので、浮遊静電容量の影響は常に最小限になる。従って、従来よりも測定精度が向上する。また、ループ形状のアース用端子が透光体を取り囲むことにより、測定に対する外光の影響を防止できる。

【００１３】

【発明の実施の形態】以下、図面を参照して本発明の様々な実施形態について説明する。

１．第１実施形態

（１）　概略構造

図１および図２に示すように、本発明に係る実施形態の生体情報計測装置は、腕時計型であって、各種の電気部品または電子部品を内蔵したハウジング（支持体）１０と、ハウジング１０に連結され人間の腕に巻回されてハウジング１０を腕に固定するリストバンド（固定手段、巻回体）２０とを備える。

【００１４】この実施形態におけるリストバンド２０は２つのバンド片２１，２２を有する。バンド片２１の一端は、ハウジング１０の下端に連結されている。バンド片２２の下端は、ハウジング１０の上端に連結されている。バンド片２１，２２のハウジング１０に対する連結方式は、バネ棒２５（図３参照）を用いた公知のものである。バンド片２１，２２の素材としては、後述する脈波センサユニットの測定誤差を抑えるため、光を透過させないものが選ばれる。

【００１５】図１に示すように、ハウジング１０から遠い方のバンド片２２の端部には、公知の形式でバックル２６とタング２７が取り付けられている。一方、バンド片２２には、その長手方向に沿って等間隔に複数の小孔２８が形成されている。バンド片２２はバックル２６に挿入され、いずれかの小孔２８にタング２７を通すことにより、この生体情報計測装置は人間の腕に固定され、ハウジング１０の裏面が手首の甲に密着する。そして、タング２７を通す小孔２８を選択することにより、装置の周長が調節される。

【００１６】図３にハウジング１０の断面を示す。同図に示すように、ハウジング１０は、表側に配置された外側ケース１１と裏側に配置された裏蓋１２とを有する。外側ケース１１と裏蓋１２は互いに組み合わせられて固

定され、内部に各種の電気部品または電子部品を収容する空間を形成している。外側ケース１１および裏蓋１２の素材としては、光を透過させないものが選ばれる。

【００１７】ハウジング１０には、脈波センサユニット１００が支持されている。脈波センサユニット１００は、反射型光学センサであって、裏蓋１２の上に配置された回路基板１０１と、この回路基板１０１の裏面に実装された発光体（発光手段）であるＬＥＤ（Light Emitting Diode）１０２と、受光体（生体情報検出手段）であるフォトダイオード１０３（図４参照）とを有する。ＬＥＤ１０２から発した光は、図中の下方に向かって進み、装着者の手首を照射する。照射光は手首の組織や血管などによって吸収され、吸収を免れた照射光が反射される。その反射光はフォトダイオード１０３により受光され、フォトダイオード１０３は受光の強度に応じた電気信号を発生する。

【００１８】裏蓋１２の中央には貫通穴が形成されており、この貫通穴を覆うように透明ガラス１０４が固定されている。透明ガラス１０４は、ＬＥＤ１０２とフォトダイオード１０３のために光の透過を許容すると同時に、これらを保護する。

【００１９】図３には示さないが、回路基板１０１には、後述するＯＰアンプ１０６や抵抗１０７ａ，１０７ｂなど（図５参照）が実装されており、これらの電気部品によりフォトダイオード１０３の出力信号が増幅・変換されるようになっている。

【００２０】また、ハウジング１０の内部空間には、メイン基板１１０が配置されている。メイン基板１１０には、後述するＣＰＵ（中央演算装置）などのＩＣ部品を含むデータ処理回路１１１が設けられている。メイン基板１１０の裏側には、この生体情報計測装置の電源となる電池１１２が配置されており、この電池１１２はメイン基板１１０上の回路に接続されている。さらに、メイン基板１１０の表側には液晶表示装置１１３が配置されている。液晶表示装置１１３の表側には、液晶表示装置１１３の視認を可能にするとともにこれを保護する透明ガラス１１４が配置され、この透明ガラス１１４はハウジング１０の外側ケース１１に支持されている。液晶表示装置１１３には、脈波センサユニット１００の計測結果である脈拍数（生体情報）が表示される。

【００２１】また、この実施形態では、メイン基板１１０に設けられた回路が、通常のディジタル時計と同様に、時刻および日付をカウントする機能を有する。液晶表示装置１１３は、上記の脈拍数に加えて、時刻および日付を表示させることも可能である。図１に示す液晶表示装置１１３において、「10:08」は時刻を表し、「127」は脈拍数を表す。図１に示すように、ハウジング１０の外側ケース１１には、時刻合わせや表示モードの切換などを行うためのボタンスイッチ１１６，１１７が設けられている。

【００２２】上記のメイン基板１１０と脈波センサユニット１００は、図示しないコネクタにより互いに接続されている。これにより、メイン基板１１０から電力が脈波センサユニット１００に供給されると共に、脈波センサユニット１００からメイン基板１１０に脈波信号が供給される。

【００２３】（２） 脈拍検出

図５は、脈波センサユニット１００の細部を示す。同図に示すようにＬＥＤ１０２のアノードには正電圧＋Ｖが与えられ、そのカソードは抵抗１０７ａおよび導線１０８ａを介して接地されている。接地は後述するアース用端子１４０を被験者の手首表面に接触させることにより行われる。抵抗１０７ａは電流制限抵抗として作用するので、所望の電流がＬＥＤ１０２に流れるようになっている。

【００２４】また、フォトダイオード１０３のカソードには正電圧＋Ｖが与えられ、アノードはＯＰアンプ１０６の負入力端子に接続されている。ＯＰアンプ１０６の出力信号は、抵抗１０７ｂを介して負入力端子にフィードバックされている。このＯＰアンプ１０６の入力インピーダンスは極めて高く、かつゲインも大きい。

【００２５】また、ＯＰアンプ１０６の正入力端子は導線１０８ｂを介して接地されている。この接地は後述するアース用端子１４１を被験者の手首表面に接触させることにより行われる。このようにＯＰアンプ１０６の正入力端子は接地されているから、フォトダイオード１０３のアノードはグランドにイマジナリーショートされる。したがって、フォトダイオード１０３は、逆バイアスされ、光がそこに入射すると、光量に応じた電流が流れる。この電流は入射光が強いほど大きい。ＯＰアンプ１０６と抵抗１０７ｂは、フォトダイオード１０３からの電流を電圧に変換するとともに増幅する。すなわち、ＯＰアンプ１０６の出力信号Ｖｍは、入射光の光量に応じて変動する。

【００２６】図６を参照して脈波センサユニット１００の原理を説明する。図において、Ｔは検出対象生体の表皮であり、Ｃは毛細血管および細動脈である。表皮Ｔから血管Ｃまでの間には、生体組織が形成されている。そして、血管Ｃの内部には血液が流れている。ＬＥＤ１０２から照射された光の一部は、生体の組織や血液中のヘモグロビンによって吸収され、また、他の一部は、生体の組織によって反射され、その反射光がフォトダイオード１０３によって受光される。フォトダイオード１０３は受光量に応じて電気信号を出力する。したがって、フォトダイオード１０３の出力信号には、生体の組織による吸収と血液中のヘモログロビンによる吸収が反映されている。

【００２７】図７は、人の血管部分に外部から光を照射したときの吸光度の変動を示す図であり、I_2は組織による吸光成分、I_3は静脈血による吸光成分、I_4は動脈

血による吸光成分である。組織による吸光成分I_2には組織濃度が変化しないため、一定である。また、静脈血による吸光成分I_3も一定である。これは、静脈には脈動がなく、濃度変化がないためである。

【００２８】図８に示すように、心臓から送り出された血液の脈動に係る血圧は、一般に心臓に近い血管ほど高くて変動も大きく、静脈では低くて変動もない。従って、フォトダイオード１０３の出力電流は、動脈の脈動に応じて変動する。そこで、フォトダイオード１０３の出力を増幅したＯＰアンプ１０６の出力信号Ｖｍを脈波信号とみなすことができる。

【００２９】図９は、メイン基板１１０のデータ処理回路１１１の機能ブロック図である。脈波センサユニット１００で生成された脈波信号Ｖｍは脈波信号変換部１２０に供給され、脈波信号変換部１２０は脈波信号Ｖｍをアナログ信号からデジタル信号（脈波データＭＤ）に変換する。脈波データＭＤは、ＲＡＭ（ランダムアクセスメモリ）等で構成される記憶部１２１に転送され、記憶部１２１は所定期間の脈波データＭＤを記憶する。

【００３０】記憶部１２１からは一定の周期で脈波データＭＤが読み出され、読み出された脈波データＭＤは周波数解析部１２２に転送される。周波数解析部１２２は脈波データＭＤに周波数解析を施して、脈波解析データＭＫＤを生成する。周波数解析の手法としては、各種のものがあるが、この例にあっては短い演算時間で解析できるようにＦＦＴ（高速フーリエ変換）が用いられている。

【００３１】次に、脈波解析データＭＫＤは脈拍数演算部１２３に供給され、脈拍数演算部１２３は脈波解析データＭＫＤに基づいて脈拍数ＨＲを算出する。この算出において、脈拍数演算部１２３は脈波解析データＭＫＤのスペクトラム強度のピークを特定し、ピークとピークの間の時間に基づいて周波数Ｆｈを算定する。周波数Ｆｈは脈波信号Ｖｍの基本波周波数であるから、脈拍数演算部５８は、次式により１分間当たりの脈拍回数である脈拍数ＨＲを算出する。ＨＲ＝６０Ｆｈ

【００３２】なお、脈波信号ＶｍのＳＮ比が十分高い場合には、周波数解析によらず、単純に脈波信号Ｖｍを波形整形し矩形波に変換して、当該矩形波の周期を求め、脈拍数ＨＲを表示するようにしてもよい。

【００３３】こうして算出された脈拍数ＨＲは、液晶表示装置１３に表示されるようになっている。被験者の脈拍はこのようにして知ることができる。

【００３４】（３）アース用端子の詳細

図３および図４に戻り、図５に示す接地のためのアース用端子１４０，１４１の詳細を説明する。ハウジング１０の裏蓋１２の裏側面、すなわち被験者の手首表面に対向する面には、凸部１３０が形成されている。この凸部１３０は円錐台状であって、その裏側の面は平面１３１になっている。凸部１３０に対応する部分は肉厚にされており、その表側の面には、上記の回路基板１０１が嵌合される収容凹部が形成されている。この収容凹部に向けて開口する断面円形の二つの穴１３２がこの肉厚の部分に形成されている。

【００３５】また、この肉厚の部分には、断面円形の二つの貫通孔１３３が形成されており、貫通孔１３３は穴１３２とそれぞれ同軸に連なっている。貫通孔１３３には、それぞれアース用端子１４０，１４１の胴部が挿入されている。

【００３６】各アース用端子１４０，１４１は導体製であって、図１０に示すように、頭部１４２、胴部１４３、係合部１４４および端部フランジ１４５とを有する。これら部分は、いずれも円形の断面を有しており、同軸上に連なっている。頭部１４２は上記貫通孔１３３の直径よりも大きい直径を有しており、胴部１４３は貫通孔１３３の直径よりもわずかに小さい直径を有する。胴部１４３の中央には周溝１４６が形成されており、ここには図３に示すゴム製の防水パッキン１５０が設けられる。この防水パッキン１５０により、貫通孔１３３とアース用端子との間がシールされ、水が回路基板１０１に向けて侵入するのが防止される。

【００３７】各アース用端子１４０，１４１の係合部１４４は、端部フランジ１４５および胴部１４３の直径よりも小さい直径を有する。ここには、図３に示す導体製のＣ形リング１５１が嵌め込まれている。Ｃ形リング１５１と頭部１４２により、各アース用端子１４０，１４１は貫通孔１３３から脱落しないようになっている。ただし、胴部１４３の長さが貫通孔１３３の長さよりも大きいので、各アース用端子１４０，１４１はその軸線方向に沿って貫通孔１３３を摺動可能である。

【００３８】また、穴１３２には、アース用端子１４０，１４１と同軸になるように導体製のコイルスプリング（付勢手段）１５２がそれぞれ配置されている。各スプリング１５２は、回路基板１０１とＣ形リング１５１とで、軸線方向に圧縮されている。このためスプリング１５２の発生する反力によって、Ｃ形リング１５１およびアース用端子１４０，１４１は常に図中の下方に向けて付勢されている。図３に示すように、下方からアース用端子１４０，１４１に力を加えない限り、Ｃ形リング１５１は穴１３２の底面に接触する。

【００３９】上述より明らかなように、スプリング１５２は回路基板１０１に常に接触している。回路基板１０１において、両方のスプリング１５２が接触するのは、それぞれ図３に示す抵抗１０７ａに接続された導線１０８ａと、ＯＰアンプ１０６の正入力端子に接続された導線１０８ｂの位置である。これにより、アース用端子１４０は、対応するＣ形リング１５１とスプリング１５２を通じて導線１０８ａに電気的に接続されており、アース用端子１４１は、同様に導線１０８ｂに電気的に接続されている。

【００４０】リストバンド２０を被験者の手首Wに巻回し、図１１に示すように、手首Wにこの生体情報計測装置を固定すると、アース用端子１４０，１４１は、手首Wの皮膚表面に常に接触する。アース用端子１４０，１４１は、手首Wの皮膚表面の法線方向に沿って移動可能であると共に、スプリング１５２により手首W側に向けて付勢されているためである。スプリング１５２の付勢力により、この接触状態は、手首Wをひねるなどの運動が行われても維持される。手首Wのように筋肉が発達した部位における測定では、被験者の運動の可能性があるので、この利点は特に有効である。

【００４１】従って、上記の必要な箇所（導線１０８ａ，１０８ｂ）が常に接地される。このため接地されるべき箇所と被験者の体との間の浮遊静電容量の影響は常に最小限になり、測定精度が向上する。手首Wのように皮膚表面の層が厚い測定部位においては、反射光の変動が小さく、フォトダイオード１０３の出力信号のレベルが小さい。しかし、このように浮遊静電容量の影響が減少することにより、測定精度を飛躍的に向上することができる。

【００４２】この接地を確保するのは、ハウジング１０に支持されたスプリング１５２である。従って、リストバンド２０で強く手首Wを締め付ける必要がなく、手首Wを圧迫する範囲は狭い。このため、被験者が感じ取る圧迫感も最小限となり、長期間の測定にも被験者が耐えることが可能である。

【００４３】さらに、手首Wに向けられた手首Wの凸部１３０にアース用端子１４０，１４１が取り付けられていると共に、アース用端子１４０，１４１が凸部１３０よりも手首W側に突出させられているので、アース用端子１４０，１４１と被験者の皮膚表面との密着性が向上し、測定精度がさらに向上する。同様に、凸部１３０に透明ガラス１０４が取り付けられていると共に、透明ガラス１０４が凸部１３０よりも手首W側に突出させられているので、透明ガラス１０４と被験者の皮膚表面との密着性が向上し、外光がフォトダイオード１０３に影響を与えるのも削減できる。

【００４４】また、図１１に示すように、アース用端子１４０，１４１の手首W側の端面と、透明ガラス１０４の手首W側の端面は、手首Wの皮膚表面に向けて押し付けられたときに、ほぼ同一の平面上に位置するように、スプリング１５２の力が設定されている。このため、アース用端子１４０，１４１の端面と透明ガラス１０４の端面が手首Wに与える圧力が均一化される。従って、圧力が集中する場合に比べて、被験者への圧迫感をやわらげることができる。

【００４５】さらに、回路基板１０１の必要箇所とアース用端子１４０，１４１との間は、アース用端子１４０，１４１に取り付けられた導体製のＣ形リング１５１とスプリング１５２とで電気的に接続される。このように接続に導体製のスプリング１５２を用いることにより、専用の配線を排除できる。すなわち、部品数を削減できるので、製造費用を廉価にすることが可能である。

【００４６】上記の実施形態では、図５の導線１０８ａがアース用端子１４０に接続され、導線１０８ｂがアース用端子１４１に接続されるが、導線１０８ａ，１０８ｂのそれぞれを、アース用端子１４０，１４１の両方に接続するようにしてもよい。

【００４７】２．第２実施形態

次に、図１２ないし図１４を参照して、本発明に係る第２実施形態を説明する。なお、第１実施形態と共通する構成要素には同一の符号を図中に付けて、その説明を省略する。第２実施形態の生体情報計測装置の概略構造および脈拍検出については第１実施形態と同一であるので、アース用端子の詳細を以下に説明する。

【００４８】ハウジング１０の裏蓋１２には、第１実施形態と同様の凸部１３０が設けられており、その平面１３１にはリング状（ループ状）のアース用端子１６０が取り付けられている。アース用端子１６０は透明ガラス１０４を取り囲むように配置されている。

【００４９】図１３に示すように、アース用端子１６０は二箇所（ネジ１６５の位置）において、凸部１３０の平面１３１に固定されている。その取付の詳細は図１４に示す。凸部１３０には断面円形の貫通孔１６２が形成されており、貫通孔１６２には導体製の円筒状のピン１６３が挿入されている。ピン１６３の内周面の上下の端部にはメネジが形成されている。これらのメネジには、回路基板１０１を胴部が貫通するネジ１６４と、アース用端子１６０を胴部が貫通するネジ１６５とが、それぞれ螺合させられている。

【００５０】このようにして、アース用端子１６０は凸部１３０に固定されている。また、ネジ１６４，１６５およびピン１６３は導体製であり、このため回路基板１０１がアース用端子１６０に電気的に接続される。回路基板１０１において、二つのネジ１６４が接触するのは、図５に示す導線１０８ａと導線１０８ｂの位置であり、これにより導線１０８ａ，１０８ｂはアース用端子１６０に電気的に接続される。

【００５１】図１２に示すように、アース用端子１６０および透明ガラス１０４は凸部１３０の平面１３１よりも被験者の手首W側に突出していると共に、アース用端子１６０の手首W側の端面と、透明ガラス１０４の手首W側の端面はほぼ同一の平面上に位置している。従って、リストバンド２０を被験者の手首Wに巻回し、手首Wにこの生体情報計測装置を固定すると、アース用端子１６０は、手首Wの皮膚表面に接触する。従って、上記の必要な箇所（導線１０８ａ，１０８ｂ）が接地される。

【００５２】図１４に示すように、ピン１６３の外周には、周溝が形成されており、ここにはゴム製の防水パッ

キン１６７が設けられる。この防水パッキン１６７により、貫通孔１６２とアース用端子との間がシールされ、水が回路基板１０１に向けて侵入するのが防止される。

【００５３】この実施形態においては、アース用端子１６０の端面と透明ガラス１０４の端面をほぼ同一の平面上に位置させ、アース用端子１６０をループ形状として透明ガラス１０４の周囲に配置したことにより、アース用端子１６０の端面と透明ガラス１０４の端面が被験者に与える圧力が均一化される。従って、圧力が集中する場合に比べて、被験者への圧迫感をやわらげることができる。

【００５４】また、アース用端子１６０がループ形状となることにより、手首Wとハウジング１０との間で相対移動があっても、アース用端子１６０と手首Wとが離れることがない。このため接地されるべき箇所と被験者の体との間の浮遊静電容量の影響は常に最小限になり、測定精度が向上する。手首Wのように皮膚表面の層が厚い測定部位においては、反射光の変動が小さく、フォトダイオード１０３の出力信号のレベルが小さい。しかし、このように浮遊静電容量の影響が減少することにより、測定精度を飛躍的に向上することができる。また、手首Wのように筋肉が発達した部位における測定では、被験者の運動の可能性があるので、この利点は特に有効である。さらに、ループ形状のアース用端子が透光体を取り囲むことにより、測定に対する外光の影響を防止できる。

【００５５】３．変更例

上記の実施形態では、バックル２６、タング２７および小孔２８とで周長調節機構を設けているが、周長調節機構は、この例に限られることなく、例えばベルクロ（Velcro）テープや、ボタンなどを用いてもよい。また、例えば伸縮性の高い素材からなる医療サポータ状のベルトを使用すれば周長調節機構は設けなくてもよい。

【００５６】反射型光学センサを利用した脈波センサユニットとしては、図５に例示した回路以外にも様々な回路が使用しうる。本発明は図５に示す回路の接地以外にも、各種の脈波センサユニットの回路の接地にも応用できる。

【００５７】上記の実施形態の生体情報計測装置は手首Wに巻回される腕時計型であるが、これに限らず指や足首などのその他の部位の検出にも本発明は応用できる。

【００５８】アース端子１４０，１４１，１６０および透明ガラス１０４の箇所は図示に限定されず、生体との接触が可能であれば、他の位置であってもよい。

【００５９】

【発明の効果】以上説明したように、本発明によれば、生体へ与える圧迫感を最小限としながらも、測定精度を向上させることができる。

【図面の簡単な説明】

【図１】　本発明の第１実施形態に係る生体情報計測装置を示す斜視図である。

【図２】　上記生体情報計測装置の裏側を示す斜視図である。

【図３】　上記生体情報計測装置の断面図である。

【図４】　上記生体情報計測装置の下面図である。

【図５】　上記生体情報計測装置の脈波センサユニットの詳細を示す回路図である。

【図６】　上記生体情報計測装置による脈波計測原理を示す図である。

【図７】　人の血管部分に外部から光を照射したときの吸光度の変動を示す図である。

【図８】　人体の血圧分布を示すグラフである。

【図９】　上記脈波センサユニットの出力信号を処理するデータ処理回路の機能ブロック図である。

【図１０】　上記生体情報計測装置のアース用端子を示す正面図である。

【図１１】　上記生体情報計測装置を人間の手首に装着した状態を示す図である。

【図１２】　本発明の第２実施形態に係る生体情報計測装置を示す断面図である。

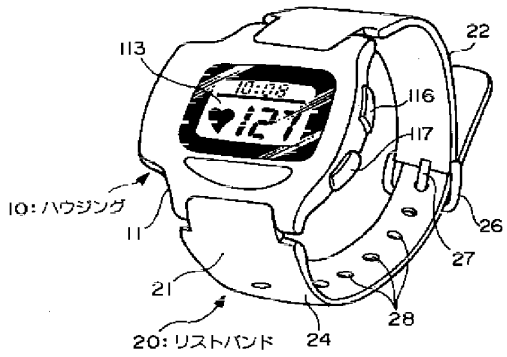
【図１３】　上記生体情報計測装置を示す下面図である。

【図１４】　上記生体情報計測装置のアース用端子の取付構造を示す断面図である。

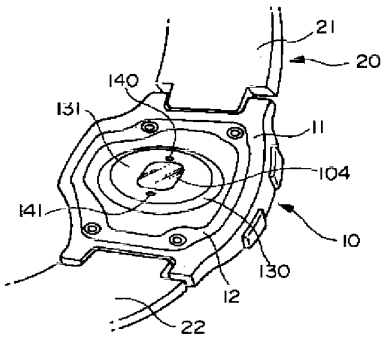
【符号の説明】

１０…ハウジング（支持体）、
２０…リストバンド（固定手段、巻回体）、
２６…バックル、
２７…タング、
２８…小孔、
１００…脈波センサユニット、
１０２…ＬＥＤ（発光手段、発光体）、
１０３…フォトダイオード（生体情報検出手段、受光体）、
１０４…透明ガラス（透光体）、
１１０…メイン基板、
１１１…データ処理回路、
１１３…液晶表示装置、
１３０…凸部、
１４０，１４１…アース用端子、
１５２…コイルスプリング（付勢手段）、
１６０…アース用端子

