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(71) Applicant *(for all designated States except US)*: **BMEYE B.V.** [NL/NL]; Meibergdreef 9, NL-1105 AZ Amsterdam (NL).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **SCHRAA, Olaf** [NL/NL]; Keizerstraat 5, NL-1011 GD Amsterdam (NL). **SCHRAA, Bob** [NL/NL]; Christiaan De Wetstraat 19/3, NL-1191 NG Amsterdam (NL). **SETTELS, Jos, J., G., M.** [NL/NL]; De Hoef Westzijde 12/B, NL-1426 AR De Hoef (NL).

(74) Agent: **VAN LOON, C., J., J.**; Johan de Wittlaan 7, Vereenigde, NL-2517 JR Den Haag (NL).

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(54) Title: A CUFF FOR DETERMINING A PHYSIOLOGICAL PARAMETER