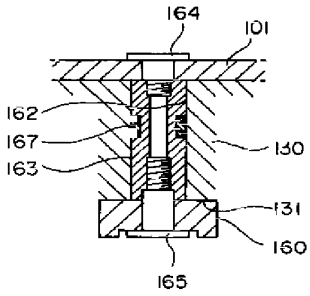
【図１】



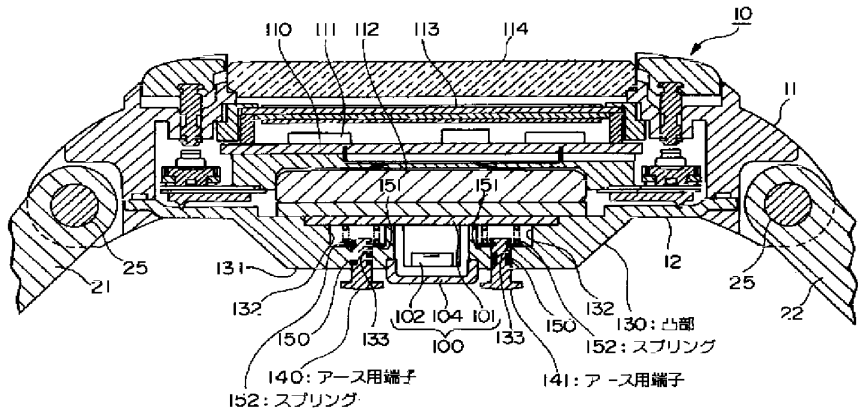
【図２】



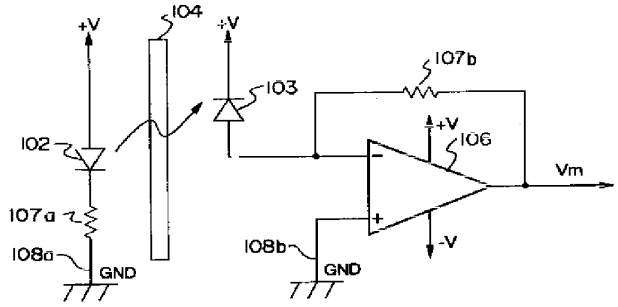
【図１４】



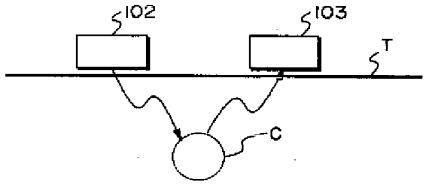
【図３】



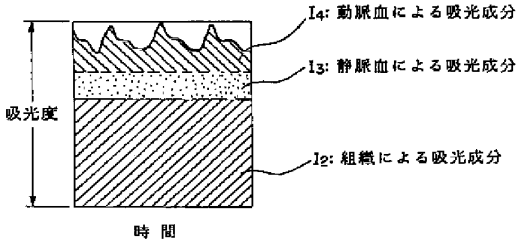
【図５】



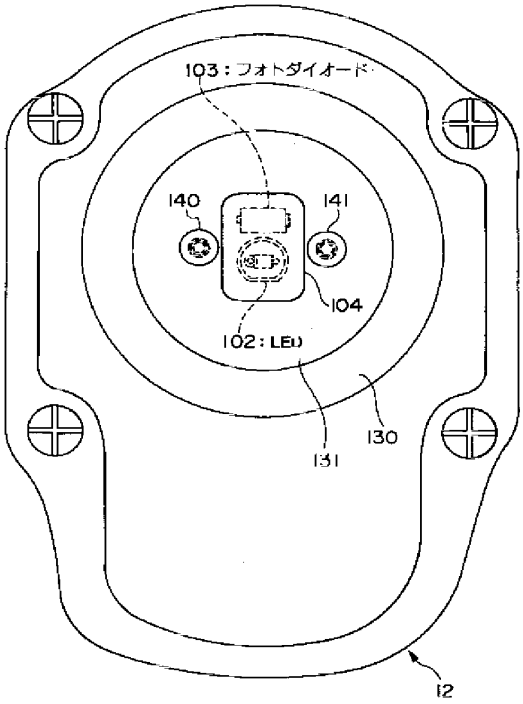
【図６】



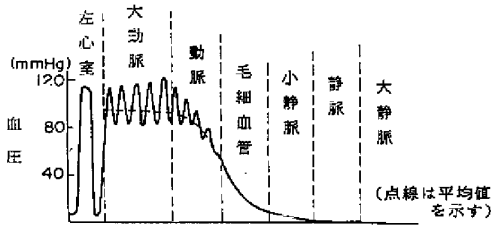
【図７】



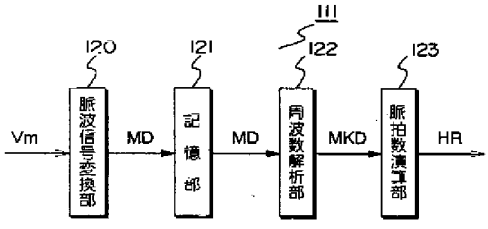
【図４】


103：フォトダイオード
140
141
104
102：LED
131
130
12

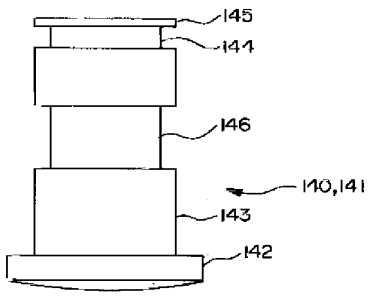
【図８】


左心室
大動脈
動脈
毛細血管
小静脈
静脈
大静脈
(mmHg)
120
80
40
血圧
(点線は平均値を示す)

【図９】


111
120
121
122
123
Vm
脈波信号変換部
MD
記憶部
MD
周波数解析部
MKD
脈拍数演算部
HR

【図１０】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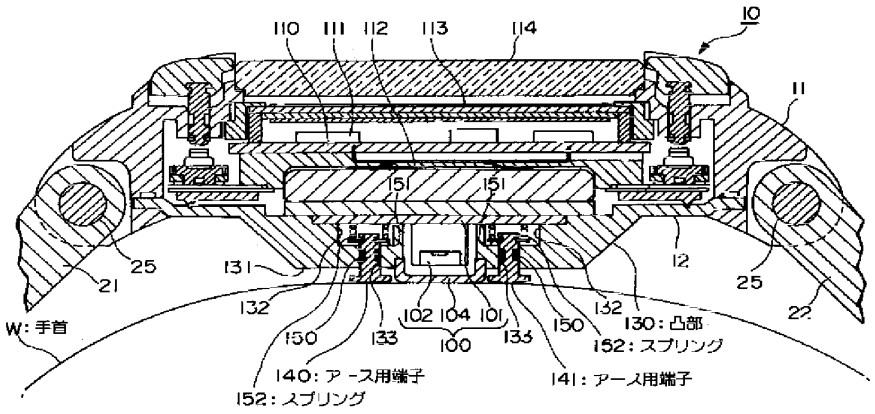
【図１１】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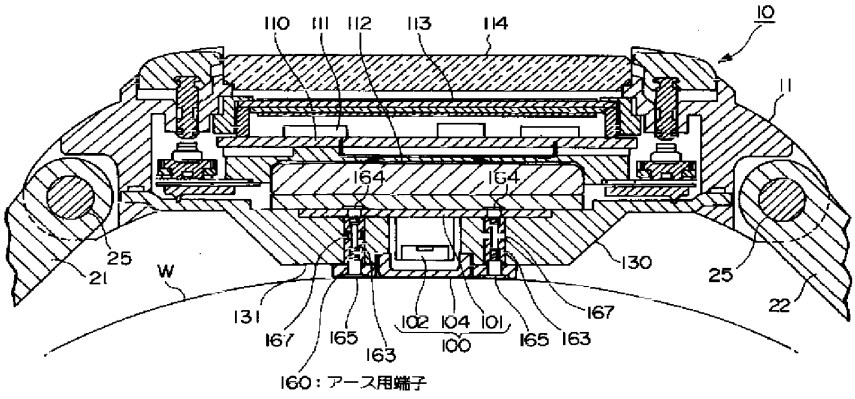
111
112
113
114
11
151
151
25
21
131
132
150
133
102
104
101
100
134
150
132
130：凸部
152：スプリング
12
25
22
W：手首
140：アース用端子
152：スプリング
141：アース用端子

【図１２】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11
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W
131
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130
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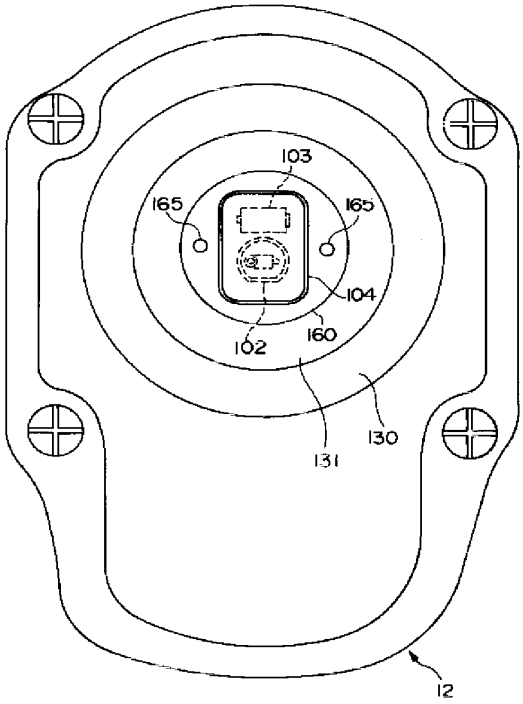
160：アース用端子

【図１３】



Espacenet

Bibliographic data: JP2004329406 (A) — 2004-11-25

MEDICAL SENSOR, PULSE TYPE OXYGEN CONCENTRATION SENSOR, AND KIT FOR ATTACHING THESE SENSORS TO BODY OF PATIENT

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Applicant(s): IIGURU KK ± (IIGURU KK)

Classification: **- international:** ***A61B5/145; A61B5/1455; G01N21/59;*** (IPC1-7): A61B5/145; G01N21/59

- cooperative:

Application number: JP20030126989 20030502

Priority number(s): JP20030126989 20030502

Abstract of JP2004329406 (A)

PROBLEM TO BE SOLVED: To provide an inexpensive pulse type oxygen concentration sensor to be manufactured at a low cost and easily used. ;SOLUTION: The oxygen concentration sensor consists of a detector body assembly 1 with a light emitter and a light receiver and a disposable band assembly 2 using an adhesive strip material. The detector body assembly 1 consists of a pair of hoods 3 and 4 as housings, light emitting diodes and light receiving elements separately stored in the housings, and a flexible cable 7 and a cable assembly 8 for transmitting signals between hoods 3 and 4 and to outside devices. The hoods 3 and 4 have openings to the outside. The band assembly 2 consists of an adhesive part 9, a connection tape part 10, and two studs 11. Each stud 11 has a hollow body part, and a projecting annular part 29 for fastening the hoods 3 and 4 with snap fasteners. Stud (11) mounting parts inside the hoods 3 and 4 are rotatable. ;COPYRIGHT: (C)2005,JPO&NCIPI

CLAIMS JP2004329406

1.
Electronic used to adhere to the patient? An optical medical sensor comprising at least one cable for connection to a monitor device, wherein the sensor body is capable of being attached to the patient's body from at least one or more directions. Medical sensor.

2.
The medical sensor according to claim 1, wherein the cable is attached so as to be swingable about an attachment position with respect to the sensor body.

3.
At least one LED and at least one light detector, the light detector being connected to at least one cable for connection to a monitor device, and at least one cable connected to the patient's body A medical sensor characterized by being attachable from the above directions.

4.
4. The medical sensor according to claim 3, wherein the cable is attached so as to be swingable around an attachment position with respect to the sensor body.

5.
A pulse-type oxygen concentration sensor, comprising one light detector and at least two LEDs, wherein the light detector and the LEDs are connected to at least one cable for connection to a

monitor device, A pulse-type oxygen concentration sensor, wherein a cable can be attached to a patient's body from at least one direction.

6.

6. The pulse type oxygen concentration sensor according to claim 5, wherein the cable is attached so as to be swingable around an attachment position with respect to the sensor body.

7.

7. The pulse-type oxygen concentration sensor according to claim 5, wherein the sensor body can be attached to a patient's body with an adhesive.

8.

8. The pulse-type oxygen concentration sensor according to claim 7, wherein the sensor body is composed of two parts, one part having one photodetector and at least two LEDs, and the other part having an adhesive part. A pulse-type oxygen concentration sensor characterized by being a band-shaped member.

9.

The medical sensor according to any one of claims 1 to 4 or the cable of the pulse-type oxygen concentration sensor according to any one of claims 5 to 8 can be attached to an existing pulse-type oxygen concentration sensor from at least two directions. An installation kit for a pulse-type oxygen concentration sensor.

10.

10. The mounting kit for a pulse type oxygen concentration sensor according to claim 9, wherein the cable is mounted so as to be swingable around a mounting position with respect to the sensor body.

11.

A pulse-type oxygen concentration sensor capable of attaching the medical sensor according to any one of claims 1 to 4 or the pulse-type oxygen concentration sensor according to any one of claims 5 to 8 to a detection unit of an existing pulse-type oxygen concentration sensor. In the mounting kit, the sensor body includes a plurality of LEDs, a light detector, and a means for attaching to the adhesive tape, and the means for attaching to the adhesive tape enables the sensor body to be attached from at least one direction. A mounting kit for a pulse-type oxygen

concentration sensor.

12.

12. The pulse type oxygen concentration sensor mounting kit according to claim 11, wherein the means for attaching to the pressure sensitive adhesive tape also includes a pressure sensitive adhesive tape.

13.

12. The pulse oxygen concentration sensor mounting kit according to claim 11, wherein the mounting means is for snap mounting.

14.

12. The mounting kit for a pulse oxygen concentration sensor according to claim 11, wherein the mounting means is a circular one for snap mounting.

15.

A pulse-type oxygen concentration sensor comprising a detector assembly including a light emitter and a light receiver, and a disposable band assembly using an adhesive strip material, wherein light emitted from the light emitter is transmitted through a patient's body. In the case of receiving light by the light receiver, the detector assembly connects at least a pair of housings, a light emitting diode and a light receiving element individually housed in the pair of housings, and the signal transmission between the pair of housings. A flexible cable including a wiring for a signal, and a flexible cable assembly including a wiring for transmitting a signal to an external device and attached to one of the pair of housings. The band assembly has an adhesive surface portion on at least a part of one surface side, At least two studs project on the surface side, each stud has at least one permeable opening, and the stud has an annular projecting portion that allows the opening of the housing to be fitted and engaged with a snap. A pulse-type oxygen concentration sensor characterized by comprising.

16.

16. The pulse type oxygen concentration sensor mounting kit according to claim 15, wherein a mounting portion of the stud is rotated inside the housing.

Notice

DESCRIPTION JP2004329406

A pulse-type oxygen concentration sensor that is inexpensive to manufacture and easy to use. A detector assembly 1 including a light emitter and a light receiver, and a disposable band assembly 2 using an adhesive strip material. The detector assembly 1 includes a pair of hoods 3 and 4 serving as housings, light-emitting diodes and light-receiving elements individually housed in the hoods 3 and 4, flexible cables 7 and cables for signal transmission between the hoods 3 and 4 and external devices. It consists of an assembly 8. The hoods 3 and 4 have openings to the outside. The band assembly 2 includes an adhesive portion 9, a connecting tape portion 10, and two studs 11, and each stud includes a hollow body portion. The stud 11 has a projecting annular portion 29 that snaps the hoods 3, 4. The mounting portion of the stud 10 is rotatable inside the hoods 3 and 4. [Selection] Figure 1

Medical sensors, pulse oxygen concentration sensors, and kits for attaching these sensors to the patient's body

[0001] 1. Field of the Invention [0002] The present invention relates to a medical sensor for measuring a state of oxygen in blood by being worn on a finger, a toe or the like of a patient's hand, and more particularly, a pulse type oxygen concentration sensor. And a kit for attaching these sensors to a patient's body. 2. Description of the Related Art In medical care, whether in a hospital or outside a hospital, it is important to monitor the oxygen concentration in a patient's blood. This is because when the oxygen concentration in the blood is low, the brain may be damaged in a short period of time, or death may occur. A pulse oximetry method is well known as an oxygen concentration measurement method. This method is a noninvasive method for measuring the oxygen saturation of arterial blood, which is an index of oxygen supply, and the measurement sensor used is a detector assembly and an adhesive strip material that is attached to a patient's finger or the like. The probe includes a cable assembly for connection to a monitor

for monitoring or the like. The detector assembly and the probe include a light emitter and a light receiver. The light emitter is composed of a light emitting diode (LED) for both red light and infrared light, for example, and the light receiver is composed of a light receiving element such as a photodiode suitable for receiving light emitted from the light emitter such as LED. To do. Such a probe is attached to the finger or toe of the patient's hand, or to the foot if the patient is a young person, etc., and the light emitted from the light emitter emits the fingernail, artery, vessel, or capillary of the patient. Set to irradiate tissue, bone, etc. The light receiver is arranged on the opposite side of the light emitter so that the light emitted from the light emitter can detect the light transmitted through the body tissue. The data obtained by such a pulse-type oxygen concentration sensor is differential absorption data by arterial blood of two wavelengths of light emitted from the probe illuminator, and the oxygen saturation can be determined by analyzing this data. In other words, are two types of probe emitters turned on alternately? It is turned off and red light and infrared light are alternately applied to the measurement site of the patient, and the transmitted light is detected by the photoreceptor. Then, using the fact that the output current of the photoreceptor is proportional to the detected transmitted light intensity, the intensity ratio of the red light and the red light is calculated, and based on this ratio, for example, by empirically preset table data Determine the value of oxygen saturation in the patient's blood. [0005] Although the use of such a pulse type oxygen concentration sensor has a clear advantage, it is difficult to fix to a patient's body and stable detection data is stable if the fixed state is not stable. It is difficult to remove, and it is troublesome to fix it when the position of the cable is shifted when it is fixed to the patient with a bandage or the like.

In addition, fixing with a bandage etc. regulates the movement of the patient, and the LED etc. generates heat, so if it is attached too firmly with a bandage etc., it can prevent the data quality from deteriorating due to the cable moving , It will not be comfortable for the patient. Therefore, there are both dangers and inconveniences especially for use in newborns. There is also an example of fixing using a clip-shaped jig, but it may cause pain to the patient. The cost is also higher than that of general sensors, and a considerable number is currently used. If the whole is made disposable to prevent infection to others, a very large amount of environmental waste is generated. That's more than a cost. The present invention solves the above-mentioned conventional problems, and provides a medical sensor, a pulse-type oxygen concentration sensor, and a kit for attaching these sensors to a patient's body, which are inexpensive to manufacture and easy to use. With the goal. Means for Solving the Problems A medical sensor according to claim 1 of the present invention is an electronic device used by adhering to a patient in order to achieve the above object. An optical medical sensor comprising at least one cable for connection to a monitor device, wherein the sensor body is capable of being attached to the patient's body from at least one or more directions. And According to the second aspect of the present invention, in order to achieve the above object, in the medical sensor according to the first aspect, the cable is attached so as to be swingable around an attachment position with respect to the sensor body. It is characterized by. According to the third aspect of the present invention, in

order to achieve the above object, the apparatus has at least one LED and at least one light detector, and the light detector is used for connection to a monitor device. The cable is connected to at least one cable, and the cable can be attached to the patient's body from at least one direction. According to a fourth aspect of the present invention, in order to achieve the above object, in the medical sensor of the third aspect, the cable is attached so as to be swingable around an attachment position with respect to the sensor body. It is characterized by. In order to achieve the above object, the pulse-type oxygen concentration sensor according to claim 5 has one photo detector and at least two LEDs, and the photo detector and the LEDs are monitored. It is characterized in that it is connected to at least one cable for connection to the body, and the cable can be attached to the patient's body from at least one direction.

In order to achieve the above object, according to the sixth aspect of the present invention, in the pulse type oxygen concentration sensor according to the fifth aspect, the cable is attached so as to be swingable around an attachment position with respect to the sensor body. It is characterized by becoming. According to the seventh aspect of the present invention, in order to achieve the above object, in the pulse type oxygen concentration sensor according to the fifth or sixth aspect, the sensor main body can be attached to a patient's body with an adhesive. Features. In order to achieve the above object, according to the eighth aspect of the present invention, in the pulse type oxygen concentration sensor according to the seventh aspect, the sensor main body is composed of two parts, and one part is one light detection. It is a band-shaped member having a body and at least two LEDs, and the other part having an adhesive part. According to the ninth aspect of the present invention, in order to achieve the above object, the cable of the medical sensor according to any one of claims 1 to 4 or the pulse type oxygen concentration sensor according to any one of claims 5 to 8 is provided. Can be attached to an existing pulse type oxygen concentration sensor from at least two directions. According to claim 10, in order to achieve the above object, in the pulse type oxygen concentration sensor mounting kit according to claim 9, the cable can be swung around a mounting position with respect to the sensor body. It is characterized by being attached to. In order to achieve the above object, the kit for mounting a pulse oxygen concentration sensor according to claim 11 is the medical sensor according to any one of claims 1 to 4 or the pulse according to any one of claims 5 to 8. In the pulse type oxygen concentration sensor mounting kit that enables the oxygen type oxygen concentration sensor to be attached to the detection unit of an existing pulse type oxygen concentration sensor, the sensor body has means for attaching to a plurality of LEDs, light detectors, and adhesive tape. In addition, the attachment means to the adhesive tape can attach the sensor body from at least one direction. According to the twelfth aspect of the present invention, in order to achieve the above object, in the attachment kit for the pulse type oxygen concentration sensor according to the eleventh aspect, the attachment means to the adhesive tape also includes the adhesive tape. Features. According to the thirteenth aspect of the present invention, in order to achieve the above object, in the pulse type oxygen concentration sensor mounting kit according to the eleventh aspect, the mounting means is for snap mounting. .

According to the fourteenth aspect of the present invention, in order to achieve the above object, in the attachment kit for the pulse type oxygen concentration sensor according to the eleventh aspect, the attachment means is a circular one for attaching a snap. And In order to achieve the above object, a pulse type oxygen concentration sensor according to claim 15 comprises a detector assembly including a light emitter and a light receiver, and a disposable band assembly using an adhesive strip material. A pulse-type oxygen concentration sensor that transmits light emitted from the light emitter through a patient's body and receives the light by the light receiver. The detector assembly includes at least a pair of housings and the pair of housings. Including a light-emitting diode and a light-receiving element individually housed, a flexible cable that connects between the pair of housings and includes a signal transmission wiring, and a signal transmission wiring to an external device, A flexible cable assembly attached to one of the pair of housings, wherein the housings are respectively connected to the outside. The band assembly has an adhesive surface portion on at least a part of one surface side, and has at least two studs protruding from the other surface side, each stud having at least one permeable opening, and the housing The opening can be detachably engaged with the stud. In order to achieve the above object, a pulse type oxygen concentration sensor according to claim 16 is the pulse oxygen concentration sensor mounting kit according to claim 15, wherein the mounting portion of the stud is rotated inside the housing. It is characterized by becoming. DESCRIPTION OF THE PREFERRED EMBODIMENTS Embodiments of the present invention will be described below with reference to the drawings. In the following, one preferred embodiment of the present invention will be described, but other embodiments, applications, etc. of the present invention will be apparent to those skilled in the art, and the description thereof will be omitted. Of course, the present invention is not limited to the illustrated example. FIG. 1 is an exploded perspective view showing an embodiment of a pulse type oxygen concentration sensor according to the present invention. The pulse-type oxygen concentration sensor according to the present embodiment includes a detector assembly 1 including a light emitter and a light receiver, and a disposable band assembly 2 using an adhesive strip material, and light emitted from the light emitter. Is transmitted through the patient's body and received by the photoreceptor. Further, the detector assembly 1 and the band assembly 2 are made into a kit for attachment to a patient's body.

The detector assembly 1 includes a pair of hoods 3 and 4 serving as housings for housing various components, and chassis 5 and 5 for housing light emitting diodes and light receiving elements in the hoods 3 and 4. Spring clips 6 and 6 for fixing the chassis 5 in the hoods 3 and 4 respectively, a flexible cable 7 for connecting the hoods 3 and 4 and including a signal transmission wiring, and a control device (not shown) And a flexible cable assembly 8 including a wiring for signal transmission to an external device such as a monitor and attached to one hood 3. The hoods 3 and 4 and the chassis 5 are formed using a grade of ABS resin suitable for

medical use. The band assembly 2 has an adhesive on the lower surface in the figure, and has rectangular island-shaped adhesive portions 9, 9 that can be attached to a patient's body, and a narrower width than the adhesive portion 9 stretched between them. The connecting tape portion 10 is composed of a pair of studs 11 and 11 held between the upper surface of the adhesive portion 9 and the lower surface of the connecting tape portion 10 and a release sheet 12 for protecting the lower surface of the adhesive portion 9. It is. For example, the pressure-sensitive adhesive portion 9 is formed using a pressure-sensitive pressure-sensitive adhesive type translucent polyester or the like having a thickness of 0.013 mm. Or although the connection tape part 10 is also formed with the same material and is affixed on the upper surface of the adhesion part 9, it is necessary to make the lower surface of the part between the adhesion parts 9 and 9 have no adhesive. The connection tape part 10 does not need to have translucency. The stud 11 will be described later. The release sheet 11 may be a known one, for example, a craft tape coated with silicon. Of course, the release sheet 11 is peeled off during use to expose the adhesive surface of the adhesive portion 9. 2 is a cross-sectional view of the detector assembly 1, FIG. 3 is a plan view (A) and a bottom view (B) of the hood 3, and FIG. 4 is a plan view (A) and a bottom view (B) of the hood 4. FIG. 5 is a perspective view of the chassis 5. As shown in FIG. 3, the hood 3 constituting the detector assembly 1 has a substantially hemispherical hollow light receiving body receiving portion 13 and a hollow cylindrical shape that holds the end portion 6 a of the spring clip 6. It is comprised from the accommodating part 14, and the connection part 15 to the cable 7 extended so that an axis line may intersect orthogonally with the clip end accommodating part 14. As shown in FIG. As shown in FIG. 2, a chassis 5 provided with a photodetector 16 as a photoreceptor is molded, for example, by molding, and the photodetector 16 is connected to the cable 7, and a spring is provided at the lowermost end. A clip 6 is attached to prevent the fall.

As shown in FIG. 3B, an opening 17 for receiving light is provided on the lower surface of the photoreceptor housing 13. The hood 3 having the shape and structure as shown in the figure is easy to manufacture if, for example, the upper part and the lower part are formed separately and bonded together. Moreover, since what is suitable for a combination with the light-emitting body with which the food | hood 4 mentioned later is equipped is used for a photoreceptor, it is not limited to a photodetector. As shown in FIG. 4, the other hood 4 has a substantially hemispherical and hollow light emitter housing portion 18, a clip end housing portion 19 similar to the hood 3, and the clip end housing portion 19 having an axis perpendicular to the hood 4. Thus, the insertion portion 20 of the cable 7 extending to one side of the light emitter housing portion 18 and the connection portion 21 to the cable assembly 8 extending to the opposite side are configured. As shown in FIG. 2, the LED 22 as a light emitter is housed in the chassis 5 by molding, for example, and connected to the cable assembly 8, and the spring clip 6 is attached to the lowermost end of the light emitter housing 18. There is a stop. As shown in FIG. 4B, an opening 23 for emitting light is provided on the lower surface of the light emitter housing 18. The cable 7 passes through the insertion portion 20 and passes through the connection portion

21, and is gathered as a part of the cable assembly 8 outside the connection portion 21. Further, as is well known in the field of pulse-type oxygen concentration sensors, two types of LEDs 22 are used as the light emitter, but the light emitter is not limited to LEDs, and various types can be used. Further, the hood 4 can be manufactured easily by forming, for example, the upper part and the lower part separately and bonding them together. The chassis 5 includes a top 24 for mounting on the hoods 3 and 4, a half-cracked body 25 connected to the lower side thereof, and a flange 27 having an opening 26 in the center. A groove 28 having a semicircular cross section for mounting the cable 7 or the cable assembly 8 is formed in the top 24. The chassis 6 is attached to the hoods 3 and 4 in such a manner that the body portion 25 is mounted on the opposite side of the clip end storage portions 14 and 19, and the end portion 6a of the clip 6 mounted in the body portion 25 is clipped. It does not interfere with the mounting in the end storage portions 14 and 19. When the hoods 3 and 4 are attached, the openings 16 and 24 of the hoods 3 and 4 and the opening 26 are aligned with each other, that is, the light emitted from the LED 22 passes from the opening 16 to the outside through the opening 26. In this state, the light entering the opening 16 can reach the photodetector 16 through the opening 26.

Needless to say, if at least the inner wall surface exposed to the light of the hood 4 and the chassis 5 attached to the hood 4 has a surface property in which light is not diffusely reflected, the light receiving property is improved. FIG. 6 is an enlarged sectional view of the stud 11 attached to the band assembly 2. The stud 11 has a hollow cylindrical body portion 30 provided with a projecting annular portion 29 for snapping the chassis 6 on the top, and a flange for fixing between the adhesive portion 9 and the connecting tape portion 10. Part 31. The outer diameter of the projecting annular portion 29 is slightly larger than the diameter of the opening 26 of the chassis 5. FIG. 7 is an enlarged cross-sectional view when the chassis 5 is fitted to the stud 11 with the band assembly 2 attached to a patient's finger or the like. As can be seen from this figure, in order to attach the hoods 3 and 4 to the stud 11, the opening 26 of the chassis 5 is applied to the top of the trunk portion 30 of the stud 11 and lightly applied to the hoods 3 and 4 from the upper surface side. 5 so that the edge of the opening 26 gets over the protruding annular portion 29 so-called snapping. After snapping, the state shown in FIG. 7B is obtained, and the projecting annular portion 29 enters the inside of the chassis 5 having a larger diameter. It will be in the state which can rotate comparatively freely around. The removal may be performed after the band assembly 2 is peeled off from the patient's finger 32 or the like. However, the edge of the opening 26 of the chassis 5 may be opposite to the protruding annular portion 29 before or after the band assembly 2 is peeled off. In addition, it is only necessary to apply a little force to the hoods 3 and 4 so as to get over the protruding annular portion 29 in a direction away from the stud 11. FIG. 8 is an enlarged perspective view of a state in which the band assembly 2 is attached to the patient's finger 32, the chassis 5 is fitted to the stud 11, and the hoods 3 and 4 are attached. For example, if the patient moves the finger 32 and changes its orientation after being attached to the finger 32 as shown in FIG. 7A, the orientation of the cable assembly 8 is restricted to some extent by connection with a monitor device (not shown). It does

not move too much, and the relative position with the finger 32 changes. When such a situation occurs in the conventional structure, the cable assembly 8 interferes with the position holding of the hoods 3 and 4 and the hoods 3 and 4 are detached from the patient's body. Further, the hoods 3 and 4 and the photo detector 16 and the LED 22 mounted on the hoods 3 and 4 rotate around the axis of the stud 11 so that stable measurement can be continued.

In the figure, 33 is a fingernail. Further, the measurement content is the same as that of a conventionally known example, and thus the description thereof is omitted. Although the embodiment described above relates to a pulse-type oxygen concentration sensor, the present invention can also be used as another medical sensor and a kit for attaching this sensor to a patient's body. This is clear from the above explanation. In the illustrated embodiment, the attachment of the cable 7 and the cable assembly 8 to the hoods 3 and 4 is a fixed attachment called a fix. However, for example, a universal joint-like attachment form can be adopted. The interference to the hoods 3 and 4 due to the movement of the cable can be further reduced than the form. The medical sensor, pulse-type oxygen concentration sensor, and kit for attaching these sensors to the patient's body according to the present invention are as described above. Even if the body is moved, the wearing state can be accurately maintained without being affected by the interference of the cable. Since the cable can be mounted away from the patient's skin, the heat of the LED and cable will not be transmitted directly to the skin, and it will be possible to prevent accidents such as burns to the patient. Because it can be molded, it can be waterproofed and vibration-proof, and it enables accurate monitoring of blood oxygen concentration, and only adhesive parts that are not so expensive. Since it can be made disposable and the high-cost part can be used any number of times, even if the cost of a single sensor increases, the total cost when considering the total usage is sufficiently reduced . BRIEF DESCRIPTION OF THE DRAWINGS FIG. 1 is an exploded perspective view showing an embodiment of a pulse oxygen concentration sensor according to the present invention. FIG. 2 is a cross-sectional view of a detector assembly. FIG. 3 is a plan view (A) and a bottom view (B) of one hood. FIG. 4 is a plan view (A) and a bottom view (B) of the other hood. FIG. 5 is a perspective view of a chassis. FIG. 6 is an enlarged cross-sectional view of the stud attached to the band assembly. FIG. 7 is an enlarged cross-sectional view when a chassis is fitted to a stud. FIG. 8 is an enlarged perspective view of a state where a band assembly is attached to a patient's finger, a chassis is fitted to a stud, and a hood is attached.

[Explanation of Symbols] 1 Detector assembly 2 Band assembly 3, 4 Hood 5 Chassis 6 Spring clip 6a End of spring clip 7 Cable 8 Cable assembly 9 Adhesive section 10 Connecting tape section 11 Stud 12 Release sheet 13 Photoreceptor storage section 14 Clip end storage portion 15 Connection portion 16 Photo detector 17 Opening portion 18 Light emitter storage portion 19 Clip end storage portion 20 Insertion portion 21 Connection portion 22 LED 23 Opening portion 24 Top portion 25 Body portion 26 Opening 27 Flange portion 28 Groove 29 Projection shape

Annular part 30 Body part 31 Flange part 32 Patient's finger 33 Patient's fingernail

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2004-329406
(P2004-329406A)
(43)公開日　平成16年11月25日(2004.11.25)

(51)Int.Cl.[7]	F I		テーマコード（参考）
A61B 5/145	A61B 5/14	310	2G059
G01N 21/59	G01N 21/59	Z	4C038

審査請求 未請求　請求項の数 16　OL　（全 11 頁）

(21)出願番号　特願2003-126989(P2003-126989)
(22)出願日　平成15年5月2日(2003.5.2)

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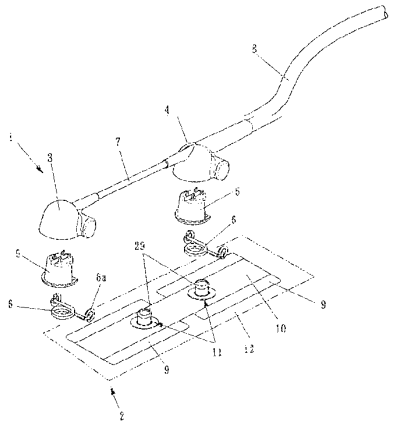
(54)【発明の名称】医療用センサ、パルス式酸素濃度センサ、これらセンサを患者の身体に取り付けるためのキット

(57)【要約】
【課題】製造コストが安価でかつ使用し易いパルス式酸素濃度センサを提供する。
【解決手段】発光体及び受光体を備える検出体アセンブリ１と、粘着ストリップ材を用いた使い捨てタイプのバンドアセンブリ２とからなる。検出体アセンブリ１は、一対のハウジングとなるフード３、４、これらに個別に収納した発光ダイオード及び受光素子、フード３、４間及び外部機器への信号伝送用の可撓性のケーブル７及びケーブルアセンブリ８からなる。フード３、４は外部への開口部を有する。バンドアセンブリ２は、粘着部９、連結テープ部１０、２つのスタッド１１からなり、各スタッドが中空の胴部を備える。スタッド１１は、フード３、４をスナップ止めする突状環状部２９を有する。フード３、４の内部でスタッド１０の装着部分は回転可能とする。
【選択図】　図１



【特許請求の範囲】
【請求項１】
患者に接着して用いる電子？光学的医療用センサであって、モニタ機器への接続用の少なくとも一本のケーブルを有し、センサ本体が、該ケーブルを患者の身体へ少なくとも一つ以上の方向から取り付け可能としてなることを特徴とする医療用センサ。
【請求項２】
請求項１の医療用センサにおいて、上記ケーブルを、上記センサ本体に対する取り付け位置を中心に揺動可能に取り付けてなることを特徴とする医療用センサ。
【請求項３】
少なくとも１個のＬＥＤと、少なくとも１個の光検出体を有し、該光検出体を、モニタ機器への接続用の少なくとも一本のケーブルに接続し、該ケーブルを患者の身体へ少なくとも一つ以上の方向から取り付け可能としてなることを特徴とする医療用センサ。
【請求項４】
請求項３の医療用センサにおいて、上記ケーブルを、上記センサ本体に対する取り付け位置を中心に揺動可能に取り付けてなることを特徴とする医療用センサ。
【請求項５】
パルス式酸素濃度センサであって、１個の光検出体と、少なくとも２個のＬＥＤを有し、これら光検出体とＬＥＤをモニタ機器への接続用の少なくとも一本のケーブルに接続し、該ケーブルを患者の身体へ少なくとも一つ以上の方向から取り付け可能としてなることを特徴とするパルス式酸素濃度センサ。
【請求項６】
請求項５のパルス式酸素濃度センサにおいて、上記ケーブルを、上記センサ本体に対する取り付け位置を中心に揺動可能に取り付けてなることを特徴とするパルス式酸素濃度センサ。
【請求項７】
請求項５または６のパルス式酸素濃度センサにおいて、上記センサ本体を粘着剤により患者の身体へ取り付け可能としてなることを特徴とするパルス式酸素濃度センサ。
【請求項８】
請求項７のパルス式酸素濃度センサにおいて、上記センサ本体が二つの部分からなり、一の部分が１個の光検出体と少なくとも２個のＬＥＤを有し、他の部分が粘着性の部分を有するバンド状部材であることを特徴とするパルス式酸素濃度センサ。
【請求項９】
請求項１ないし４のいずれかの医療用センサまたは請求項５ないし８のいずれかのパルス式酸素濃度センサの上記ケーブルを、既存のパルス式酸素濃度センサに少なくとも二つ以上の方向から取り付け可能としてなることを特徴とするパルス式酸素濃度センサの取り付けキット。
【請求項１０】
請求項９のパルス式酸素濃度センサの取り付けキットにおいて、上記ケーブルを、上記センサ本体に対する取り付け位置を中心に揺動可能に取り付けてなることを特徴とするパルス式酸素濃度センサの取り付けキット。
【請求項１１】
請求項１ないし４のいずれかの医療用センサまたは請求項５ないし８のいずれかのパルス式酸素濃度センサを、既存のパルス式酸素濃度センサの検知部に取り付け可能としてなるパルス式酸素濃度センサの取り付けキットにおいて、センサ本体が、複数のＬＥＤ、光検出体及び粘着テープへの取り付け手段を含み、該粘着テープへの取り付け手段が、上記センサ本体を少なくとも一つ以上の方向から取り付け可能としてなることを特徴とするパルス式酸素濃度センサの取り付けキット。
【請求項１２】
請求項１１のパルス式酸素濃度センサの取り付けキットにおいて、上記粘着テープへの取り付け手段が、粘着テープをも含むことを特徴とするパルス式酸素濃度センサの取り付け

キット。
【請求項１３】
請求項１１のパルス式酸素濃度センサの取り付けキットにおいて、上記取り付け手段がスナップ取り付け用のものであることを特徴とするパルス式酸素濃度センサの取り付けキット。
【請求項１４】
請求項１１のパルス式酸素濃度センサの取り付けキットにおいて、上記取り付け手段がスナップ取り付け用の円形のものであることを特徴とするパルス式酸素濃度センサの取り付けキット。
【請求項１５】
発光体及び受光体を備える検出体アセンブリと、粘着ストリップ材を用いた使い捨てタイプのバンドアセンブリとからなるパルス式酸素濃度センサであって、上記発光体から射出させた光を患者の身体を透過させ、上記受光体で受光するものにおいて、
上記検出体アセンブリは、少なくとも一対のハウジングと、該一対のハウジングにそれぞれ個別に収納した発光ダイオード及び受光素子と、上記一対のハウジング間を接続するとともに信号伝送用の配線を内包した可撓性のケーブルと、外部機器への信号伝送用の配線を内包し、上記一対のハウジングの一方に取り付けた可撓性のケーブルアセンブリとからなり、上記ハウジングがそれぞれ外部への開口部を有し、
上記バンドアセンブリは、一面側の少なくとも一部分に粘着面部を有し、他面側に少なくとも２つのスタッドを突設し、各スタッドが少なくとも一つの透過性開口を備え、
上記スタッドが、上記ハウジングの上記開口部をスナップ止めで装着、係合可能とする環状の突部を有してなることを特徴とするパルス式酸素濃度センサ。
【請求項１６】
請求項１５のパルス式酸素濃度センサの取り付けキットにおいて、上記ハウジングの内部で上記スタッドの装着部分が回転としてなることを特徴とするパルス式酸素濃度センサ。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明は、患者の手の指、足の指等に装着して血中の酸素の状態を測定するための医療用センサに関し、特にパルス式酸素濃度センサと称されるかつ再使用可能なもの、及びこれらセンサを患者の身体に取り付けるためのキットに関する。
【０００２】
【従来の技術】
病院であれ、病院外であれ、医療においては、患者の血中の酸素濃度をモニタすることが重要視されている。血中酸素濃度が低い場合、短時間で脳に損傷を与え、あるいは死に至ることもあるためである。酸素濃度測定方法としてはパルス酸素測定法が良く知られている。この方法は、酸素供給の指標である動脈血の酸素飽和度を測定する非侵襲性のものであり、使用する測定センサは、検出体アセンブリと、これを患者の指等に装着する粘着ストリップ材を用いた使い捨てタイプのバンドアセンブリとからなり、プローブは、監視用のモニタ等に接続するためのケーブルアセンブリを含んでいる。
【０００３】
検出体アセンブリ、プローブは、発光体及び受光体を備える。発光体は、例えば赤色光と赤外光の両方の発光ダイオード（ＬＥＤ）から構成し、受光体は、ＬＥＤ等の発光体が射出する光を受光するのに適する光ダイオード等の受光素子で構成する。このようなプローブを患者の手の指や足の指、または患者が年少者等の場合には足に取り付け、発光体から射出する光が、患者の指の爪、動脈、脈管、毛細血管、組織、骨等を照射するようにセットする。受光体は、発光体の射出光が体組織を透過してきた光を検出できるように発光体の反対側に配置する。
【０００４】
このようなパルス式酸素濃度センサによって得るデータは、プローブの発光体が射出した

二つの波長の光の動脈血による示差吸収データであり、これを解析することによって酸素飽和度が決定できる。すなわち、プローブの二種類の発光体を交互にオン？オフさせて赤色光と赤外光を交互に患者の被測定部位に対して照射し、その透過光を受光体によって検出する。そして、受光体の出力電流が検出した透過光の強度に比例することを利用して赤色光及び赤光の強度比を算出し、この比に基づいて、例えば経験的にあらかじめ設定したテーブルデータによって患者の血液中の酸素飽和値を決定する。

【０００５】

【発明が解決しようとする課題】

このようなパルス式酸素濃度センサの使用は明確に利点があるが、患者の身体への固定が難しく、固定状態が安定しないと良い検出データを安定して取り難く、包帯等で患者に固定するとケーブルの位置がずれてしまった場合等に直すのが面倒である。また包帯等での固定では患者の動きを規制し、しかもＬＥＤ等が熱を発するので、包帯等であまりしっかりと装着してしまうと、ケーブルが動いてデータの質が劣化することは防ぎ得るものの、患者にとっては心地良いものではなくなる。したがって、特に新生児に用いるには危険と不都合が両方存在することになる。またクリップ状の治具を用いて固定する例もあるが、患者に苦痛を与えることになりかねない。コストも一般的なセンサより高価であり、現在かなりの数が使用されているため、他者への感染を防止するために全体を使い捨てにすると、非常に多量の環境廃棄物を生じさせてしまうことになり、コスト以上に問題となる。

【０００６】

本発明は、上記従来の問題点を解決し、製造コストが安価でかつ使用し易い医療用センサ、パルス式酸素濃度センサ、これらセンサを患者の身体に取り付けるためのキットを提供することを目的とする。

【０００７】

【課題を解決するための手段】

本発明の請求項１に係る医療用センサは、上記目的を達成するために、患者に接着して用いる電子？光学的医療用センサであって、モニタ機器への接続用の少なくとも一本のケーブルを有し、センサ本体が、該ケーブルを患者の身体へ少なくとも一つ以上の方向から取り付け可能としてなることを特徴とする。

【０００８】

同請求項２に係るものは、上記目的を達成するために、請求項１の医療用センサにおいて、上記ケーブルを、上記センサ本体に対する取り付け位置を中心に揺動可能に取り付けてなることを特徴とする。

【０００９】

同請求項３に係るものは、上記目的を達成するために、少なくとも１個のＬＥＤと、少なくとも１個の光検出体を有し、該光検出体を、モニタ機器への接続用の少なくとも一本のケーブルに接続し、該ケーブルを患者の身体へ少なくとも一つ以上の方向から取り付け可能としてなることを特徴とする。

【００１０】

同請求項４に係るものは、上記目的を達成するために、請求項３の医療用センサにおいて、上記ケーブルを、上記センサ本体に対する取り付け位置を中心に揺動可能に取り付けてなることを特徴とする。

【００１１】

同請求項５に係るパルス式酸素濃度センサは、上記目的を達成するために、１個の光検出体と、少なくとも２個のＬＥＤを有し、これら光検出体とＬＥＤをモニタ機器への接続用の少なくとも一本のケーブルに接続し、該ケーブルを患者の身体へ少なくとも一つ以上の方向から取り付け可能としてなることを特徴とする。

【００１２】

同請求項６に係るものは、上記目的を達成するために、請求項５のパルス式酸素濃度センサにおいて、上記ケーブルを、上記センサ本体に対する取り付け位置を中心に揺動可能に取り付けてなることを特徴とする。

【００１３】
同請求項７に係るものは、上記目的を達成するために、請求項５または６のパルス式酸素濃度センサにおいて、上記センサ本体を粘着剤により患者の身体へ取り付け可能としてなることを特徴とする。
【００１４】
同請求項８に係るものは、上記目的を達成するために、請求項７のパルス式酸素濃度センサにおいて、上記センサ本体が二つの部分からなり、一の部分が１個の光検出体と少なくとも２個のＬＥＤを有し、他の部分が粘着性の部分を有するバンド状部材であることを特徴とする。
【００１５】
同請求項９に係るものは、上記目的を達成するために、請求項１ないし４のいずれかの医療用センサまたは請求項５ないし８のいずれかのパルス式酸素濃度センサの上記ケーブルを、既存のパルス式酸素濃度センサに少なくとも二つ以上の方向から取り付け可能としてなることを特徴とする。
【００１６】
同請求項１０に係るものは、上記目的を達成するために、請求項９のパルス式酸素濃度センサの取り付けキットにおいて、上記ケーブルを、上記センサ本体に対する取り付け位置を中心に揺動可能に取り付けてなることを特徴とする。
【００１７】
同請求項１１に係るパルス式酸素濃度センサの取り付けキットは、上記目的を達成するために、請求項１ないし４のいずれかの医療用センサまたは請求項５ないし８のいずれかのパルス式酸素濃度センサを、既存のパルス式酸素濃度センサの検知部に取り付け可能としてなるパルス式酸素濃度センサの取り付けキットにおいて、センサ本体が、複数のＬＥＤ、光検出体及び粘着テープへの取り付け手段を含み、該粘着テープへの取り付け手段が、上記センサ本体を少なくとも一つ以上の方向から取り付け可能としてなることを特徴とする。
【００１８】
同請求項１２に係るものは、上記目的を達成するために、請求項１１のパルス式酸素濃度センサの取り付けキットにおいて、上記粘着テープへの取り付け手段が、粘着テープをも含むことを特徴とする。
【００１９】
同請求項１３に係るものは、上記目的を達成するために、請求項１１のパルス式酸素濃度センサの取り付けキットにおいて、上記取り付け手段がスナップ取り付け用のものであることを特徴とする。
【００２０】
同請求項１４に係るものは、上記目的を達成するために、請求項１１のパルス式酸素濃度センサの取り付けキットにおいて、上記取り付け手段がスナップ取り付け用の円形のものであることを特徴とする。
【００２１】
同請求項１５に係るパルス式酸素濃度センサは、上記目的を達成するために、発光体及び受光体を備える検出体アセンブリと、粘着ストリップ材を用いた使い捨てタイプのバンドアセンブリとからなるパルス式酸素濃度センサであって、上記発光体から射出させた光を患者の身体を透過させ、上記受光体で受光するものにおいて、上記検出体アセンブリは、少なくとも一対のハウジングと、該一対のハウジングにそれぞれ個別に収納した発光ダイオード及び受光素子と、上記一対のハウジング間を接続するとともに信号伝送用の配線を内包した可撓性のケーブルと、外部機器への信号伝送用の配線を内包し、上記一対のハウジングの一方に取り付けた可撓性のケーブルアセンブリとからなり、上記ハウジングがそれぞれ外部への開口部を有し、上記バンドアセンブリは、一面側の少なくとも一部分に粘着面部を有し、他面側に少なくとも２つのスタッドを突設し、各スタッドが少なくとも一つの透過性開口を備え、上記ハウジングの上記開口部を上記スタッドに着脱可能に係合可

能としてなることを特徴とする。
【００２２】
請求項１６に係るパルス式酸素濃度センサは、上記目的を達成するために、請求項１５のパルス式酸素濃度センサの取り付けキットにおいて、上記ハウジングの内部で上記スタッドの装着部分が回転としてなることを特徴とする。
【００２３】
【発明の実施の形態】
以下本発明の実施の形態を図面を参照して説明する。なお以下では、本発明の一つの好ましい実施形態の説明をするが、本発明のその他の実施形態、用途等は当業者に明らかであるので説明を省略する。もちろん本発明が図示の例に限定されることはない。
【００２４】
図１は本発明に係るパルス式酸素濃度センサの一実施形態を示す分解斜視図である。本実施形態のパルス式酸素濃度センサは、発光体及び受光体を備える検出体アセンブリ１と、粘着ストリップ材を用いた使い捨てタイプのバンドアセンブリ２とから構成してあり、発光体から射出させた光を患者の身体を透過させ、それを受光体で受光するものである。また検出体アセンブリ１とバンドアセンブリ２を患者の身体への取り付け用にキット化したものとなっている。
【００２５】
検出体アセンブリ１は、各種構成要素を収納するハウジングとなる一対のフード３、４と、これらのフード３、４内に発光ダイオードや受光素子を収納するためのシャーシ５、５と、シャーシ５をフード３、４内にそれぞれ固定するためのスプリングクリップ６、６と、フード３、４間を接続するとともに信号伝送用の配線を内包した可撓性のケーブル７と、図示しない制御機器やモニタ等の外部機器への信号伝送用の配線を内包し、一方のフード３に取り付けた可撓性のケーブルアセンブリ８とから構成してある。なおフード３、４とシャーシ５は、医療用に適するグレードのＡＢＳ樹脂等を用いて形成する。
【００２６】
バンドアセンブリ２は、図中下面に粘着剤を有し、患者の身体に貼り付け可能な矩形で島状の粘着部９、９と、その間に張り渡した粘着部９より細幅の連結テープ部１０と、粘着部９上面と連結テープ部１０の下面との間に挟んで保持した一対のスタッド１１、１１と、粘着部９の下面を保護するための離型シート１２から構成してある。粘着部９は、例えば厚さが０．０１３ｍｍで感圧粘着タイプで透光性を有するポリエステル等を用いて構成し、その形状は図示のような矩形以外にも種々公知の形状を採用できる。または連結テープ部１０も同素材で形成して粘着部９の上面に貼り付けるが、粘着部９、９の間の部分の下面が粘着剤を有しないようにする必要がある。連結テープ部１０は、透光性を有しなくてもよい。スタッド１１については後述する。離型シート１１は公知のもの、例えばシリコンをコーティングしたクラフトテープ等を用いればよく、もちろん使用時には剥離させて粘着部９の粘着面を露出させる。
【００２７】
図２は検出体アセンブリ１の断面図、図３はフード３の平面図（Ａ）と底面図（Ｂ）、図４はフード４の平面図（Ａ）と底面図（Ｂ）、図５はシャーシ５の斜視図である。
【００２８】
検出体アセンブリ１を構成するフード３は、図３に示すように、略半球状で中空の受光体収納部１３と、中空円筒状でスプリングクリップ６の端部６ａを収納するクリップ端収納部１４と、クリップ端収納部１４と軸線が直交するように伸びるケーブル７への接続部１５とから構成してある。受光体収納部１３内には、図２に示すように、受光体であるフォトデテクタ１６を例えばモールド成形により備えたシャーシ５を収納してフォトデテクタ１６をケーブル７と接続させ、最下端にスプリングクリップ６を装着して落下止めとしてある。また図３（Ｂ）に示すように、受光体収納部１３の下面には、受光用の開口部１７が設けてある。なお図示のような形状、構造のフード３は、例えば上部と下部とを別体で形成して張り合わせる等して形成すると製造が容易である。また受光体には後述するフー

ド４が備える発光体との組み合わせで適するものを用いることになるので、フォトデテクタには限定されない。

【００２９】

他のフード４は、図４に示すように、略半球状で中空の発光体収納部１８と、フード３と同様のクリップ端収納部１９と、クリップ端収納部１９と軸線が直交するように発光体収納部１８の一側へ伸びるケーブル７の挿通部２０と、その反対側へ伸びるケーブルアセンブリ８への接続部２１とから構成してある。発光体収納部１８内には、図２に示すように、発光体であるＬＥＤ２２を例えばモールド成形によりシャーシ５に収納してケーブルアセンブリ８と接続させ、最下端にスプリングクリップ６を装着して落下止めとしてある。また図４（Ｂ）に示すように、発光体収納部１８の下面には、光を射出させるための開口部２３が設けてある。なお、ケーブル７は挿通部２０を貫通して接続部２１内を通り、接続部２１の外側ではケーブルアセンブリ８の一部としてまとめてある。また発光体としてはパルス式酸素濃度センサの分野において周知のように、２種類のＬＥＤ２２を使用することになるが、発光体としてはＬＥＤに限定されず、種々のものを用い得る。さらに、フード４についても、例えば上部と下部とを別体で形成して張り合わせる等して形成すると製造が容易である。

【００３０】

シャーシ５は、フード３、４への装着用の頂部２４と、その下側に連なる半割れの胴部２５と、中央に開口２６を設けたフランジ部２７とから構成してある。頂部２４にはケーブル７あるいはケーブルアセンブリ８を装着するための断面が半円状の溝２８が形成してある。このシャーシ６をフード３、４へ取り付ける形態は、胴部２５がクリップ端収納部１４、１９の反対側に位置するように装着し、胴部２５内に装着したクリップ６の端部６ａをクリップ端収納部１４、１９内へ装着する際の邪魔にならないようにする。そしてフード３、４へ装着した状態では、フード３、４の開口部１６、２４と開口２６とを軸線が一致した状態、すなわちＬＥＤ２２が射出する光が開口部１６から開口２６を通って外部へ出る状態に、また開口部１６に入射する光が開口２６を通ってフォトデテクタ１６へ達し得る状態になる。なお、少なくともフード４とこれに装着するシャーシ５の光に対して露出する内壁面を光が乱反射しにくい面性状のものにしておくと、受光性が向上することはもちろんである。

【００３１】

図６は、バンドアセンブリ２に取り付けた状態のスタッド１１の拡大断面図である。スタッド１１は、頂部にシャーシ６をスナップ装着するための突状環状部２９を備えた中空円筒状の胴部３０と、粘着部９と連結テープ部１０との間に挟んで固定するためのフランジ部３１とから構成してある。突状環状部２９の外径はシャーシ５の開口２６の径よりは若干大きくしてある。

【００３２】

図７は、患者の指等にバンドアセンブリ２を貼り付けた状態でスタッド１１にシャーシ５を嵌着する際の拡大断面図である。この図からわかるように、フード３、４をスタッド１１に取り付けるには、シャーシ５の開口２６をスタッド１１の胴部３０の頂部にあてがってフード３、４に上面側から軽く力を掛け、シャーシ５の開口２６の縁が突状環状部２９を乗り越えるようにする、いわゆるスナップ止めを行う。スナップ止め後は、図７（Ｂ）に示す状態となり、突状環状部２９がそれより径が大きいシャーシ５の内部に入るため、シャーシ５とそれを装着したフード３、４はスタッド１１の軸線の周りで比較的自由に回転できる状態になる。なお、取り外しは、バンドアセンブリ２ごと患者の指３２等から引き剥がした後で行えばよいが、剥がす前でも後でも、シャーシ５の開口２６の縁が突状環状部２９を、上記とは逆に、スタッド１１から外れる方向へ突状環状部２９を乗り越えるようにフード３、４に若干力を掛けるだけでよい。

【００３３】

図８は、患者の指３２にバンドアセンブリ２を貼り付け、スタッド１１にシャーシ５を嵌着してフード３、４を取り付けた状態の拡大斜視図である。例えば指３２へ図７（Ａ）の

ように取り付けた後、患者が指３２を動かして向きを変えたとすると、ケーブルアセンブリ８は図示しないモニタ装置等との接続により向きがある程度規制されるため、あまり大きくは動けず、指３２との相対位置が変わる。従来の構造ではそのような事態が生じると、ケーブルアセンブリ８がフード３、４の位置保持に対する干渉となり、フード３、４が患者の身体から外れたりしてしまうが、本実施形態では上述のようにスタッド１１の軸線周りでフード３、４及びそれらに装着したフォトデテクタ１６やＬＥＤ２２が回転し、安定した計測を継続できる。なお図中３３は指の爪である。また、計測内容については従来公知の例と同様であるので、説明は省略する。

【００３４】

なお、以上説明してきた実施形態はパルス式酸素濃度センサについてのものであるが、本発明はその他の医療用センサと、このセンサを患者の身体に取り付けるためのキットとして用いることも可能なことは上記の説明から明らかである。また図示の実施形態ではフード３、４へのケーブル７、ケーブルアセンブリ８の取り付けは、フィックスと称する固定的取り付けであるが、例えばユニバーサルジョイント状の取り付け形態を採用することも可能であり、上記実施形態よりもさらにケーブルの動きによるフード３、４への干渉を低減させ得る。

【００３５】

【発明の効果】

本発明に係る医療用センサ、パルス式酸素濃度センサ、これらセンサを患者の身体に取り付けるためのキットは、それぞれ以上説明してきたようなものなので、患者が装着箇所の身体を動かす等しても、ケーブルの干渉を受けることなく装着状態を正確に維持でき、発光体や受光体が患者の皮膚から分離することによる光学的損失を生じさせることがなく、発光体やケーブルを患者の皮膚から離して装着できるため、ＬＥＤやケーブルの熱が皮膚に直接に伝わらなくなり、患者が火傷をする等の事故を防ぐことができるようになり、発光体等の光学的素子をモールド成形できるために防水化、防振化でき、しかも正確な血中酸素濃度のモニタリングを可能とし、さらにはさほどコストが高くはない粘着部品だけを使い捨てにすることができ、高コストである部分は何回でも使用可能になるので、一つのセンサとしてのコストがかりに高くなっても、全使用量を考慮した場合のトータルコストは十分に低下する。

【図面の簡単な説明】

【図１】本発明に係るパルス式酸素濃度センサの一実施形態を示す分解斜視図である。

【図２】検出体アセンブリの断面図である。

【図３】一方のフードの平面図（Ａ）と底面図（Ｂ）である。

【図４】他方のフードの平面図（Ａ）と底面図（Ｂ）である。

【図５】シャーシの斜視図である。

【図６】バンドアセンブリに取り付けた状態のスタッドの拡大断面図である。

【図７】スタッドにシャーシを嵌着する際の拡大断面図である。

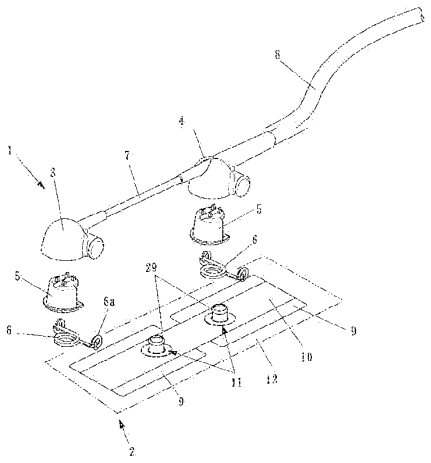
【図８】患者の指にバンドアセンブリを貼り付け、スタッドにシャーシを嵌着してフードを取り付けた状態の拡大斜視図である。

【符号の説明】

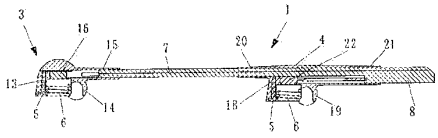
１　検出体アセンブリ
２　バンドアセンブリ
３、４　フード
５　シャーシ
６　スプリングクリップ
６ａ　スプリングクリップの端部
７　ケーブル
８　ケーブルアセンブリ
９　粘着部
１０　連結テープ部

１１　スタッド
１２　離型シート
１３　受光体収納部
１４　クリップ端収納部
１５　接続部
１６　フォトデテクタ
１７　開口部
１８　発光体収納部
１９　クリップ端収納部
２０　挿通部
２１　接続部
２２　ＬＥＤ
２３　開口部
２４　頂部
２５　胴部
２６　開口
２７　フランジ部
２８　溝
２９　突状環状部
３０　胴部
３１　フランジ部
３２　患者の指
３３　患者の指の爪

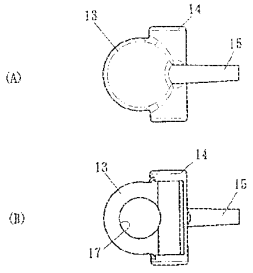
【図１】



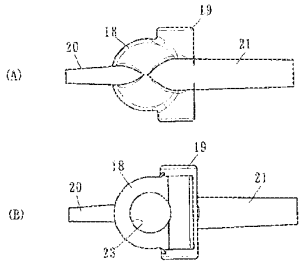
【図２】



【図３】



【図４】



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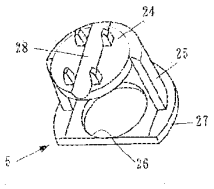
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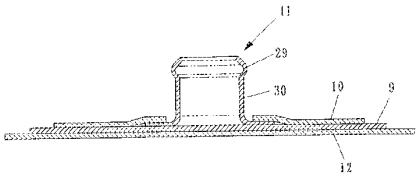
【図６】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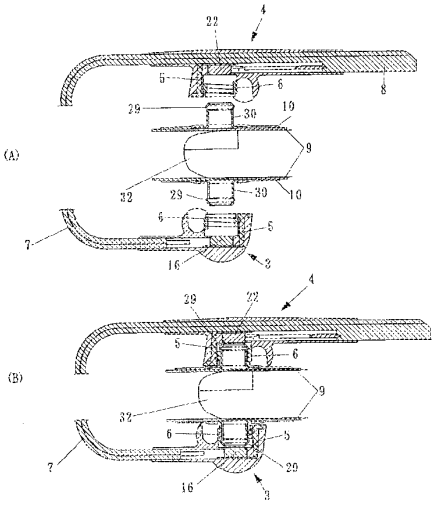
【図７】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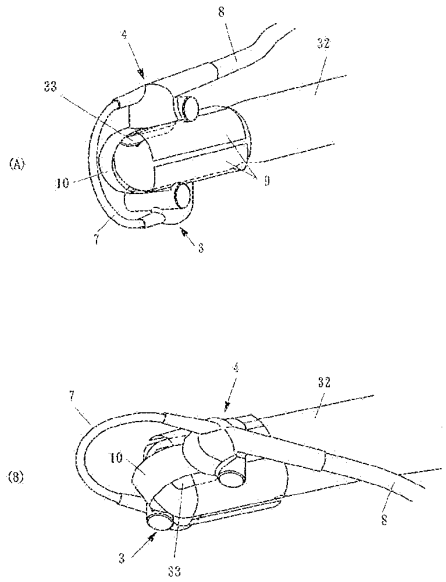
【図８】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フロントページの続き

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Ｆターム(参考) 2G059 AA01 AA06 BB13 CC07 DD13 EE01 GG02 GG03 GG08 KK03
4C038 KK01 KL05 KL07 KM00 KY03 KY04

Espacenet

Bibliographic data: JP2005270543 (A) — 2005-10-06

BIOLOGICAL INFORMATION MEASURING DEVICE

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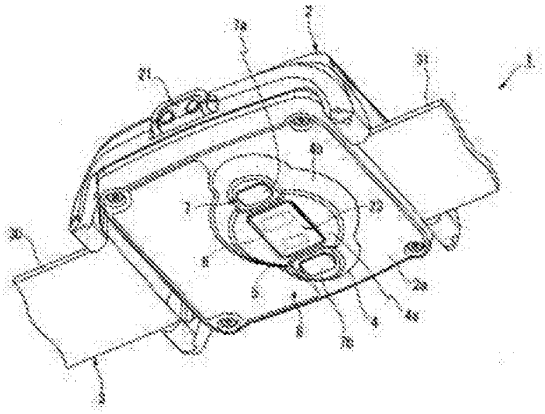
Classification: **- international:** ***A61B5/024; A61B5/0245;*** (IPC1-7): A61B5/0245
- cooperative: **A61B5/02416 (EP); A61B5/681 (EP)**

Application number: JP20040091942 20040326 Global Dossier

Priority number(s): JP20040091942 20040326

Also published as: JP4485234 (B2) WO2005092182 (A1)

Abstract of JP2005270543 (A)



PROBLEM TO BE SOLVED: To provide a biological information measuring device capable of improving adhesion and being put on for a long period of time without an unpleasant feeling. SOLUTION: The biological information measuring device 1 comprises: a main body 2; a projection part 4 formed by being projected from the lower surface 2a of the main body 2; a fixing means 3 for mounting the main body 2 on an arm in the state of turning the lower surface 2a of the main body 2 to a living body surface side; a living body sensor part 8 provided with a light emitting part 5 for emitting light toward a living body in the state of being in contact with a living body surface, a light receiving part 6 for receiving reflected light from the living body of the light emitted by the light emitting part 5 and generating biological information signals corresponding to a received light quantity and a contact detection means 7 for detecting whether or not the light emitting part 5 and the light receiving part 6 are in contact with the living body surface; and a

biological information detection part provided in the main body 2 for detecting biological information on the basis of the biological information signals. The living body sensor part 8 provides the biological information measuring device 1 that is arranged on the lower surface 4a of the projection part 4. ;COPYRIGHT: (C)2006,JPO&NCIPI

CLAIMS JP2005270543

1.

A main body, a protruding portion formed to protrude from the lower surface of the main body, a fixing means for mounting the main body on an arm with the lower surface of the main body facing the biological surface, and a living body in contact with the biological surface A light emitting unit that emits light toward the light, a light receiving unit that receives reflected light from the living body and generates a biological information signal according to the amount of received light among the light emitted by the light emitting unit, and a light A biological sensor unit having contact detecting means for detecting whether or not the light emitting unit and the light receiving unit are in contact with the surface of the biological body, and biological information provided in the main body and detecting biological information based on the biological information signal A biological information measuring device, wherein the biological sensor unit is disposed on a lower surface of the protruding portion.

2.

2. The biological information measuring apparatus according to claim 1, wherein at least one protrusion is formed on the lower surface of the main body so as to protrude from the lower surface of the main body at a predetermined distance from a side surface of the protrusion. A distance between the lower surface of the ridge and the lower surface of the main body is set to be equal to or greater than the distance between the lower surface of the protruding portion and the lower surface of the main body. A biological information measuring device as a feature.

3.

The biological information measuring apparatus according to claim 1 or 2, wherein the contact

detection means includes at least a pair of electrodes, and the light emitting unit and the light receiving unit are based on a potential difference between the pair of electrodes. A biological information measuring device for detecting whether or not the surface of a biological body is touched.

4.

The biological information measuring apparatus according to claim 3, wherein the pair of electrodes are arranged so as to sandwich the light emitting unit and the light receiving unit therebetween.

5.

5. The biological information measuring apparatus according to claim 1, further comprising: a flexible substrate that electrically connects the light emitting unit and the light receiving unit to the biological information detecting unit. The biological information measuring apparatus according to claim 1, wherein the substrate is provided in the main body so as to press the light emitting unit and the light receiving unit toward the lower surface side of the main body by its elasticity.

6.

The biological information measuring apparatus according to claim 1, further comprising a display unit that displays detected biological information on an upper surface of the main body.

7.

The biological information measuring apparatus according to any one of claims 1 to 6, wherein the fixing means includes a first band and a second band that are attached to an arm with a proximal end attached to the main body, The biological information measuring device, wherein the first band and the second band are arranged so as to face each other with the main body interposed therebetween, and are formed of a stretchable elastic material.

8.

The biological information measuring apparatus according to claim 7, wherein the biological sensor unit is arranged at a position shifted from a center position of the main body toward a proximal end side of the first band or the second band. A biological information measuring device as a feature.

9.
The biological information measuring apparatus according to any one of claims 1 to 8, wherein the main body includes a rechargeable battery that can be charged and a charging unit that charges the rechargeable battery with electric power. Biological information measuring device.

10.
The biological information measuring device according to any one of claims 1 to 9, wherein a distance between a lower surface of the protruding portion and a lower surface of the main body is set to 2 to 4 mm. apparatus.

11.
The biological information measuring device according to any one of claims 1 to 10, wherein the protruding portion is formed so that an outer periphery thereof is circular.

12.
The biological information measuring apparatus according to claim 11, wherein the protruding portion is formed such that an outer edge is a curved surface.

13.
The biological information measuring apparatus according to claim 11, wherein the protruding portion is formed to be a curved surface from the center of the lower surface toward the outer edge.

14.
The biological information measuring device according to any one of claims 11 to 13, wherein a diameter of the projecting portion is set to 20 mm or less.

15.
The biological information measuring device according to any one of claims 2 to 14, wherein the protruding portion is provided at a position spaced 8 mm from a side surface of the protruding portion, and the lower surface of the protruding portion and the main body. A biological information measuring device characterized in that the distance to the lower surface is set to 4 mm.

DESCRIPTION JP2005270543

PROBLEM TO BE SOLVED To perform wearing for a long time without feeling uncomfortable while improving adhesion. [MEANS FOR SOLVING PROBLEMS] A main body (2), a protruding portion (4) projecting from a lower surface (2a) of the main body (2), and a fixing means (3) for attaching the main body (2) to an arm with the lower surface (2a) of the main body (2) facing the living body surface. And a light emitting unit 5 that emits light toward the living body in contact with the surface of the living body, and a living body that receives reflected light from the living body among the light emitted by the light emitting unit 5 and that corresponds to the amount of light received Provided in the main body 2, a biological sensor unit 8 having a light receiving unit 6 that generates an information signal, and a contact detection unit 7 that detects whether the light emitting unit 5 and the light receiving unit 6 are in contact with the biological surface. And a biological information detection unit that detects biological information based on the biological information signal, and the biological sensor unit 8 provides the biological information measuring device 1 disposed on the lower surface 4a of the protruding portion 4. [Selection] Figure 5

Biological information measuring device

[0001]
The present invention relates to a biological information measuring apparatus capable of measuring biological information such as a pulse rate while being worn on a wrist (arm).

[0002]
Due to the recent increase in interest in health management, various biological information measuring devices capable of measuring various biological information such as pulse rate while

being worn on the wrist (arm) or the like have been provided (for example, Patent Document 1). reference).

[0003]

Among this type of biological information measuring device, for example, a device that detects a pulse rate irradiates light toward a living body while being worn on a wrist, and reflects light from a blood vessel by a pulse sensor or the like, that is, reflected light. A signal is received, a pulse signal corresponding to a pulse is extracted from the reflected signal, and a pulse rate is calculated.

Particularly, since the pulse rate can be easily measured while wearing on the wrist, it is easily used by the user.

JP 2001-78973 A (paragraph numbers 0011-0031, FIG. 1 to FIG. 7)

[0004]

The above-described conventional biological information measuring apparatus is generally used by being worn on the wrist. However, depending on the movement of the user, the muscle moves and the thickness (diameter) of the wrist changes, which may cause a gap between the biological information measuring device and the biological surface. For this reason, there is a possibility that the adhesiveness is lowered and accurate biological information cannot be detected. Further, in order to securely fix the biological information measuring device to the wrist, for example, when it is tightened with a band, a feeling of pressure on the wrist increases and it is difficult to perform wearing for a long time.

[0005]

The present invention has been made in view of such circumstances, and an object of the present invention is to provide a biological information measuring device that can be worn for a long time without feeling uncomfortable while improving adhesion. That is.

[0006]

The present invention provides the following means in order to solve the above problems.

[0007]

The biological information measuring device of the present invention includes a main body, a protruding portion formed to protrude from the lower surface of the main body, and a fixing means for attaching the main body to the arm with the lower surface of the main body facing the biological surface side, A light emitting unit that emits light toward the living body in contact with the surface of the living body, and a living body information signal that receives reflected light from the living body among the light irradiated by the light emitting unit and that corresponds to the amount of light received A living body sensor section having a light receiving section for generating a light, a contact detecting means for detecting whether the light emitting section and the light receiving section are in contact with the surface of the living body, and the body information signal. And a biological information detection unit that detects biological information based on the biological sensor unit, wherein the biological sensor unit is disposed on a lower surface of the protruding portion.

[0008]

In the biological information measuring apparatus according to the present invention, the fixing means irradiates light from the light emitting unit toward the living body after the body is mounted on the wrist (arm).

A part of the irradiated light is absorbed by, for example, hemoglobin in the blood vessel, and a part of the other light is reflected by the living tissue.

The light receiving unit receives the reflected light and generates a biological information signal such as a pulse signal corresponding to the amount of received light.

Then, the biological information detection means can perform predetermined processing on the biological information signal to detect biological information such as the pulse rate. In addition, it is possible to detect whether or not the light emitting unit and the light receiving unit are reliably in contact with the living body surface by the contact detection means.

[0009]

In particular, when the main body is attached to the wrist by the fixing means, since the protruding portion protrudes from the lower surface of the main body, the living body surface and the lower surface of the protruding portion are easily brought into contact with each other. That is, the adhesion of the biosensor unit is improved. Therefore, it is not necessary to fix the main body so that it is strongly pressed against the surface of the living body (to be pressed) by the fixing means. Therefore, even if it is worn for a long time, there is no discomfort. Moreover, since the adhesiveness of the biosensor unit is improved, the light emitting unit and the light receiving unit can efficiently irradiate and receive light. Therefore, it is possible to detect biological information with high accuracy.

[0010]
Further, the biological information measuring apparatus according to the present invention is the biological information measuring apparatus according to the present invention, wherein the main body is located at a position spaced at least a predetermined distance from the side surface of the protruding portion while sandwiching at least the protruding portion on the lower surface of the main body. And a distance between the lower surface of the protrusion and the lower surface of the main body is the same as or the distance between the lower surface of the protrusion and the lower surface of the main body. The above distance is set.

[0011]

In the biological information measuring apparatus according to the present invention, when the main body is attached to the arm by the fixing means, the biological surface is in contact with the lower surface of the protruding portion and the lower surface of the protruding portion.

At this time, since the protruding portion protrudes at a predetermined distance from the side surface of the protruding portion while sandwiching the protruding portion, there is a gap between the protruding portion and the protruding portion. Yes. Thereby, the living body comes into contact with the lower surface of the protruding portion and the protruding strip portion in a state where the living body once enters the gap on both sides sandwiching the protruding portion. Therefore, the adhesion between the living body surface and the living body sensor unit can be ensured more reliably.

[0012]

In particular, since the protruding portion protrudes from the lower surface of the main body by the same height or higher than the protruding portion, the protruding portion contacts the living body surface at the same height as or earlier than the protruding portion. Further, the ridge portion contacts the living body surface outside the protruding portion. Thereby, the living body surface can be stably brought into contact with the lower surface of the protruding portion in the same state, and the contact pressure can be made constant. Therefore, it is possible to detect biological information stably for a long time.

[0013]
The biological information measuring apparatus according to the present invention is the biological information measuring apparatus according to the present invention, wherein the contact detecting means has at least a pair of electrodes, and the light emission based on a potential difference between the pair of electrodes. It is detected whether the part and the light receiving part are in contact with the surface of the living body.

[0014]

In the biological information measuring apparatus according to the present invention, when the main body is attached to the arm, the pair of electrodes come into contact with the surface of the living body, and discharge is performed through the surface of the living body.

Thereby, the electric potential between electrodes decreases. By detecting the potential difference between the pair of electrodes, it can be easily and reliably detected whether or not the light emitting unit and the light receiving unit are reliably in contact with the surface of the living body. Note that the electrodes do not have to be a pair. For example, a plurality of electrodes may be provided, and whether or not they are in contact may be detected based on a potential difference between these electrodes.

[0015]
Moreover, the biological information measuring device according to the present invention is characterized in that, in the biological information measuring device according to the present invention, the pair of electrodes are arranged so as to sandwich the light emitting unit and the light receiving unit therebetween. It is what.

[0016]
In the biological information measuring apparatus according to the present invention, the pair of electrodes are arranged so as to sandwich the light emitting unit and the light receiving unit therebetween, so that the light emitting unit and the light receiving unit contact the surface of the living body with high accuracy. It is possible to detect whether or not

[0017]
Moreover, the biological information measuring device according to the present invention electrically connects the light emitting unit, the light receiving unit, and the biological information detecting unit in any one of the biological information measuring devices of the present invention. A flexible substrate is provided, and the flexible substrate is provided in the main body so as to press the light emitting portion and the light receiving portion toward the lower surface side of the main body by its own elasticity. It is.

[0018]

In the biological information measuring apparatus according to the present invention, since the light emitting unit and the light receiving unit are always pressed against the lower surface side of the main body due to the elasticity of the flexible substrate, when the main body is attached to the wrist, The light receiving part is in a state of being close to the surface of the living body.

Therefore, it is possible to more efficiently irradiate and receive light with respect to the living body, and improve detection accuracy of living body information.

[0019]
Moreover, the biological information measuring device according to the present invention is characterized in that, in any one of the biological information measuring devices according to the present invention, a display unit for displaying detected biological information is provided on the upper surface of the main body. To do.

[0020]
In the biological information measuring apparatus according to the present invention, since the biological information displayed on the display unit can be easily visually confirmed, the detected biological information can be confirmed whenever necessary, or the biological information is

correctly detected. It is easy to use and simple.

[0021]
Further, the biological information measuring apparatus according to the present invention is the biological information measuring apparatus according to any one of the present invention described above, wherein the fixing means includes a first band that is attached to the arm and has a proximal end attached to the main body. A second band is provided, and the first band and the second band are arranged so as to face each other with the main body interposed therebetween, and are formed of a stretchable elastic material. is there.

[0022]

In the biological information measuring apparatus according to the present invention, the main body can be easily and reliably attached to the wrist like a wristwatch by the first band and the second band.

In particular, since both bands are made of elastic material that can be stretched, even if the thickness of the wrist changes slightly due to muscle movement, the amount of change can be absorbed. Can be prevented.

Therefore, it is not necessary to tighten both bands, and long-time wearing is possible.

[0023]
Moreover, the biological information measuring device according to the present invention is the biological information measuring device according to any one of the present invention described above, wherein the biological sensor unit is connected to the first band or the second band from the center position of the main body. It is arranged at a position shifted to the base end side.

[0024]
In the biological information measuring apparatus according to the present invention, when the main body is attached to the wrist like a wristwatch by the first band and the second band, there is some play between the wrist and the main body due to this play. Shifted due to gravity (for example, when the arm is shifted downward (ground side), or when the upper surface of the main body is held in front of the eyes with the back of the hand inside and the arm horizontal) In

this case, the biosensor unit is disposed at a position shifted from the center position of the main body to the base end side of the first band or the second band, so that the adhesion of the biosensor unit is reduced. Can be prevented.

[0025]
Moreover, the biological information measuring device according to the present invention is the biological information measuring device according to any one of the present invention, wherein the main body includes a rechargeable battery that can be charged, and a charging unit that charges the rechargeable battery with electric power. It is characterized by that.

[0026]

In the biological information measuring apparatus according to the present invention, since the external battery can be charged with the rechargeable battery via the charging means, it is not necessary to prepare a normal battery or the like separately.

Therefore, the cost for maintaining the product can be reduced.

[0027]
In the biological information measuring device according to the present invention, in any one of the biological information measuring devices according to the present invention, a distance between the lower surface of the protruding portion and the lower surface of the main body is set to 2 to 4 mm. It is characterized by.

[0028]

In the biological information measuring apparatus according to the present invention, the protrusion is attached to the wrist with the lower surface of the protrusion protruding from the lower surface of the main body by 2 to 4 mm.

Thereby, a protrusion part can be made to contact a biological body surface reliably, and the adhesiveness of a biosensor part can be ensured.

That is, when the distance between the lower surface of the protrusion and the lower surface of the main body is 2 mm or less, there are few steps and a gap is formed between the living body surface and external light is likely to enter.

In addition, when the distance between the lower surface of the protruding portion and the lower surface of the main body is 4 mm or more, a feeling of pressure is generated between the attachments and there is a height, so that the state becomes unstable. It becomes easy for outside light to enter between.

[0029]
As described above, by making the distance between the lower surface of the protruding portion and the lower surface of the main body 2 to 4 mm, it is possible to prevent a feeling of pressure and the incidence of external light.

[0030]
Moreover, the biological information measuring device according to the present invention is characterized in that, in any one of the biological information measuring devices according to the present invention, the projecting portion is formed so as to have a circular outer periphery. .

[0031]

In the biological information measuring apparatus according to the present invention, since the protruding portion is circular, when the main body is attached to the wrist, it is pushed into the surface of the biological body with an equal force.

Therefore, the adhesion is good.

[0032]
Moreover, the biological information measuring device according to the present invention is characterized in that, in any one of the biological information measuring devices according to the present invention, the protruding portion is formed such that an outer edge is a curved surface. .

[0033]

In the biological information measuring apparatus according to the present invention, since the outer edge of the projecting portion is formed in a curved surface, the adhesion can be further improved when the main body is attached to the wrist.

Moreover, even if it is worn for a long time, it is easy to wear because it is difficult to have a compression mark.

[0034]
The biological information measuring apparatus according to the present invention is characterized in that, in the biological information measuring apparatus according to the present invention, the projecting portion is formed to be a curved surface from the center of the lower surface toward the outer edge. It is.

[0035]

In the biological information measuring apparatus according to the present invention, since the curved surface is formed from the center of the lower surface of the projecting portion toward the outer edge, the biological surface is smoothly deformed when the body is attached to the wrist, and the center of the lower surface It is mounted in a state where the contact pressure of the part is increased, and the adhesion can be further improved.

Moreover, even if it is worn for a long time, it is easy to wear because it is difficult to have a compression mark.

[0036]
Moreover, the biological information measuring device according to the present invention is characterized in that, in any one of the biological information measuring devices according to the present invention, a diameter of the protruding portion is set to 20 mm or less.

[0037]
In the biological information measuring device according to the present invention, since the

diameter of the protrusion is 20 mm or less, the protrusion can be easily pressed against the surface of the living body with a light force.

[0038]
Moreover, the biological information measuring device according to the present invention is the biological information measuring device according to any one of the present invention described above, wherein the protruding portion is provided at a position spaced 8 mm from the side surface of the protruding portion. The distance between the lower surface of the part and the lower surface of the main body is set to 4 mm.

[0039]

In the biological information measuring apparatus according to the present invention, the ridge portion can be formed in the vicinity of 8 mm from the side surface of the protruding portion, and can be suppressed to a height of 4 mm.

As described above, since the ridges can be formed in a small space, the main body can be downsized, that is, the entire apparatus can be downsized.

[0040]

According to the biological information measuring apparatus of the present invention, when the main body is attached to the wrist by the fixing means, the protruding portion protrudes from the lower surface of the main body, so that the living body surface and the lower surface of the protruding portion are reliably in contact with each other. The adhesion of the biosensor unit is improved.

Therefore, it is not necessary to fix the main body so as to strongly press (squeeze) the body against the surface of the living body as in the prior art.

Therefore, even if it is worn for a long time, there is no discomfort.

Moreover, since the adhesiveness of the biosensor unit is improved, light irradiation and light reception can be performed efficiently, and biometric information can be detected with high accuracy.

[0041]
Hereinafter, an embodiment of a biological information measuring apparatus according to the present invention will be described with reference to FIGS.

[0042]
As shown in FIGS. 1 to 7, the biological information measuring apparatus 1 according to the present embodiment is a wristwatch type and detects a pulse rate which is biological information in a state of being worn on a wrist (arm) A.

[0043]

The biological information measuring apparatus 1 includes a housing (main body) 2 containing various electric parts and electronic parts, and fixing means for attaching the housing 2 to the wrist A with the lower surface 2a of the housing 2 facing the biological surface B side. 3 is provided.

Further, the lower surface 2a of the housing 2 is formed with a protruding portion 4 protruding from the lower surface 2a.

[0044]
An LED (Light Emitting Diode) 5 that irradiates light toward the living body while being in contact with the surface B of the living body, and the light emitted by the LED 5 Whether PD (Photodetector) (light receiving unit) 6 that receives reflected light from the living body and generates a pulse signal (biological information signal) corresponding to the amount of light received, and LED 5 and PD6 are in contact with living body surface B A biosensor unit 8 having a contact detection means 7 for detecting the above is disposed.

[0045]
In the housing 2, a data processing unit (biological information detection unit) 9 that detects the pulse rate based on the generated pulse signal is provided.

[0046]

The housing 2 is made of a metal material such as plastic or aluminum, and has a predetermined thickness, for example, a substantially rectangular shape when viewed from above.

A cover glass 10 having a substantially square shape is fitted in a central portion of the upper surface 2b of the housing 2, and a display unit 11 for displaying the detected pulse rate and other various information is provided inside the cover glass 10. It is arranged.

[0047]
Further, as shown in FIGS. 6 and 7, a main board 12 is provided in the housing 2, and the data processing unit 9, the display unit 11, the rechargeable battery 13, The memory 14 for recording the pulse rate, the sub-board 15 and other various electronic components are electrically connected by mounting or wiring.

[0048]

The data processing unit 9 includes an IC component such as a CPU, and after the pulse signal generated by the PD 6 is once amplified by an amplifier or the like, a predetermined process such as a fast Fourier transform process (FFT process) is performed. It has a function of detecting the pulse rate by analyzing the processing result.

The data processing unit 9 records the detected pulse rate in the memory 14 and displays it on the display unit 11 based on input from each button 20 described later.

Further, the data processing unit 9 has a function of comprehensively controlling other components.

[0049]

The display unit 11 is a liquid crystal display such as an LCD (Liquid Crystal Display), for example. In addition to the above-described pulse rate, for example, a time display function for displaying a time counted by a crystal resonator (not shown) or other It has a function to display various information.

For example, the time, date, day of the week, remaining power amount of the rechargeable battery 13 and the like can be displayed.

[0050]

As shown in FIGS. 1 and 2, the housing 2 includes a plurality of buttons 20, for example, three buttons 20 disposed on the lower surface of the display unit 11 on the upper surface 2 b of the housing 2 and the housing 2. One button 20 arranged on the side surface is provided.

Various operations can be performed by pressing these buttons 20.

For example, operations such as starting measurement of pulse rate, stopping measurement, switching display of pulse rate and time, and transmitting pulse rate data recorded in memory 14 to an external device can be performed. Yes.

[0051]

Furthermore, an external connection terminal (charging means) 21 is provided on the side surface of the housing 2 to supply power to the rechargeable battery 13 from outside such as a charger.

A cover or the like may be attached to cover the external connection terminal 21 to protect the external connection terminal 21. By doing so, it is possible to protect the external connection terminal 21 from water drops, dust, and the like, which is more preferable. Further, not only the external connection terminal 21, but also a charger and a transformer for supplying power to the housing 2 may be provided, and the rechargeable battery 13 may be charged in a non-contact state.

[0052]

As shown in FIG. 5, the protrusion 4 is formed by combining three circles when viewed from below, that is, a central circle, and two circles having a diameter smaller than the circle are sandwiched between the left and right sides. It is formed in a shape like a keyhole. Further, the protruding portion 4 is formed so that the center position thereof is shifted to the second band 31 side described later than the center position of the housing 2. Thereby, the said biosensor part 8 distribute | arranged to the lower surface of the protrusion part 4 is similarly arrange | positioned in the position shifted | deviated to the 2nd band 31 side. Further, the protruding portion 4 does not protrude perpendicularly from the lower surface of the housing 2 but is formed so that the side surface 4b is an inclined surface.

[0053]

Further, as shown in FIG. 7, a through hole 22 that penetrates the outside and the inside of the housing 2 is formed at the center of the lower surface 4 a of the protruding portion 4, and a cover glass 23 is formed so as to close the through hole 22. It is fixed to the housing 2. The LED 5 and the PD 6 are arranged adjacent to each other in a direction perpendicular to the longitudinal direction of the housing 2 so as to contact the inside of the cover glass 23. That is, the LED 5 and the PD 6 are configured to be dropped into the protruding portion 4. As a result, the LED 5 and the PD 6 are as close as possible to the biological surface B.

[0054]

At this time, as shown in FIG. 6, the LED 5 and the PD 6 are mounted on one end side of the flexible board 24 electrically connected to the sub-board 15, and the lower surface 2 a of the housing 2 is caused by the elasticity of the flexible board 24. It is arranged in a state pressed toward the side. Also from this, LED5 and PD6 are located in the lower surface 4a side of the protrusion part 4 as much as possible. That is, the LED 5 and the PD 6 are as close to the living body surface B as possible. The sub board 15 and the flexible board 14 are formed as an integral structure. The flexible substrate on which the LED 5 and the PD 6 are mounted may be fixed to the lower surface 2a side of the housing 2 with a fixing member such as a double-sided tape.

[0055]

The pulse signal generated by the PD 6 is sent to the data processing unit 9 via the flexible substrate 24, the sub substrate 15, and the main substrate 12.

[0056]

The contact detection means 7 has a pair of electrodes 7a and 7b, and the pair of electrodes 7a and 7b are arranged on the lower surface 4a of the protruding portion 4 with the LED 5 and the PD 6 interposed therebetween.

In other words, the pair of electrodes 7 a and 7 b, the LED 5, and the PD 6 are arranged in a line in a direction orthogonal to the longitudinal direction of the housing 2. The pair of electrodes 7 a and 7 b are provided so that the distal ends thereof slightly protrude from the lower surface 4 a of the protrusion 4, and the base end side is provided so as to be electrically connected to the sub-substrate 15.

[0057]

The pair of electrodes 7a and 7b has a function of detecting whether or not the living body surface B is in contact based on a potential difference between the electrodes. The data processing unit 9 is set so as to control the operation of the LED 5 so as to irradiate light from the LED 5 when, for example, it is detected that it is in contact with the living body surface B in response to the detection result. . In addition to this case, for example, when it is detected that the living body surface B is not touched, the FFT processing may be set not to be performed.

[0058]

The fixing means 3 has a first band 30 and a second band 31 that are attached to the wrist A with the base end side attached to the housing 2. The first band 30 and the second band 31 are provided in the longitudinal direction of the housing 2 so as to face each other with the housing 2 interposed therebetween. Moreover, both the bands 30 and 31 are formed with the elastic material which can be expanded·contracted.

[0059]

A buckle 30a and a tongue 30b are attached to the tip of the first band 30. The second band 31 has a plurality of insertion holes 31 a into which the tongue 30 b is inserted along the longitudinal direction of the second band 31. Thereby, the lengths of the first band 30 and the second band 31 can be adjusted according to the thickness of the wrist A of the user.

[0060]
A case will be described in which the pulse rate is detected while wearing the wrist A by the biological information measuring apparatus 1 configured as described above.

[0061]

First, as shown in FIGS. 2 and 3, the bands 30 and 31 are wound so as to wind the wrist A of the user, and the tongue 30b of the first band 30 is set to the second according to the size of the wrist A. The housing 2 is attached to the wrist A by being inserted into the insertion hole 31 a of the band 31.

When the housing 2 is attached to the wrist A, the protruding portion 4 protrudes from the lower surface 2a of the housing 2, so that the living body surface B and the lower surface 4a of the protruding portion 4 are in close contact with each other. Therefore, it is not necessary to mount the housing 2 so as to tighten the wrist A, and the lengths of both bands 30 and 31 may be adjusted so as to be tightened with a predetermined force. In particular, since the protrusion 4 has the side surface 4b as an inclined surface, the living body surface B is smoothly deformed in accordance with the outer shape of the protrusion 4, and thus is easily adhered.

[0062]

When the biological surface B and the lower surface 4a of the protruding portion 4 are in close contact, that is, when the biological surface B comes into contact with the lower surface 4a of the protruding portion 4, the pair of electrodes 7a and 7b come into contact with the biological surface B. In particular, the pair of electrodes 7 a and 7 b are arranged so as to protrude slightly from the lower surface 4 a of the protruding portion 4, and therefore easily contact the biological surface B. When the pair of electrodes 7a and 7b come into contact with the living body surface B, discharge is performed through the living body surface B, and the voltage between both

electrodes decreases. In response to this voltage drop (for example, lower than a certain threshold), the data processing unit 9 detects that the pair of electrodes 7a and 7b are in contact with the biological surface B reliably. That is, it is detected that the biological sensor unit 8 including the LED 5 and the PD 6 is in contact with the biological surface B reliably. In particular, since the pair of electrodes 7a and 7b are arranged with the LED 5 and the PD 6 interposed therebetween, it is possible to detect with high accuracy whether or not the LED 5 and the PD 6 are in contact with the biological surface B.

[0063]

When detecting that the LED 5 and the PD 6 are in contact with the living body surface B, the data processing unit 9 irradiates light from the LED 5 toward the living body. A part of the irradiated light is absorbed by, for example, hemoglobin in the blood vessel, and a part of the other light is reflected by the living tissue. The PD 6 receives the reflected light and generates a pulse signal (biological information signal) corresponding to the amount of received light and outputs the pulse signal to the data processing unit 9. That is, the amount of reflected light of the light emitted from the LED 5 varies according to the blood flow variation in the arteries and arterioles in the wrist A (living body), so the PD 6 responds to the pulsation of the artery, that is, the pulse wave. Receives reflected light. Thereby, the PD 6 can generate a pulse signal.

[0064]

The data processing unit 9 amplifies the transmitted pulse signal, performs predetermined processing such as FFT processing, etc., and then performs analysis to detect the pulse rate. Then, the data processing unit 9 records the detected pulse rate in the memory 14 and displays it on the display unit 11 based on the operation of each button 20.

[0065]

Since the user can confirm the pulse rate easily detected on the display unit 11 by pressing each button 20 when necessary, it is convenient for use. In addition, the user can easily check other information other than the pulse rate, for example, the time and the remaining power of the rechargeable battery 13 by the operation of each button 20.

[0066]
In addition, as described above, the user fastens the housing 2 with a predetermined force with both the bands 30 and 31 and attaches it to the wrist A, so even if it is worn for a long time, it does not feel a sense of pressure. I do not feel uncomfortable.

[0067]

For example, when the user holds something in his hand or performs some work, the thickness (diameter) of the wrist A (arm) changes due to the movement of the muscle.

Even in this case, the biosensor unit 8 is disposed on the lower surface 4a of the projecting portion 4 projecting from the lower surface 2a of the housing 2, so that the contact (adhesion) between the biosensor unit 8 and the biosurface B is reduced. Can be suppressed as much as possible. In particular, since the first band 30 and the second band 31 can be expanded and contracted, the first band 30 and the second band 31 can be expanded and contracted in accordance with the change in the thickness of the wrist A.

[0068]

Accordingly, even if the thickness of the wrist A changes, the state in which the LED 5 and the PD 6 are in contact with the living body surface B can be maintained, so that an accurate pulse rate can always be detected. Therefore, the pulse rate detection accuracy can be improved. Further, the LED 5 and the PD 6 are dropped into the protruding portion 4 and are pressed toward the lower surface 2a side of the housing 2 by the elasticity of the flexible substrate 24 so that they are as close as possible to the living body surface B. In addition, the pulse rate can be detected with high accuracy.

[0069]

In addition, when the user holds the display unit 11 in front of his / her eyes with the back of the hand facing inward in order to check various information displayed on the display unit 11, the housing is temporarily 2 is shifted to the ground side, that is, the second band 31 side due to gravity, the biosensor unit 8 is arranged at a position shifted toward the proximal end side of the second band 31 from the center position of the housing 2. Therefore, it is possible to prevent the

contact between the biological sensor unit 8 and the biological surface B from being lowered. The same applies when the arm is directed to the ground side, that is, when the arm is lowered.

[0070]

In addition, when charging the rechargeable battery 13, for example, charging can be performed by connecting a charging cord or the like connected to a charger to the external connection terminal 21, and a normal battery is separately prepared. do not have to. Therefore, the maintenance cost can be reduced. It should be noted that a sound output means such as a buzzer for outputting sound is provided in the housing 2, and when the charge amount of the rechargeable battery 13 decreases to near "0", the sound is output and the charging time (charging timing) is reached. You may comprise so that it may notify.

[0071]

As described above, according to the biological information measuring apparatus 1 of the present embodiment, when the main body is attached to the wrist A by the fixing means 3, the protruding portion 4 protrudes from the lower surface 2 a of the housing 2. B and the lower surface 4a of the protrusion 4 are reliably in contact with each other, and the adhesion of the biosensor unit 8 is improved. Therefore, it is not necessary to fix the housing 2 so as to strongly press (squeeze) the housing 2 against the living body surface B as in the prior art. Therefore, even if it is worn for a long time, there is no discomfort. Moreover, since the adhesiveness of the biosensor unit 8 is improved, it is possible to efficiently irradiate and receive light, and to detect the pulse rate with high accuracy.

[0072]

The technical scope of the present invention is not limited to the above embodiment, and various modifications can be made without departing from the spirit of the present invention.

[0073]

For example, in the above-described embodiment, the shape of the protruding portion 4 is a keyhole shape combining three circles. However, the shape is not limited to this, and the shape can be freely formed as long as it protrudes from the lower surface 2a of the housing 2. It doesn't matter.

[0074]

For example, as shown in FIG. 8, the protrusion 4 may be formed so that the outer periphery is circular.

Further, the protrusion 4 shown in FIG. 8 has a diameter of 20 mm, and is formed such that the lower surface 4a of the protrusion 4 and the lower surface 2a of the housing 2 have a distance of 3 mm.

[0075]

By making the protruding portion 4 circular, when the housing 2 is attached to the wrist A, the protruding portion 4 is pushed into the living body surface B with an equal force, so that the adhesion is good.

At this time, since the diameter of the protruding portion 4 is 20 mm or less, the protruding portion 4 can be pressed with a light force, and the feeling of pressure can be further eliminated. Here, generally, the difference between the maximum diameter and the minimum diameter of the wrist is 3 mm. Therefore, as shown in FIG. 8, by setting the distance between the lower surface 4a of the protruding portion 4 and the lower surface 2a of the housing 2 to 3 mm, it is possible to cope with a change in the thickness of the wrist, and the lower surface 4a of the protruding portion 4 and the living body Adhesion can be improved without creating a gap with the surface B. Therefore, the adhesion of the biosensor unit 8 can be improved.

[0076]

In addition, although the distance of the lower surface 4a of the protrusion part 4 and the lower surface 2a of the housing 2 was set to 3 mm, not only 3 mm but what is necessary is just set to the range of 2 mm-4 mm. If it is 2 mm or less, the level difference is reduced, a gap is formed between the living body surface B, and external light easily enters. In the case of 4 mm or more, a feeling of pressure is generated and the height is unstable, so that it becomes unstable, and when it is inclined, a gap is formed between the living body surface B and external light easily enters. That is, as shown in FIG. 8, by setting the distance between the lower surface 4a of the protrusion

4 and the lower surface 2a of the housing 2 within a range of 2 mm to 4 mm, it is possible to prevent a feeling of pressure and the incidence of external light. .

[0077]

Moreover, you may form the protrusion part 4 shown in FIG. 8 so that an outer edge may become a curved surface, as shown in FIG. By doing so, it is possible to improve the adhesion, and even if it is worn for a long time, it is difficult to have a compression mark, so it is easy to wear.

[0078]

Furthermore, as shown in FIG. 10, you may form so that it may become a curved surface from the center of the lower surface 4a of the protrusion part 4 toward an outer edge. By doing so, the living body surface B can be smoothly deformed and mounted in a state where the contact pressure at the center of the lower surface 4a is increased, so that the adhesion can be further improved, and further, it is difficult to have a compression mark. easy.

[0079]

Further, as shown in FIG. 11, the protrusion 2 is formed on the lower surface 2a of the housing 2 so as to protrude from the lower surface 2a of the housing 2 at a predetermined distance, that is, 8 mm away from the side surface 4b of the protrusion 4. The protruding ridge 40 may be provided. In addition, the protrusion part 4 shown in FIG. 11 is the same shape as what is shown in FIG.

[0080]
The distance between the lower surface 40a of the ridge 40 and the lower surface 2a of the housing 2 is set to 4 mm, which is slightly higher than the distance (3 mm) between the lower surface 4a of the protrusion 4 and the lower surface 2a of the housing 2. Yes.

[0081]

In such a configuration, when the housing 2 is attached to the wrist A, the living body enters the 8 mm gap formed between the protruding portion 4 and the protruding strip portion 40, and the protruding portion 4 The lower surface 4a of the ridge and the lower surface 40a of the ridge 40 are in contact.

Under the present circumstances, the protruding item | line part 40 contacts a biological body on the outer side of the protrusion part 4, and contacts the protrusion part 4 ahead. Therefore, the living body can be brought into contact with the lower surface 4a of the protruding portion 4 in a stable state, and the contact pressure can be made uniform with respect to the lower surface 4a of the protruding portion 4. Therefore, the pulse rate can be detected stably for a long time. Moreover, since the protruding line part 40 can be formed in the vicinity of the protruding part 4, that is, in a small space, even if the protruding line part 40 is provided, the size can be reduced.

[0082]

In addition, you may comprise the said protruding item | line part in combination with the protrusion part 4 shown in FIG.9 and FIG.10 mentioned above, as shown in FIG.12 and FIG.13. Moreover, you may form a protruding item | line part so that the circumference | surroundings of a protrusion part may be enclosed in the position spaced apart from the side surface of the protrusion part by predetermined distance.

[0083]

Moreover, in the said embodiment, although demonstrated using the pulse rate as an example as biometric information, not only a pulse rate but biometric information may be sufficient.

[0084]

Moreover, although the contact detection means has a pair of electrodes, it is not limited to a pair and may have a plurality of electrodes.

In this case, it may be set to detect whether or not the contact is made based on the potential difference between the electrodes.

[0085]

In addition, the biosensor unit is configured to be displaced toward the proximal end side of the second band from the center position of the housing, but may be formed to be displaced toward the proximal end side of the first band side. That is, the design may be performed according to the relationship between both bands and the display unit.

[0086]

Moreover, you may add functions, such as a radio | wireless communication means which can be communicated by radio | wireless with another electronic device, to a housing. In this way, the pulse rate recorded in the memory can be transmitted to an external electronic device or various information can be obtained in the memory by wireless communication such as Bluetooth.

[0087]

It is a front view which shows one Embodiment of the biological information measuring device which concerns on this invention. It is a side view which shows the state which mounted | wore the wrist with the biological information measuring device shown in FIG. It is a side view which shows the state with which the biological information measuring device shown in FIG. 1 was mounted | worn on the wrist, and is the figure seen from the direction opposite to the direction shown in FIG. It is a perspective view which shows the state which looked at the biological information measuring device shown in FIG. 1 from diagonally upward. It is a perspective view which shows the state which looked at the biological information measuring device shown in FIG. 1 from diagonally downward. It is a cross-sectional arrow CC figure of the biological information measuring device shown in FIG. It is a cross-sectional arrow DD figure of the biological information measuring device shown in FIG. It is a figure which shows the shape of the protrusion part different from the biological information measuring device shown in FIG. 1, Comprising: It is a figure in case the outer periphery of a protrusion part is circular. It is a figure at the time of forming the protrusion part shown in FIG. 8 so that an outer edge may become a curved surface. It is a figure at the time of forming the protrusion part shown in FIG. 8 so that it may become a curved surface toward the outer edge from the center of a lower surface. It is a figure at the time of forming a protruding item | line part so that the protrusion part shown in FIG. 8 may be pinched | interposed. It is a figure at the time of forming a protruding item | line

part so that the protrusion part shown in FIG. 9 may be pinched | interposed. It is a figure at the time of forming a protruding item | line part so that the protrusion part shown in FIG. 10 may be pinched | interposed.

Explanation of symbols

[0088]

B Living body surface 1 Living body upper measuring device 2 Housing (main body) 2a Lower surface of main body 2b Upper surface of main body 3 Fixing means 4 Protruding portion 4a Lower surface of protruding portion 4b Side surface of protruding portion 5 LED (light emitting portion) 6 PD (light receiving portion) 7) Contact detection means 7a, 7b A pair of electrodes 8 Biosensor part 9 Data processing part (biological information detection part) 11 Display part 13 Rechargeable battery 21 External connection terminal (charging means) 24 Flexible substrate 30 First band 31 Second Band 40 ridge 40a under surface of ridge

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2005-270543
(P2005-270543A)
(43)公開日　平成17年10月6日(2005.10.6)

(51)Int.Cl.[7]	F I		テーマコード（参考）
A61B 5/0245	A61B	5/02　320B	4C017

審査請求 未請求　請求項の数 15　OL　（全 17 頁）

(21)出願番号　特願2004-91942(P2004-91942)
(22)出願日　平成16年3月26日(2004.3.26)

（特許庁注：以下のものは登録商標）
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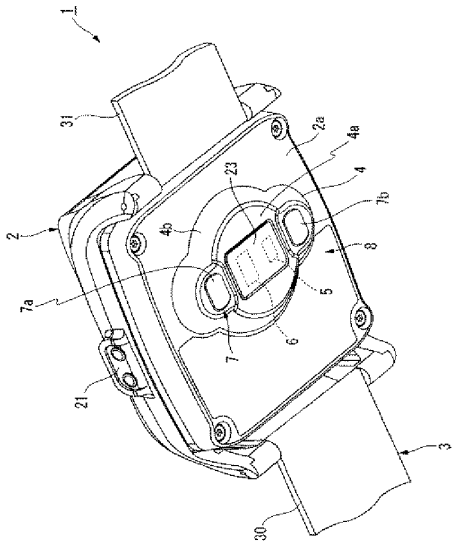
最終頁に続く

(54)【発明の名称】生体情報計測装置

(57)【要約】
【課題】　密着性が向上すると共に、不快感を感じることなく長時間の装着を行うこと。
【解決手段】　本体２と、該本体２の下面２ａから突出して形成された突出部４と、本体２の下面２ａを生体表面側に向けた状態で該本体２を腕に装着する固定手段３と、生体表面に接触した状態で生体に向けて光を照射する光発光部５と、該光発光部５により照射された光のうち生体からの反射光を受光すると共に受光量に応じた生体情報信号を生成する光受光部６と、光発光部５及び光受光部６が生体表面に接触しているか否かを検出する接触検出手段７とを有する生体センサ部８と、本体２に設けられ、生体情報信号に基づいて生体情報を検出する生体情報検出部とを備え、生体センサ部８は、突出部４の下面４ａに配されている生体情報計測装置１を提供する。
【選択図】　図５



【特許請求の範囲】
【請求項1】
本体と、
該本体の下面から突出して形成された突出部と、
前記本体の下面を生体表面側に向けた状態で該本体を腕に装着する固定手段と、
前記生体表面に接触した状態で生体に向けて光を照射する光発光部と、該光発光部により照射された光のうち前記生体からの反射光を受光すると共に受光量に応じた生体情報信号を生成する光受光部と、光発光部及び光受光部が生体表面に接触しているか否かを検出する接触検出手段とを有する生体センサ部と、
前記本体に設けられ、前記生体情報信号に基づいて生体情報を検出する生体情報検出部とを備え、
前記生体センサ部は、前記突出部の下面に配されていることを特徴とする生体情報計測装置。
【請求項2】
請求項１に記載の生体情報計測装置において、
前記本体の下面には、少なくとも前記突出部を挟むと共に該突出部の側面から所定距離離間した位置に、本体の下面から突出して形成された凸条部が設けられ、
該凸条部の下面と前記本体部の下面との距離は、前記突出部の下面と前記本体部の下面との距離と同一又はそれ以上の距離に設定されていることを特徴とする生体情報計測装置。
【請求項3】
請求項１又は２に記載の生体情報計測装置において、
前記接触検出手段が、少なくとも一対の電極を有し、該一対の電極間の電位差に基づいて、前記光発光部及び前記光受光部が前記生体表面に接触しているか否かを検出することを特徴とする生体情報計測装置。
【請求項4】
請求項３に記載の生体情報計測装置において、
前記一対の電極が、前記光発光部及び前記光受光部を間に挟むように配されていることを特徴とする生体情報計測装置。
【請求項5】
請求項１から４のいずれか１項に記載の生体情報計測装置において、
前記光発光部及び前記光受光部と前記生体情報検出部との間を電気的に接続するフレキシブル基板を備え、
該フレキシブル基板は、前記光発光部及び前記光受光部を自身の弾性により記本体の下面側に向けて押圧するように前記本体内に設けられていることを特徴とする生体情報計測装置。
【請求項6】
請求項１から５のいずれか１項に記載の生体情報計測装置において、
前記本体の上面に、検出された生体情報を表示する表示部を備えていることを特徴とする生体情報計測装置。
【請求項7】
請求項１から６のいずれか１項に記載の生体情報計測装置において、
前記固定手段は、前記本体に基端側が取り付けられて腕に装着可能な第１のバンド及び第２のバンドを備え、
前記第１のバンド及び第２のバンドは、前記本体を挟んで対向するように配されると共に、伸縮自在な弾性材料により形成されていることを特徴とする生体情報計測装置。
【請求項8】
請求項７に記載の生体情報計測装置において、
前記生体センサ部は、前記本体の中心位置から前記第１のバンド又は前記第２のバンド

の基端側にずれた位置に配されていることを特徴とする生体情報計測装置。
【請求項9】
請求項１から８のいずれか１項に記載の生体情報計測装置において、
前記本体に、充電可能な充電池と、該充電池に電力を充電する充電手段とを備えていることを特徴とする生体情報計測装置。
【請求項10】
請求項１から９のいずれか１項に記載の生体情報計測装置において、
前記突出部の下面と前記本体の下面との距離が、２～４ｍｍに設定されていることを特徴とする生体情報計測装置。
【請求項11】
請求項１から１０のいずれか１項に記載の生体情報計測装置において、
前記突出部は、外周が円形となるように形成されていることを特徴とする生体情報計測装置。
【請求項12】
請求項１１に記載の生体情報計測装置において、
前記突出部は、外縁が曲面となるように形成されていることを特徴とする生体情報計測装置。
【請求項13】
請求項１１に記載の生体情報計測装置において、
前記突出部は、下面の中心から外縁に向かって曲面となるように形成されていることを特徴とする生体情報計測装置。
【請求項14】
請求項１１から１３のいずれか１項に記載の生体情報計測装置において、
前記突出部の直径が、２０ｍｍ以下に設定されていることを特徴とする生体情報計測装置。
【請求項15】
請求項２から１４のいずれか１項に記載の生体情報計測装置において、
前記凸条部は、前記突出部の側面から８ｍｍ離間した位置に設けられると共に、該凸条部の下面と前記本体の下面との距離が４ｍｍに設定されていることを特徴とする生体情報計測装置。
【発明の詳細な説明】
【技術分野】
【0001】
本発明は、手首（腕）に装着した状態で脈拍数等の生体情報を測定することができる生体情報計測装置に関するものである。
【背景技術】
【0002】
近年の健康管理への関心の高まりにより、手首（腕）等に装着したまま脈拍数等の様々な生体情報を計測することができる生体情報計測装置が各種提供されている（例えば、特許文献１参照）。
【0003】
この種の生体情報計測装置のうち、例えば、脈拍数を検出するものは、手首に装着した状態で、生体に向けて光を照射すると共に、脈拍センサ等により血管からの反射光、即ち、反射信号を受信して、該反射信号から脈拍に相当する脈拍信号を抽出して脈拍数を算出している。特に、手首に装着したまま容易に脈拍数の測定が行えるので、使用者に簡便に使用されている。
【特許文献1】特開２００１－７８９７３号公報（段落番号００１１－００３１、図１－図７）
【発明の開示】
【発明が解決しようとする課題】
【0004】

上述した従来の生体情報計測装置は、一般的に手首に装着して使用されている。ところが、使用者の動きによっては筋肉が動き手首の太さ（径）が変化してしまい、生体情報計測装置と生体表面との間に隙間が空いてしまう恐れがあった。そのため、密着性が低下し正確な生体情報を検出できない可能性があった。また、生体情報計測装置を確実に手首に固定するため、例えば、バンドにより締め付けた場合には、手首への圧迫感が増し長時間の装着を行うには困難なものであった。

【0005】

本発明は、このような事情に考慮してなされたもので、その目的は、密着性が向上すると共に、不快感を感じることなく長時間の装着を行うことができる生体情報計測装置を提供することである。

【課題を解決するための手段】

【0006】

本発明は、前記課題を解決するために以下の手段を提供する。

【0007】

本発明の生体情報計測装置は、本体と、該本体の下面から突出して形成された突出部と、前記本体の下面を生体表面側に向けた状態で該本体を腕に装着する固定手段と、前記生体表面に接触した状態で生体に向けて光を照射する光発光部と、該光発光部により照射された光のうち前記生体からの反射光を受光すると共に受光量に応じた生体情報信号を生成する光受光部と、光発光部及び光受光部が生体表面に接触しているか否かを検出する接触検出手段とを有する生体センサ部と、前記本体に設けられ、前記生体情報信号に基づいて生体情報を検出する生体情報検出部とを備え、前記生体センサ部は、前記突出部の下面に配されていることを特徴とするものである。

【0008】

この発明に係る生体情報計測装置においては、固定手段により、本体を手首(腕)に装着した後、光発光部から生体に向けて光を照射する。照射された光は、その一部が、例えば、血管内のヘモグロビン等により吸収され、また、他の光の一部は生体組織にて反射する。光受光部は、この反射された光を受光すると共に、受光量に応じた脈拍信号等の生体情報信号を生成する。そして、生体情報検出手段により、生体情報信号を所定処理して脈拍数等の生体情報の検出を行える。また、接触検出手段により、光発光部及び光受光部が確実に生体表面に接触しているか否かの検出を行える。

【0009】

特に、固定手段により本体を手首に装着したときに、本体の下面から突出部が突出しているので、生体表面と突出部の下面とが接触し易い状態となる。即ち、生体センサ部の密着性が向上する。そのため、固定手段により、従来のように本体を生体表面に強く押し付けるように（圧迫するように）固定する必要はない。従って、長時間装着したとしても、不快感を感じることはない。また、生体センサ部の密着性が向上しているので、光発光部及び光受光部により、効率良く光の照射及び受光を行うことができる。従って、高精度に生体情報の検出を行うことができる。

【0010】

また、本発明に係る生体情報計測装置は、上記本発明の生体情報計測装置において、前記本体の下面には、少なくとも前記突出部を挟むと共に該突出部の側面から所定距離離間した位置に、本体の下面から突出して形成された凸条部が設けられ、該凸条部の下面と前記本体部の下面との距離は、前記突出部の下面と前記本体部の下面との距離と同一又はそれ以上の距離に設定されていることを特徴とするものである。

【0011】

この発明に係る生体情報計測装置においては、固定手段により、本体を腕に装着したときに、生体表面は、凸条部の下面及び突出部の下面に接触している状態となる。この際、凸条部は、突出部を挟むと共に該突出部の側面から所定距離離間した位置に突出しているので、突出部と凸条部との間には、隙間が空いた状態となっている。これにより、生体は、突出部を挟む両側の隙間に一旦入り込んだ状態で、突出部及び凸条部の下面に接触する

。従って、より確実に生体表面と生体センサ部との密着性を確保することができる。

【0012】

特に、凸条部は突出部に対して本体の下面から同一高さ又はそれ以上の高さだけ突出しているので、突出部と同一又は突出部より先に生体表面に接触する。また、凸条部は、突出部の外側で生体表面に接触する。これにより、生体表面を突出部の下面に同一状態で安定して接触させることができると共に、接触圧力を一定にすることができる。従って、長時間に亘り安定して生体情報を検出することができる。

【0013】

また、本発明に係る生体情報計測装置は、上記本発明の生体情報計測装置において、前記接触検出手段が、少なくとも一対の電極を有し、該一対の電極間の電位差に基づいて、前記光発光部及び前記光受光部が前記生体表面に接触しているか否かを検出することを特徴とするものである。

【0014】

この発明に係る生体情報計測装置においては、本体を腕に装着したときに、一対の電極が生体表面に接触し、該生体表面を通して放電が行われる。これにより、電極間の電位が減少する。そして、この一対の電極間の電位差を検出することで、光発光部及び光受光部が確実に生体表面に接触しているか否かを容易且つ確実に検出することができる。なお、電極は一対でなくても良く、例えば、複数の電極を備えて、これら各電極の電位差に基づいて接触しているか否かを検出しても良い。

【0015】

また、本発明に係る生体情報計測装置は、上記本発明の生体情報計測装置において、前記一対の電極が、前記光発光部及び前記光受光部を間に挟むように配されていることを特徴とするものである。

【0016】

この発明に係る生体情報計測装置においては、一対の電極が、光発光部及び光受光部を間に挟むように配されているので、高精度に光発光部及び光受光部が生体表面に接触しているか否かを検出ことができる。

【0017】

また、本発明に係る生体情報計測装置は、上記本発明のいずれか１つの生体情報計測装置において、前記光発光部及び前記光受光部と前記生体情報検出部との間を電気的に接続するフレキシブル基板を備え、該フレキシブル基板は、前記光発光部及び前記光受光部を自身の弾性により前記本体の下面側に向けて押圧するように前記本体内に設けられていることを特徴とするものである。

【0018】

この発明に係る生体情報計測装置においては、光発光部及び光受光部がフレキシブル基板の弾性により、常に本体の下面側に押圧されているので、本体を手首に装着したときに、光発光部及び光受光部は生体表面に対して近接した状態となる。従って、生体に対してより効率良く光の照射及び受光を行うことができ、生体情報の検出精度を向上することができる。

【0019】

また、本発明に係る生体情報計測装置は、上記本発明のいずれか１つの生体情報計測装置において、前記本体の上面に、検出された生体情報を表示する表示部を備えていることを特徴とするものである。

【0020】

この発明に係る生体情報計測装置においては、表示部に表示された生体情報を容易に視認できるので、必要なときにいつでも検出された生体情報を確認したり、生体情報の検出が正しく行なわれているか等を確認することができ、使い易く簡便である。

【0021】

また、本発明に係る生体情報計測装置は、上記本発明のいずれか１つの生体情報計測装置において、前記固定手段は、前記本体に基端側が取り付けられて腕に装着可能な第１の

バンド及び第２のバンドを備え、前記第１のバンド及び第２のバンドは、前記本体を挟んで対向するように配されると共に、伸縮自在な弾性材料により形成されていることを特徴とするものである。

【0022】

この発明に係る生体情報計測装置においては、第１のバンド及び第２のバンドにより、本体を手首に腕時計のように容易且つ確実に装着することができる。特に、両バンドは、伸縮自在な弾性材料により形成されているので、筋肉の動きにより多少手首の太さが変化した場合にもその変化量を吸収でき、本体と生体表面との間に隙間等が生じることを防止することができる。よって、両バンドを締め付ける必要がなく、長時間の装着が可能になる。

【0023】

また、本発明に係る生体情報計測装置は、上記本発明のいずれか１つの生体情報計測装置において、前記生体センサ部は、前記本体の中心位置から前記第１のバンド又は前記第２のバンドの基端側にずれた位置に配されていることを特徴とするものである。

【0024】

この発明に係る生体情報計測装置においては、第１のバンド及び第２のバンドにより本体を腕時計のように手首に装着したときに、仮に手首との間に若干の遊びがあり、この遊びにより本体が重力作用によりずれた（例えば、腕を下方（地面側）に向けた状態でずれた場合や、手の甲を内側にすると共に腕を水平にして目の前に本体の上面をかざした状態でずれた場合等）としても、生体センサ部は、本体の中心位置から第１のバンド又は第２のバンドの基端側にずれた位置に配されているので、生体センサ部の密着性の低下を防止することができる。

【0025】

また、本発明に係る生体情報計測装置は、上記本発明のいずれか１つの生体情報計測装置において、前記本体に、充電可能な充電池と、該充電池に電力を充電する充電手段とを備えていることを特徴とするものである。

【0026】

この発明に係る生体情報計測装置においては、充電手段を介して充電池に外部からの電力を充電できるので、通常の電池等を別個に用意する必要がない。従って、製品の維持に係るコストを低減することができる。

【0027】

また、本発明に係る生体情報計測装置は、上記本発明のいずれか１つの生体情報計測装置において、前記突出部の下面と前記本体の下面との距離が、２～４ｍｍに設定されていることを特徴とするものである。

【0028】

この発明に係る生体情報計測装置においては、突出部の下面が本体の下面から２～４ｍｍ突出した状態で手首に装着される。これにより、確実に突出部を生体表面に接触させることができ、生体センサ部の密着性を確保できる。つまり、突出部の下面と本体の下面との距離が２ｍｍ以下の場合には、段差が少なく生体表面との間に隙間ができ外光が入り易い。また、突出部の下面と本体の下面との距離が４ｍｍ以上の場合には、装着間に圧迫感が生じると共に高さがあるので不安定な状態となり、例えば、斜めになった際に生体表面との間に外光が入り易くなってしまう。

【0029】

上述したように、突出部の下面と前記本体の下面との距離を２～４ｍｍにすることで、圧迫感及び外光の入射を防止することができる。

【0030】

また、本発明に係る生体情報計測装置は、上記本発明のいずれか１つの生体情報計測装置において、前記突出部は、外周が円形となるように形成されていることを特徴とするものである。

【0031】

この発明に係る生体情報計測装置においては、突出部が円形であるので、本体を手首に装着したときに、生体表面に均等な力で押し込まれる。従って、密着性が良い。

【0032】

また、本発明に係る生体情報計測装置は、上記本発明のいずれか１つの生体情報計測装置において、前記突出部は、外縁が曲面となるように形成されていることを特徴とするものである。

【0033】

この発明に係る生体情報計測装置においては、突出部の外縁が曲面に形成されているので、本体を手首に装着したときに、密着性のさらなる向上を図ることができる。また、長時間装着したとしても、圧迫痕が付き難いので、装着し易い。

【0034】

また、本発明に係る生体情報計測装置は、上記本発明の生体情報計測装置において、前記突出部は、下面の中心から外縁に向かって曲面となるように形成されていることを特徴とするものである。

【0035】

この発明に係る生体情報計測装置においては、突出部の下面の中心から外縁に向かって曲面に形成されているので、本体を手首に装着したときに、生体表面が滑らかに変形し、下面の中心部の接触圧力が上昇した状態で装着され、密着性のさらなる向上を図ることができる。また、長時間装着したとしても、圧迫痕が付き難いので、装着し易い。

【0036】

また、本発明に係る生体情報計測装置は、上記本発明のいずれか１つの生体情報計測装置において、前記突出部の直径が、２０ｍｍ以下に設定されていることを特徴とするものである。

【0037】

この発明に係る生体情報計測装置においては、突出部の直径が２０ｍｍ以下であるので、軽い力で容易に突出部を生体表面に押し付けることができる。

【0038】

また、本発明に係る生体情報計測装置は、上記本発明のいずれか１つの生体情報計測装置において、前記凸条部は、前記突出部の側面から８ｍｍ離間した位置に設けられると共に、該凸条部の下面と前記本体の下面との距離が４ｍｍに設定されていることを特徴とするものである。

【0039】

この発明に係る生体情報計測装置においては、凸条部を突出部の側面から８ｍｍという近傍に形成できると共に、４ｍｍの高さで抑えることができる。このように、小さなスペースで凸条部を形成できるので、本体の小型化、即ち、装置全体の小型化を図ることができる。

【発明の効果】

【0040】

本発明に係る生体情報計測装置によれば、固定手段により本体を手首に装着したときに、本体の下面から突出部が突出しているので、生体表面と突出部の下面とが確実に接触して、生体センサ部の密着性が向上する。そのため、固定手段により、従来のように本体を生体表面に強く押し付ける（圧迫する）ように固定する必要はない。従って、長時間装着したとしても、不快感を感じることはない。また、生体センサ部の密着性が向上しているので、効率良く光の照射及び受光を行うことができ、高精度に生体情報の検出を行うことができる。

【発明を実施するための最良の形態】

【0041】

以下、本発明に係る生体情報計測装置の一実施形態を、図１から図７を参照して説明する。

【0042】

本実施形態の生体情報計測装置１は、図１から図７に示すように、腕時計型であって手首（腕）Ａに装着した状態で、生体情報である脈拍数を検出するものである。

【0043】

この生体情報計測装置１は、各種の電気部品及び電子部品を内蔵したハウジング（本体）２と、ハウジング２の下面２ａを生体表面Ｂ側に向けた状態でハウジング２を手首Ａに装着する固定手段３とを備えている。また、ハウジング２の下面２ａには、該下面２ａから突出した突出部４が形成されている。

【0044】

この突出部４の下面４ａには、生体表面Ｂ側に接触した状態で生体に向けて光を照射するＬＥＤ（Light Emitting Diode）（光発光部）５と、該ＬＥＤ５により照射された光のうち生体からの反射光を受光すると共に受光量に応じた脈拍信号（生体情報信号）を生成するＰＤ（Photodetector）（光受光部）６と、ＬＥＤ５及びＰＤ６が生体表面Ｂに接触しているか否かを検出する接触検出手段７とを有する生体センサ部８が配されている。

【0045】

また、ハウジング２内には、生成された脈拍信号に基づいて脈拍数を検出するデータ処理部（生体情報検出部）９が設けられている。

【0046】

上記ハウジング２は、プラスチックやアルミニウム等の金属材料からなり、所定の厚みをもって、例えば、上面視略長方形状に形成されている。ハウジング２の上面２ｂの中央部分には、略正方形状のカバーガラス１０が嵌め込まれており、該カバーガラス１０の内側には検出された上記脈拍数やその他各種の情報を表示する表示部１１が配されている。

【0047】

また、ハウジング２内には、図６及び図７に示すように、メイン基板１２が設けられており、該メイン基板１２に上記データ処理部９、上記表示部１１、充電可能な充電池１３、脈拍数を記録するメモリ１４、サブ基板１５及びその他各種の電子部品が実装又は配線等により電気的に接続されている。

【0048】

上記データ処理部９は、ＣＰＵ等のＩＣ部品を含むものであり、ＰＤ６により生成された脈拍信号を一旦アンプ等により増幅した後に、高速フーリエ変換処理（ＦＦＴ処理）等の所定処理を行い、その処理結果を解析することにより脈拍数を検出する機能を有している。また、データ処理部９は、検出した脈拍数をメモリ１４に記録すると共に、後述する各ボタン２０からの入力に基づいて表示部１１に表示させるようになっている。更に、データ処理部９は、他の構成品を総合的に制御する機能も有している。

【0049】

上記表示部１１は、例えば、ＬＣＤ（Liquid Crystal Display）等の液晶表示器であり、上述した脈拍数以外に、例えば、図示しない水晶振動子によりカウントされた時刻を表示する時刻表示機能やその他の各種情報を表示する機能を有している。例えば、時刻、日付、曜日や充電池１３の残電力量等を表示できるようになっている。

【0050】

また、ハウジング２には、図１及び図２に示すように、複数のボタン２０、例えば、ハウジング２の上面２ｂであって表示部１１の下側に配された３つのボタン２０及びハウジング２の側面に配された１つのボタン２０が設けられている。これら各ボタン２０を押下することで、各種操作ができるようになっている。例えば、脈拍数の計測開始、計測停止や、脈拍数と時刻との表示切替や、メモリ１４内に記録されている脈拍数データを外部の機器にデータ送信する等の操作ができるようになっている。

【0051】

更に、ハウジング２の側面には、上記充電池１３に充電器等の外部から電力を供給して充電させる外部接続端子（充電手段）２１が設けられている。なお、外部接続端子２１を覆うようにカバー等を取り付けて、外部接続端子２１を保護しても構わない。こうすることで、外部接続端子２１を水滴や埃等から保護することが可能となり、より好適である。

また、外部接続端子２１に限らず、充電器及びハウジング２内にそれぞれ電力を供給するためのトランス等を設け、非接触状態で充電池１３の充電を行うように構成しても構わない。

【0052】

上記突出部４は、図５に示すように、下面視した際に３つの円を組み合わせた形状、即ち、中央の円形に、該円形より径が小さい２つの円形を左右から挟むように結合した鍵穴のような形状に形成されている。また、突出部４は、その中心位置がハウジング２の中心位置よりも後述する第２のバンド３１側にずれた位置になるように形成されている。これにより、突出部４の下面に配された上記生体センサ部８も同様に、第２のバンド３１側にずれた位置に配されるようになっている。また、突出部４は、ハウジング２の下面から垂直に突出するのではなく、側面４ｂが斜面となるように形成されている。

【0053】

また、突出部４の下面４ａの中心には、図７に示すように、外部とハウジング２の内部を貫通させる貫通孔２２が形成されており、該貫通孔２２を塞ぐようにカバーガラス２３がハウジング２に固定されている。そして、カバーガラス２３の内側に接するように、上記ＬＥＤ５及びＰＤ６がハウジング２の長手方向に直交する方向に、互いに隣接するように配されている。つまり、ＬＥＤ５及びＰＤ６は、突出部４内に落とし込まれる構成となっている。これにより、ＬＥＤ５及びＰＤ６は、生体表面Ｂに可能な限り近づくようになっている。

【0054】

この際、ＬＥＤ５及びＰＤ６は、図６に示すように、上記サブ基板１５に電気的に接続されたフレキシブル基板２４の一端側に実装されており、該フレキシブル基板２４の弾性によってハウジング２の下面２ａ側に向けて押圧された状態で配されている。このことからも、ＬＥＤ５及びＰＤ６は、可能な限り突出部４の下面４ａ側に位置するようになっている。即ち、ＬＥＤ５及びＰＤ６は、生体表面Ｂに可能な限り近づくようになっている。なお、サブ基板１５及びフレキシブル基板１４は、一体構造として形成されている。また、ＬＥＤ５及びＰＤ６が実装されているフレキシブル基板の固定は、両面テープ等の固定部材でハウジング２の下面２ａ側に固定してもよい。

【0055】

上記ＰＤ６により生成された脈拍信号は、フレキシブル基板２４、サブ基板１５及びメイン基板１２を介して、上記データ処理部９に送られるようになっている。

【0056】

上記接触検出手段７は、一対の電極７ａ、７ｂを有しており、該一対の電極７ａ、７ｂはＬＥＤ５及びＰＤ６を間に挟んだ状態で突出部４の下面４ａに配されている。即ち、一対の電極７ａ、７ｂ、ＬＥＤ５及びＰＤ６は、ハウジング２の長手方向に直交する方向に一列に並ぶように配されている。また、一対の電極７ａ、７ｂは、その先端が突出部４の下面４ａから若干突出するように設けられていると共に、基端側がサブ基板１５に電気的に接続するように設けられている。

【0057】

この一対の電極７ａ、７ｂは、電極間の電位差に基づいて生体表面Ｂに接触しているか否かを検出する機能を有している。データ処理部９は、この検出結果を受けて、例えば、生体表面Ｂに接触していると検出されたときに、ＬＥＤ５から光を照射するようにＬＥＤ５の作動を制御するように設定されている。なお、この場合だけに限らず、例えば、生体表面Ｂに接触していないことが検出されたときに、ＦＦＴ処理を行なわないように設定しても構わない。

【0058】

上記固定手段３は、ハウジング２に基端側が取り付けられて手首Ａに装着可能な第１のバンド３０及び第２のバンド３１を有している。第１のバンド３０及び第２のバンド３１は、ハウジング２の長手方向に、該ハウジング２を挟んで対向するように設けられている。また、両バンド３０、３１は、伸縮自在な弾性材料により形成されている。

【0059】
上記第１のバンド３０には、先端にバックル３０ａ及びタング３０ｂが取り付けられている。また、第２のバンド３１には、上記タング３０ｂが挿入される挿入孔３１ａが該第２のバンド３１の長手方向に沿って複数形成されている。これにより、使用者の手首Ａの太さに応じて第１のバンド３０及び第２のバンド３１の長さを調整することができるようになっている。
【0060】
このように構成された生体情報計測装置１により、手首Ａに装着した状態で脈拍数を検出する場合について説明する。
【0061】
まず、図２及び図３に示すように、使用者の手首Ａを巻回するよう両バンド３０、３１を巻き、手首Ａの大きさに応じて第１のバンド３０のタング３０ｂを第２のバンド３１の挿入孔３１ａに挿入し、ハウジング２を手首Ａに装着する。ハウジング２が手首Ａに装着されると、突出部４はハウジング２の下面２ａよりも突出しているので、生体表面Ｂと突出部４の下面４ａとが密着した状態となる。従って、手首Ａを締め付けるようにハウジング２を装着する必要はなく、所定の力で締まるように両バンド３０、３１の長さを調整すれば良い。特に、突出部４は、側面４ｂが斜面となっているので、突出部４の外形形状に合わせて生体表面Ｂが滑らかに変形するので、密着し易い。
【0062】
生体表面Ｂと突出部４の下面４ａとが密着状態、即ち、生体表面Ｂが突出部４の下面４ａに接触すると、一対の電極７ａ、７ｂが生体表面Ｂに接触する。特に、一対の電極７ａ、７ｂは、突出部４の下面４ａよりも若干突出するように配されているので、生体表面Ｂに接触し易い。一対の電極７ａ、７ｂが、生体表面Ｂに接触すると、生体表面Ｂを通して放電が行なわれ両電極間の電圧が低下する。この電圧低下（例えば、ある閾値より低下）を受けて、データ処理部９は、一対の電極７ａ、７ｂが確実に生体表面Ｂに接触していることの検出を行う。即ち、ＬＥＤ５及びＰＤ６を含む生体センサ部８が、確実に生体表面Ｂに接触していることを検出する。特に、一対の電極７ａ、７ｂは、ＬＥＤ５及びＰＤ６を間に挟んで配されているので、ＬＥＤ５及びＰＤ６が生体表面Ｂに接触している否かを高精度に検出することができる。
【0063】
ＬＥＤ５及びＰＤ６が生体表面Ｂに接触していることを検出すると、データ処理部９は、ＬＥＤ５から生体に向けて光を照射させる。照射された光の一部は、血管内の、例えば、ヘモグロビンによって吸収され、他の光の一部は、生体組織で反射される。ＰＤ６は、この反射光を受光すると共に受光量に応じた脈拍信号（生体情報信号）を生成して、データ処理部９に出力する。つまり、手首Ａ（生体）内部の動脈及び細動脈内の血流変動に応じて、ＬＥＤ５から照射された光の反射光量が変動するので、ＰＤ６は、動脈の脈動、即ち、脈波に応じた反射光の受光が行える。これにより、ＰＤ６は、脈拍信号の生成が行える。
【0064】
データ処理部９は、送られてきた脈拍信号を増幅した後に、ＦＦＴ処理等の所定処理をした後、解析を行なって脈拍数を検出する。そして、データ処理部９は、検出した脈拍数をメモリ１４に記録すると共に各ボタン２０操作に基づいて表示部１１に表示させる。
【0065】
使用者は、必要時に各ボタン２０を押下することで、容易に検出された脈拍数を表示部１１に表示させて確認が行えるので、使用に関して簡便である。また、使用者は、各ボタン２０の操作により、脈拍数以外のその他の情報、例えば、時刻や充電池１３の残電力等についても表示部１１により確認することができるので使い易い。
【0066】
また、上述したように、使用者は、ハウジング２を両バンド３０、３１により所定の力で締め付けて手首Ａに装着しているので、長時間装着したとしても圧迫感を感じることが

ないので、不快に感じることがない。

【0067】

また、使用者が、例えば、何かを手に持ったり、何らかの作業を行った場合には、筋肉の動きにより、手首Ａ（腕）の太さ（径）が変化する。この場合においても、生体センサ部８は、ハウジング２の下面２ａから突出した突出部４の下面４ａに配されているので、生体センサ部８と生体表面Ｂとの接触性（密着性）が低下することを極力抑えることができる。特に、第１のバンド３０及び第２のバンド３１は、伸縮自在であるので手首Ａの太さの変化に合わせて伸縮できることからも、密着性の低下を抑えることができる。

【0068】

従って、手首Ａの太さが変化したとしても、ＬＥＤ５及びＰＤ６を生体表面Ｂに接触した状態を維持できるので、常に正確な脈拍数の検出を行える。従って、脈拍数の検出精度の向上を図ることができる。また、ＬＥＤ５及びＰＤ６は、突出部４内に落とし込まれていると共に、フレキシブル基板２４の弾性によって、ハウジング２の下面２ａ側に向けて押圧されて生体表面Ｂに出来るだけ近接していることからも、脈拍数を高精度に検出することができる。

【0069】

また、使用者が、表示部１１に表示された各種情報を確認するために、手の甲を内側に向けた状態で腕を水平に向けて表示部１１を目の前にかざした場合、仮に、ハウジング２が重力により地面側、即ち、第２のバンド３１側にずれたとしても、生体センサ部８はハウジング２の中心位置よりも第２のバンド３１の基端側に向けてずれた位置に配されているので、生体センサ部８と生体表面Ｂとの接触性が低下することを防止することができる。なお、腕を地面側に向けた、即ち、腕を下に下ろした場合も同様である。

【0070】

また、充電池１３に電力を充電する場合には、例えば、充電器に接続されている充電コード等を外部接続端子２１に接続することで充電を行うことができ、通常の電池を別個に用意する必要はない。従って、維持経費の削減を図ることができる。なお、ハウジング２内に音声を出力するブザー等の音声出力手段を設けて、充電池１３の充電量が“０”に近くなるまで減少した場合に、音声を出力させて充電時期（充電タイミング）を知らせるように構成しても構わない。

【0071】

以上説明したように、本実施形態の生体情報計測装置１によれば、固定手段３により本体を手首Ａに装着したときに、ハウジンング２の下面２ａから突出部４が突出しているので、生体表面Ｂと突出部４の下面４ａとが確実に接触して、生体センサ部８の密着性が向上する。そのため、固定手段３により、従来のようにハウジング２を生体表面Ｂに強く押し付ける（圧迫する）ように固定する必要はない。従って、長時間装着したとしても、不快感を感じることはない。また、生体センサ部８の密着性が向上しているので、効率良く光の照射及び受光を行うことができ、高精度に脈拍数の検出を行うことができる。

【0072】

なお、本発明の技術範囲は上記実施の形態に限定されるものではなく、本発明の趣旨を逸脱しない範囲において種々の変更を加えることが可能である。

【0073】

例えば、上記実施形態においては、突出部４の形状を３つの円形を組み合わせた鍵穴のような形状にしたが、これに限らず、ハウジング２の下面２ａより突出していれば形状は自由に形成して構わない。

【0074】

例えば、図８に示すように、外周が円形となるように突出部４を形成しても構わない。また、図８に示される突出部４は、その直径が２０ｍｍに設定され、突出部４の下面４ａとハウジング２の下面２ａとが３ｍｍの距離になるように形成されている。

【0075】

突出部４を円形にすることで、ハウジング２を手首Ａに装着したときに、突出部４が生

体表面Ｂに均等な力で押し込まれるので、密着性が良い。この際、突出部４の直径が２０ｍｍ以下であるので、軽い力で突出部４を押し付けることができ、より圧迫感をなくすことができる。ここで、一般的に手首の最大径と最小径との差は３ｍｍとされている。よって、図８に示すように、突出部４の下面４ａとハウジング２の下面２ａとの距離を３ｍｍに設定することで、手首の太さの変化に対応でき、突出部４の下面４ａと生体表面Ｂとの間に隙間を作ることなく、密着性の向上を図ることができる。従って、生体センサ部８の密着性を良くすることができる。

【0076】

なお、突出部４の下面４ａとハウジング２の下面２ａとの距離を３ｍｍに設定したが、３ｍｍに限らず、２ｍｍ～４ｍｍの範囲に設定されていれば構わない。仮に、２ｍｍ以下の場合には、段差が少なくなり、生体表面Ｂとの間に隙間ができ、外光が入り易くなってしまう。また、４ｍｍ以上の場合には、圧迫感が生じると共に、高さがあるので不安定となり、斜めになった際にやはり生体表面Ｂとの間に隙間ができ外光が入り易くなってしまう。即ち、図８に示すように、突出部４の下面４ａとハウジング２の下面２ａとの距離を２ｍｍ～４ｍｍの範囲内に設定することで、圧迫感及び外光の入射を防止することができる。

【0077】

また、図８に示す突出部４を、図９に示すように、外縁が曲面となるように形成しても構わない。こうすることで、密着性のより良くすることができると共に長時間装着したとしても、圧迫痕が付き難いので、装着し易い。

【0078】

更に、図１０に示すように、突出部４の下面４ａの中心から外縁に向かって曲面となるように形成しても構わない。こうすることで、生体表面Ｂが滑らかに変形し、下面４ａの中心部の接触圧力が上昇した状態で装着でき、密着性のさらなる向上を図ることができると共に、さらに圧迫痕が付き難く装着し易い。

【0079】

また、図１１に示すように、ハウジング２の下面２ａに、突出部４を挟むと共に突出部４の側面４ｂから所定距離、即ち、８ｍｍ離間した位置に、ハウジング２の下面２ａから突出して形成された凸条部４０を設けても良い。なお、図１１に示す突出部４は、図８に示すものと同一形状である。

【0080】

また、凸条部４０の下面４０ａとハウジング２の下面２ａとの距離は４ｍｍに設定されており、突出部４の下面４ａとハウジング２の下面２ａとの距離（３ｍｍ）よりも若干高くなっている。

【0081】

このように構成した場合には、ハウジング２を手首Ａに装着したときに、生体は、突出部４と凸条部４０との間に形成された８ｍｍの隙間に入り込んだ状態で、突出部４の下面４ａ及び凸条部４０の下面４０ａに接触する。この際、凸条部４０は、突出部４の外側で生体に接触すると共に突出部４より先に接触する。従って、生体を安定させた状態で突出部４の下面４ａに接触させることができると共に、突出部４の下面４ａに対して接触圧力を均一にすることができる。よって、長時間に亘り安定して脈拍数の検出を行うことができる。また、凸条部４０を突出部４の近傍、即ち、小さなスペースで形成できるので、凸条部４０を設けたとしても、小型化を図ることができる。

【0082】

なお、上記凸条部は、図１２及び図１３に示すように、上述した図９及び図１０に示す突出部４と組み合わせて構成しても構わない。また、凸条部は、突出部の側面から所定距離離間した位置に、突出部の周囲を囲むように形成しても構わない。

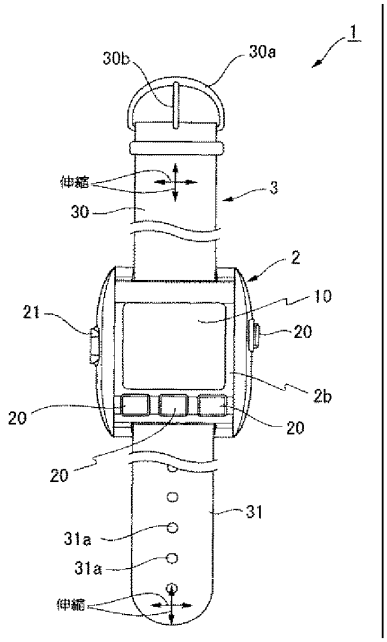
【0083】

また、上記実施形態においては、生体情報として脈拍数を例にして説明したが、脈拍数に限らず、生体情報であれば構わない。

【0084】
　また、接触検出手段は、一対の電極を有したが、一対に限らず、複数の電極を有しても構わない。この場合には、各電極間の電位差に基づいて接触したか否かを検出するように設定すれば良い。
【0085】
　また、生体センサ部は、ハウジングの中心位置より、第２のバンドの基端側にずれるように構成したが、第１のバンド側の基端側にずれるように形成しても構わない。つまり、両バンドと表示部との関係により、設計すれば良い。
【0086】
　また、ハウジングに、他の電子機器との間で無線通信可能な無線通信手段等の機能を付加しても良い。こうすることで、Ｂｌｕｅｔｏｏｔｈ等の無線通信により、メモリに記録した脈拍数を外部の電子機器にデータ送信したり、各種情報をメモリに入手させることができる。
【図面の簡単な説明】
【0087】
【図1】本発明に係る生体情報計測装置の一実施形態を示す正面図である。
【図2】図１に示す生体情報計測装置を手首に装着した状態を示す側面図である。
【図3】図１に示す生体情報計測装置を手首に装着した状態を示す側面図であり、図２に示す方向とは逆方向から見た図である。
【図4】図１に示す生体情報計測装置を斜め上方から見た状態を示す斜視図である。
【図5】図１に示す生体情報計測装置を斜め下方から見た状態を示す斜視図である。
【図6】図４に示す生体情報計測装置の断面矢視Ｃ－Ｃ図である。
【図7】図４に示す生体情報計測装置の断面矢視Ｄ－Ｄ図である。
【図8】図１に示す生体情報計測装置とは別の突出部の形状を示す図であって、突出部の外周が円形の場合の図である。
【図9】図８に示す突出部を、外縁が曲面となるように形成した場合の図である。
【図10】図８に示す突出部を、下面の中心から外縁に向けて曲面となるように形成した場合の図である。
【図11】図８に示す突出部を挟むように、凸条部を形成した場合の図である。
【図12】図９に示す突出部を挟むように、凸条部を形成した場合の図である。
【図13】図１０に示す突出部を挟むように、凸条部を形成した場合の図である。
【符号の説明】
【0088】
Ｂ　　生体表面
１　　生体上方計測装置
２　　ハウジング（本体）
２ａ　　本体の下面
２ｂ　　本体の上面
３　　固定手段
４　　突出部
４ａ　　突出部の下面
４ｂ　　突出部の側面
５　　ＬＥＤ（光発光部）
６　　ＰＤ（光受光部）
７　　接触検出手段
７ａ、７ｂ　　一対の電極
８　　生体センサ部
９　　データ処理部（生体情報検出部）
１１　　表示部
１３　　充電池

２１　外部接続端子（充電手段）
２４　フレキシブル基板
３０　第１のバンド
３１　第２のバンド
４０　凸条部
４０ａ　凸条部の下面

【図1】



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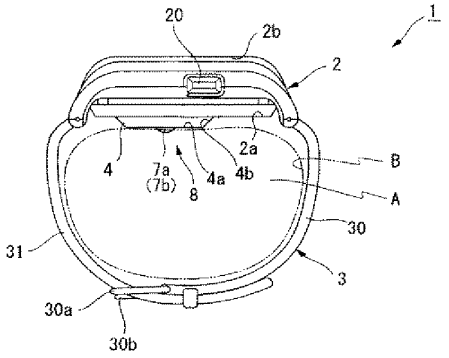

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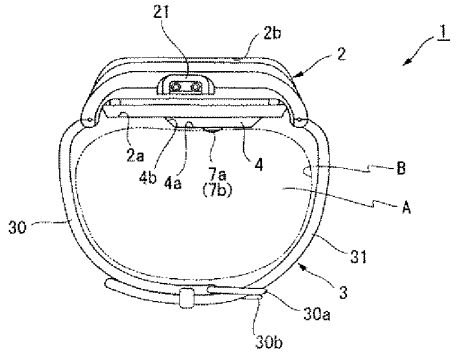
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30a
30b

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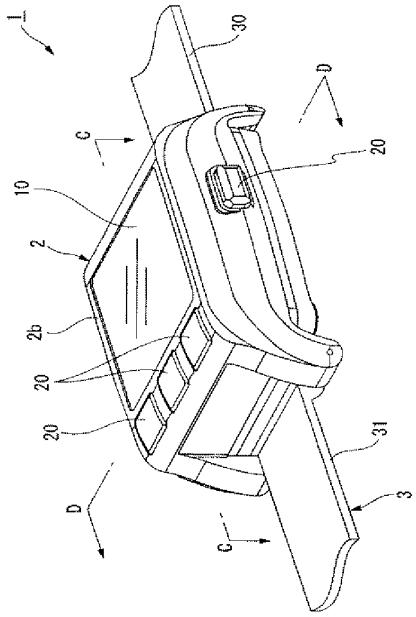
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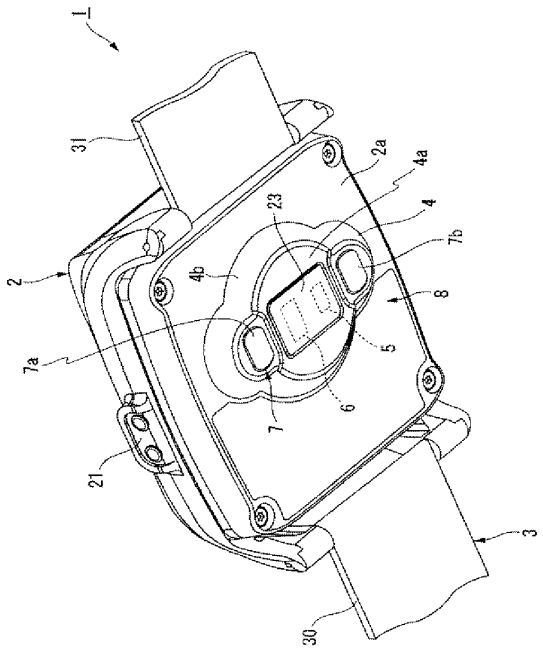
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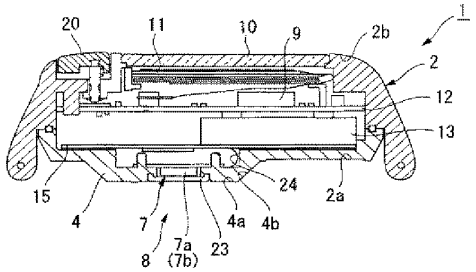
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(7b)
23

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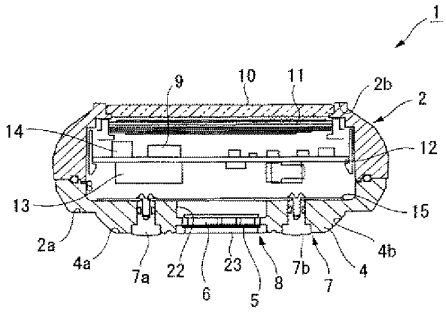
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7b
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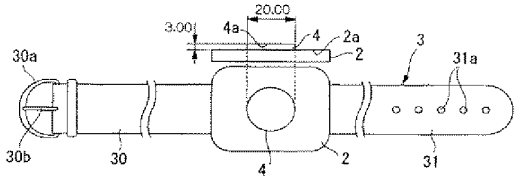
【図8】



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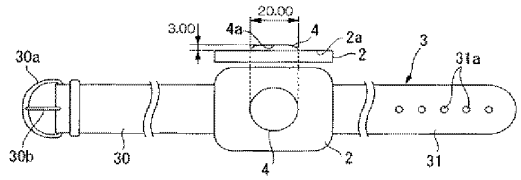

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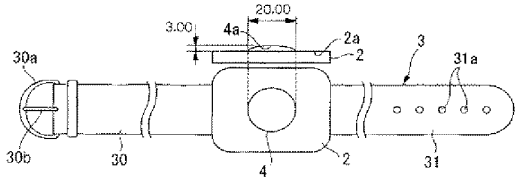

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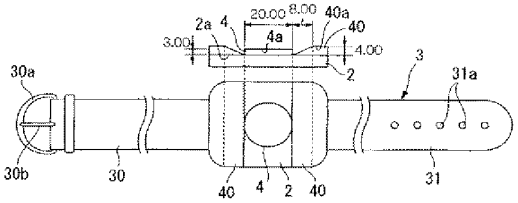

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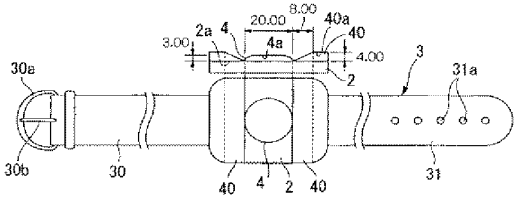

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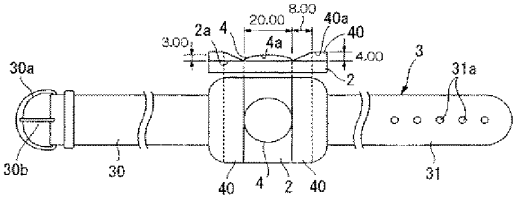

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Ｆターム(参考) 4C017 AA10　AB02　AC16　AC28　BC11　BC16　CC01　CC06

Espacenet

Bibliographic data: JP2006102164 (A) — 2006-04-20

BIOLOGICAL INFORMATION DETECTOR

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Applicant(s): NIPPON TELEGRAPH & TELEPHONE; NTT ADVANCED TECH KK ± (NIPPON TELEGR & TELEPH CORP <NTT>, ; NTT ADVANCED TECHNOLOGY CORP)

Classification: **- international:** ***A61B5/0245***
- cooperative: **A61B5/021 (EP)**; **A61B5/6816 (EP)**; **A61B5/6817 (EP)**; A61B5/02241 (EP); Y10T24/44427 (EP,US)

Application number: JP20040293238 20041006 Global Dossier

Priority number(s): JP20040293238 20041006

Also published as: CN100479745 (C) CN101014282 (A) EP1806094 (A1) EP1806094 (A4) EP2229877 (A1) more

Abstract of JP2006102164 (A)

PROBLEM TO BE SOLVED: To provide a biological information detector which can be easily mounted and which detects biological information stably. ;SOLUTION: The biological information detector is provided with a sensor for detecting biological information at a pair of arms connected via a supporting shaft, and the sensor is adhered to the protrusion part of a living body, particularly the tragus of the pinna. The biological information detector can be used for measuring blood pressure, pulse waves and a blood flow for health and beauty. ;COPYRIGHT: (C)2006,JPO&NCIPI

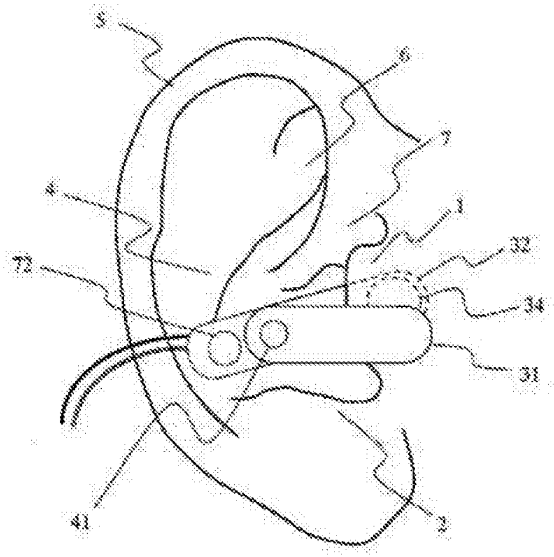

FIG. 5

Notice

CLAIMS JP2006102164

1.
A pair of opposing arms; a spindle connecting the pair of arms at one end of each of the pair of arms; and a spacing between the other ends of the pair of arms provided on the spindle. A distance variable mechanism; a sensor that detects biological information that is attached to the opposite side of the pair of arms at the other end of at least one of the pair of arms; A biological information detection apparatus comprising; an elastic body that reduces a distance between the other ends.

2.
A pair of opposing arms; a support shaft connecting the pair of arms at one end of each of the pair of arms; and a spacing between the other ends of the pair of arms provided on the support shaft. A variable distance mechanism; a sensor that detects biological information that is attached to the opposite end of the pair of arms at the other end of at least one of the pair of arms; A biological information detection apparatus comprising; a latch that temporarily restricts the distance between the other ends so as not to increase.

3.
The living body information detecting apparatus according to claim 1, wherein the sensor is mounted on a tip of an adjustment screw attached to a screw hole penetrating the other end of the arm.

4.

The sensor is a light emitting element that makes output light incident on a living body of an auricle, and a light receiving element that receives light scattered by the living body or light transmitted through the living body. The biological information detection device according to claim 1.

5.
The living body information detecting apparatus according to claim 1, wherein the sensor is a cuff that applies pressure to the living body and detects pressure from the living body.

6.
A cuff for pressing a living body, which is attached to the opposite end of the pair of arms and is the other end of at least one of the pair of arms, and the sensor is built in the cuff. The living body information detecting apparatus according to claim 1, wherein the living body information detecting apparatus is a living body information detecting apparatus.

7.
A pair of opposing arms; a spindle connecting the pair of arms at one end of each of the pair of arms; and a spacing between the other ends of the pair of arms provided on the spindle. A living body information detecting device comprising: a variable distance mechanism; and a cuff for pressing a living body, which is attached to the other end of at least one arm of the pair of arms and opposite to the pair of arms. The arm around which the cuff is attached or the frame surrounding the cuff contacts the living body in a state where air is exhausted from the cuff, and the cuff is in a state where air is supplied to the cuff. A biological information detection device characterized by pressing a tragus in contact with a biological surface.

8.
A pair of opposing arms; a spindle connecting the pair of arms at one end of each of the pair of arms; and a spacing between the other ends of the pair of arms provided on the spindle. A living body information detecting device comprising: a variable distance mechanism; and a cuff for pressing a living body, which is attached to the other end of at least one arm of the pair of arms and opposite to the pair of arms. A biological information detection apparatus, wherein at least the cuff is detachable from an arm to which the cuff is attached.

9.
A pair of opposing arms; a support shaft connecting the pair of arms at one end of each of the pair of arms; and a spacing between the other ends of the pair of arms provided on the support

shaft. A biological information detection device comprising: a distance variable mechanism; and a cuff that presses the living body, which is attached to the opposite end of the pair of arms at the other end of at least one of the pair of arms. The biological information detecting apparatus according to claim 1, wherein at least one of the cuffs can change a direction in contact with the living body.

10.

A pair of opposing arms; a spindle connecting the pair of arms at one end of each of the pair of arms; and a spacing between the other ends of the pair of arms provided on the spindle. A living body information detecting device comprising: a variable distance mechanism; and a cuff for pressing a living body, which is attached to the other end of at least one arm of the pair of arms and opposite to the pair of arms. The biological information detecting apparatus according to claim 1, wherein at least one of the cuffs is slidable in a longitudinal direction of an arm to which the cuff is attached.

11.

The biological information detection apparatus according to claim 10, further comprising an elastic body that brings the cuff closer to the other end direction of the arm to which the cuff is attached.

12.

The biological information detection apparatus according to claim 1, further comprising a rotation mechanism that rotates at least one of the pair of arms around the support shaft as a central axis.

13.

The pair of arms is an arm disposed on one side of the protrusion of the human auricle and an arm disposed on the other side of the protrusion of the human auricle. The living body information detecting apparatus according to claim 1, wherein the living body information detecting apparatus is configured to sandwich the protruding portion.

14.

The pair of arms are arranged on one side of the tragus as a protrusion of the human auricle and on the other side of the tragus as a protrusion of the human auricle. The biological information detecting apparatus according to claim 13, wherein the biological information detecting apparatus is configured to sandwich an tragus as a protrusion of the human auricle with an arm.

15.
The biological information detecting apparatus according to claim 13, further comprising an ear hook that goes around the base of the pinna of the human body.

16.
A cushion provided on the auricle side of the arm arranged on the auricle side of the pair of arms, a magnet provided on at least one of the arm provided with the cushion and the ear hook, and a magnet provided on the other side The biological information detection device according to claim 15, further comprising: a magnetic material.

17.
A bridge connecting the pair of arms attached to one of the left and right auricles of the human body and the other auricle not attached to the pair of arms; The biological information detection device according to claim 1, further comprising: a power supply unit that drives the sensor.

18.
The living body information detecting apparatus according to claim 1, further comprising: an ear hook for suspending on a base of an auricle of a human body; and a power supply unit disposed on the ear hook.

Notice

DESCRIPTION JP2006102164

[PROBLEMS] To measure blood pressure stably because it is difficult to accurately measure a pulse wave and blood pressure value because noise due to vibration is likely to be mixed in a measurement requiring pressurization to a living tissue such as blood pressure measurement. Was an issue. In addition, since it is difficult to measure blood pressure at regular intervals or continuously with daily blood pressure measurement or with a sphygmomanometer attached, a method for holding a biological information detection device has been a problem. The present invention has been made to solve the above-described problems, and an object of the present invention is to provide a biological information detection device that is easy to wear and stably detects biological information. In order to achieve the above object, a biological information detection apparatus according to the present invention comprises a pair of arms connected by a spindle and a sensor for detecting biological information, and the sensor is a protrusion of a living body, in particular. It was set as the structure closely_contact | adhered to the tragus. [Selection] Figure 1

Biological information detection device

[0001]
The present invention relates to a biological information detection apparatus that detects biological information from a part of a living body such as a pinna of a human body.

[0002]

With the aging of society, dealing with adult lifestyle-related diseases has become a major social

issue.

It is recognized that long-term blood pressure data collection is very important, especially for diseases related to high blood pressure. From such a viewpoint, various biological information detection devices including blood pressure have been developed.

[0003]

2. Description of the Related Art Conventionally, there is a patient monitor device that is inserted into an external auditory canal or other site in the external ear and is always worn as a device that detects biological information in the external ear portion (see, for example, Patent Document 1). In Patent Literature 1, as a method for detecting a pulse wave or blood flow of an artery, scattered light scattered by an artery of a living body or a blood cell in the artery is received by a light receiving element. A method for detecting pulse waves and blood flow from scattered light is disclosed. Here, the pulse, pulse wave, electrocardiogram, body temperature, arterial oxygen saturation, blood pressure, and the like can be calculated from the amounts of received infrared light and visible light scattered in the living body.

[0004]

Moreover, as an apparatus to be mounted on the ear canal or earlobe, there is an emergency information apparatus that includes wireless communication means and includes an arterial blood oxygen saturation sensor, a body temperature sensor, an electrocardiogram sensor, and a pulse wave sensor (for example, Patent Document 2 reference.).

[0005]

On the other hand, with regard to blood pressure measurement, blood pressure measurement devices using pulsation waveforms of blood vessels are blood pressure measurement devices using other methods such as the cuff vibration method or volume compensation method (see Non-Patent Document 1, for example).

) Is recognized as a powerful blood pressure measurement method.

[0006]

In the present application, the name of the pinna is based on Non-Patent Document 2, and the name of the pinna cartilage is based on Non-Patent Document 3. Japanese Patent Laid-Open No. 9-128203 Japanese Patent Laid-Open No. 11-128174 Kenichi Yamakoshi, Tatsuo Togawa, "Biological Sensors and Measuring Devices", edited by the Japan EM Society / ME textbook series A-1, pages 39-52 Sobotta Volume 1 (Translator: Michio Okamoto), p. 126, Medical School Co., Ltd., issued on October 1, 1996. Sobotta Illustrated Human Anatomy Volume 1 (Translation: Michio Okamoto), p. 127, Medical School, issued October 1, 1996

[0007]

In measurements that require pressure on living tissue such as blood pressure measurements, it is difficult to measure accurate pulse waves and blood pressure values because noise due to vibration is likely to be mixed in, and it is difficult to measure blood pressure stably, there were. In addition, since it is difficult to measure blood pressure at regular intervals or continuously with daily blood pressure measurement or with a sphygmomanometer attached, a method for holding a biological information detection device has been a problem.

[0008]

The present invention has been made to solve the above-described problems, and an object of the present invention is to provide a biological information detection device that is easy to wear and stably detects biological information.

[0009]

In order to achieve the above object, a biological information detecting apparatus according to the present invention comprises a pair of arms connected by a support shaft and a sensor for detecting biological information, and the sensor is a protrusion of a living body, particularly an ear of an auricle. It was set as the structure closely_contact | adhered to a bead.

[0010]

Specifically, the biological information detection apparatus according to the present invention includes a pair of opposed arms, a support shaft that connects the pair of arms at one end of each of the pair of arms, and the support shaft. And a distance variable mechanism for adjusting the distance between the other ends of the pair of arms, and the other end of at least one arm of

the pair of arms and attached to the opposite side of the pair of arms. A sensor for detecting living body information, and an elastic body for reducing a distance between the other ends of the pair of arms.

[0011]
The distance between the other ends of the pair of arms can be adjusted by a variable distance mechanism provided on the support shaft, and the sensor attached to the arm can be brought into close contact with the living body by an elastic body that reduces the distance between the other ends. it can.

[0012]
The biological information detection apparatus according to the present invention is provided on the support shaft, the pair of arms facing each other, a support shaft connecting the pair of arms at each end of the pair of arms, and the pair of arms. A variable distance mechanism that adjusts the distance between the other ends of the arms, and biometric information that is attached to the opposite side of the pair of arms at the other end of at least one of the pair of arms And a latch that temporarily restricts the distance between the other ends of the pair of arms so as not to widen.

[0013]
The distance between the other arms of the pair of arms can be adjusted by a variable distance mechanism provided on the support shaft, and the sensor attached to the arms can be controlled by a latch that temporarily restricts the distance between the other arms so as not to widen. The adhesion to the living body can be continued.

[0014]
In the biological information detection apparatus according to the present invention, the sensor may be mounted on a tip of an adjustment screw attached to a screw hole that penetrates the other end of the arm.

[0015]
By mounting the sensor on the tip of the adjustment screw, the degree of close contact with the living body can be adjusted.

[0016]

In the biological information detection apparatus according to the present invention, the sensor receives a light emitting element that causes output light to enter the living body of the auricle, and light output from the light emitting element is scattered by the living body or transmitted through the living body. It may be a light receiving element.

[0017]

Biological information can be acquired by causing the output light of the light emitting element to enter the living body and receiving the light scattered by the living body or the light transmitted through the living body by the light receiving element.

For example, a pulse wave can be detected.

[0018]
In the living body information detecting apparatus according to the present invention, the sensor may be a cuff that applies pressure to the living body and detects pressure from the living body.

[0019]
A pressure pulse wave from a living body can be detected by measuring minute pressure fluctuations in the cuff while applying pressure to the living body by the cuff.

[0020]
The biological information detection apparatus according to the present invention includes a cuff that presses a living body, which is attached to the other end of at least one arm of the pair of arms and is opposed to the pair of arms, The sensor may be built in the cuff.

[0021]

By incorporating the sensor in the cuff, it is possible to acquire biological information on the biological part pressed by the cuff.

In addition, the biological information detection apparatus can be reduced in size.

[0022]
The biological information detection apparatus according to the present invention is provided on the support shaft, the pair of arms facing each other, a support shaft connecting the pair of arms at each end of the pair of arms, and the pair of arms. A distance variable mechanism that adjusts the distance between the other ends of the arms, and the other end of at least one of the pair of arms that is attached to the opposite side of the pair of arms and presses the living body An arm attached to the cuff or a frame surrounding the cuff in a state where air is being exhausted from the cuff, and a living body is in contact with the living body, and air is supplied to the cuff. The cuff presses the tragus in contact with the surface of the living body.

[0023]
The distance between the other ends of the pair of arms can be adjusted by the variable distance mechanism provided on the support shaft, and the pressurization in the cuff can be reduced to eliminate the measurement error factor due to the pressurization.

[0024]
The biological information detection apparatus according to the present invention is provided on the support shaft, the pair of arms facing each other, a support shaft connecting the pair of arms at each end of the pair of arms, and the pair of arms. A distance variable mechanism that adjusts the distance between the other ends of the arms, and the other end of at least one of the pair of arms that is attached to the opposite side of the pair of arms and presses the living body And at least the cuff is detachable from an arm to which the cuff is attached.

[0025]
The distance variable mechanism provided on the support shaft can adjust the distance between the other ends of the pair of arms, and can exchange cuffs that are easily soiled or worn, and facilitate hygiene management.

[0026]
The biological information detection apparatus according to the present invention is provided on the support shaft, the pair of arms facing each other, a support shaft connecting the pair of arms at each end of the pair of arms, and the pair of arms. A distance variable mechanism that adjusts the distance between the other ends of the arms, and the other end of at least one of the pair of arms that is attached to the opposite side of the pair of arms and presses the living body And at least one of the cuffs is capable of changing a direction in contact with the living body.

[0027]
The distance between the other ends of the pair of arms can be adjusted by the distance variable mechanism provided on the support shaft, and the degree of adhesion to the living body can be increased by the freedom of the cuff direction.

[0028]
The biological information detection apparatus according to the present invention is provided on the support shaft, the pair of arms facing each other, a support shaft connecting the pair of arms at each end of the pair of arms, and the pair of arms. A distance variable mechanism that adjusts the distance between the other ends of the arms, and the other end of at least one of the pair of arms that is attached to the opposite side of the pair of arms and presses the living body And at least one of the cuffs is slidable in a longitudinal direction of an arm to which the cuff is attached.

[0029]
The distance between the other ends of the pair of arms can be adjusted by the variable distance mechanism provided on the support shaft, and the cuff can be slid to be arranged at the optimum position of the living body.

[0030]
The biological information detection apparatus according to the present invention includes an elastic body that brings the cuff closer to the other end direction of the arm to which the cuff is attached.

[0031]
By pressing the cuff toward the other end of the arm, the cuff can be brought into close contact with the living body.

[0032]
The biological information detection apparatus according to the present invention further includes a rotation mechanism that rotates at least one of the pair of arms with the support shaft as a central axis.

[0033]
Even when the shape of the living body is complicated, the cuff can be brought into close contact with the living body by changing the angle at which the arms intersect.

[0034]
In the biological information detection apparatus according to the present invention, the pair of arms are arranged on one side of the projection of the human auricle and on the other side of the projection of the human auricle. The arm is configured so as to sandwich the protrusions of the human auricle with the arm.

[0035]
By sandwiching the projections of the auricle with a pair of arms, the biological information detecting device can be attached to the auricle.

[0036]
In the biological information detecting apparatus according to the present invention, the pair of arms are arranged on one side of the tragus as a protrusion of the human auricle and the ear as a protrusion of the human auricle. It is comprised so that the tragus as a projection part of the auricle of the said human body may be pinched | interposed with the arm arrange | positioned at the other side surface side of a tragus.

[0037]
By sandwiching the tragus with a pair of arms, the biological information detecting device can be attached to the auricle.

[0038]
The biological information detection apparatus according to the present invention further includes an ear hook that goes around the base of the pinna of the human body.

[0039]
The biological information detection device can be stably attached to the auricle.

[0040]
The biological information detection apparatus according to the present invention is provided on

at least one of the cushion provided on the auricle side of the arm disposed on the auricle side of the pair of arms, the arm provided with the cushion, and the ear hook. And a magnet or a magnetic body provided on the other side.

[0041]
By providing the cushion, the biological information detecting device can be worn for a long time, and noise caused by body movement can be reduced by attracting the ear hook and the cushion by magnetic force.

[0042]
The biological information detecting apparatus according to the present invention connects the pair of arms attached to one of the left and right auricles of a human body and the other auricle not attached to the pair of arms. It further comprises a bridge and a power supply unit that is arranged in the middle of the bridge and drives the sensor.

[0043]

By providing the bridge straddling the left and right pinna, the biological information detecting device can be stably attached to the pinna.

In addition, by reducing the power supply unit from the arm, the arm can be reduced.

[0044]
The living body information detecting apparatus according to the present invention further includes an ear hook for suspending on the base of an auricle of a human body, and a power supply unit arranged on the ear hook.

[0045]
By providing the ear hook, the biological information detection device can be stably attached to the auricle, and by placing the power supply unit on the ear hook, the burden on the arm is lightened and noise due to wiring vibration is reduced. be able to.

[0046]

According to the biological information detection apparatus of the present invention, it is easy to wear and can stably detect biological information.

[0047]

Embodiments of the biological information detection apparatus of the present invention will be described with reference to the accompanying drawings.

Note that the present invention is not limited to the following embodiments.

[0048]

In the present application, "inner side of the tragus" refers to the side of the concha cavity 8 of the tragus 1 in FIG.

"Outside of tragus" refers to the side of tragus 1 opposite to concha cavity 8 in FIG.

[0049]
(Embodiment 1) The biological information detection apparatus of this embodiment includes a pair of opposed arms, a support shaft that connects the pair of arms at each end of the pair of arms, and the support shaft. A distance variable mechanism that adjusts the distance between the other ends of the pair of arms, and the other end of at least one arm of the pair of arms on the opposite side of the pair of arms. A sensor that detects attached biological information; and an elastic body that reduces a distance between the other ends of the pair of arms.

[0050]
In addition, a rotation mechanism that rotates at least one of the pair of arms about the support shaft as a central axis may be further provided.

[0051]

FIG. 1A is a front view of a configuration example of the biological information detection apparatus of the present embodiment, and FIG. 1B is a plan view of the configuration example of the biological information detection apparatus of the present invention.

The biological information detection apparatus shown in FIGS. 1A and 1B has, for example, a portion where each of the first arm 31 and the second arm 32 is connected to the support shaft 35, or the support shaft 35. The first arm 31 and the second arm 32 are provided with a variable distance mechanism that adjusts the distance between the other ends facing each other.

The distance variable mechanism 40 changes the angle α shown in FIG. 1A by changing the angle between the support shaft 35 and the first arm 31, so that the first arm 31 and the second arm 32 face each other. It has a function of adjusting the distance between the surfaces.

[0052]

Here, the mechanism for changing the angle of the distance variable mechanism 40 may be any of a mechanism for adjusting the angle of the support shaft 35 and the first arm 31 with a screw, or a mechanism for using both friction and screw fixing.

Further, as a mechanism for adjusting the distance between the other ends of the first arm 31 and the second arm 32 facing each other, a mechanism for expanding and contracting the length of the support shaft 35 may be used.

[0053]

Further, the biological information detecting apparatus shown in FIG. 1A has a rotation mechanism 41 that moves the first arm 31 in the rotation direction around the support shaft 35 at the connection portion between the first arm 31 and the support shaft 35. The rotation mechanism 41 has a function of changing an angle β formed between the direction of the first arm 31 and the direction of the second arm 32 as viewed from the axial direction of the support shaft 35 shown in FIG. .

Note that the rotation mechanism 41 is optional.

[0054]
In the case of the configuration example of the biological information detection apparatus shown in FIGS. 1A and 1B, a spring 70 is provided to reduce the distance between the other end of the first arm 31 and the other end of the second arm 32. Yes.

[0055]

The spring 70 shown in FIG. 1A acts in a direction in which the other end of the first arm 31 and the other end of the second arm 32 are contracted.

For example, if one end of the first arm 31 and one end of the second arm 32 are pinched to widen the distance between the sensor 33 and the sensor 34 and the spring 70 is released when the living body is sandwiched, the extension of the spring 70 The sensor 33 and the sensor 34 are brought into close contact with the living body due to the force.

[0056]
When the spring 70 is disposed on the other end side with respect to the support shaft 35, one end of the first arm 31 and one end of the second arm 32 are pinched to widen the interval between the sensor 33 and the sensor 34, and When the spring 70 is released when the sensor is sandwiched, the sensor 33 and the sensor 34 are brought into close contact with the living body due to the pulling force of the spring 70.

[0057]
Here, a coiled spring is taken as an example of the elastic body, but an elastic body such as a plate spring, a torsion spring, an air spring, rubber, or resin may be used instead of the coiled spring.

[0058]

The biological information detecting device has a function of detecting biological information by bringing the sensor 33 and the sensor 34 into contact with part of a protrusion of the human auricle, for example, both sides of the tragus.

Here, when the sensor 33 and the sensor 34 are brought into contact with both sides of the tragus, the distance between the sensor 33 and the sensor 34 is determined by the distance variable mechanism 40 between the opposing surfaces of the first arm 31 and the second arm 32. By changing the distance, it is adjusted to an appropriate contact state. Further, the position where the sensor 33 and the sensor 34 are in contact is changed to an appropriate position by changing the angle β shown in FIG. Adjust to.

After the adjustment, the spring 70 acts in a direction to reduce the distance between the other end of the first arm 31 and the other end of the second arm 32, so that the sensor 33 and the sensor 34 can be brought into close contact with the living body.

[0059]

As described above, the living body information detection apparatus according to the present embodiment is an elastic body that can adjust the distance between the other ends of the pair of arms and can reduce the distance between the other ends by the distance variable mechanism provided on the support shaft. By this, the sensor attached to the arm can be brought into close contact with the living body.

Moreover, even if the shape of the living body is complicated by the rotating mechanism that rotates the arm, the cuff can be brought into close contact with the living body by changing the angle at which the arms intersect.

Therefore, it is possible to detect biological information stably with a small size and light weight that can be mounted at an appropriate position with an appropriate contact pressure corresponding to a difference in individual body shape.

[0060]

(Embodiment 2) The biological information detection apparatus according to the present embodiment includes a pair of opposed arms, a support shaft that connects the pair of arms at each end of the pair of arms, and the support shaft. A distance variable mechanism that adjusts the distance between the other ends of the pair of arms, and the other end of at least one arm of the pair of arms on the opposite side of the pair of arms. A sensor for detecting attached

biological information; and a latch for temporarily limiting the distance between the other ends of the pair of arms so as not to increase.

[0061]

FIG. 2A is a front view of a configuration example of the biological information detection apparatus of this embodiment, and FIG. 2B is a plan view of the configuration example of the biological information detection apparatus of the present invention.

In the case of the configuration example of the biological information detection device shown in FIGS. 2A and 2B, a spring 70 is provided to reduce the distance between the other end of the first arm 31 and the other end of the second arm 32. Furthermore, a latch mechanism 71 is also provided so that the distance between the other end of the first arm 31 and the other end of the second arm 32 does not increase.

[0062]

The spring 70 shown in FIG. 2A works in a direction to widen one end of the first arm 31 and one end of the second arm 32.

For example, if one end of the first arm 31 and one end of the second arm 32 are pinched to widen the distance between the sensor 33 and the sensor 34 and the spring 70 is released when the living body is sandwiched, the sensor 33 and the sensor 34 comes into close contact with the living body.

The latch mechanism 71 maintains the state where the sensor 33 and the sensor 34 are in close contact with the living body.

[0063]

The latch mechanism will be described with reference to FIG.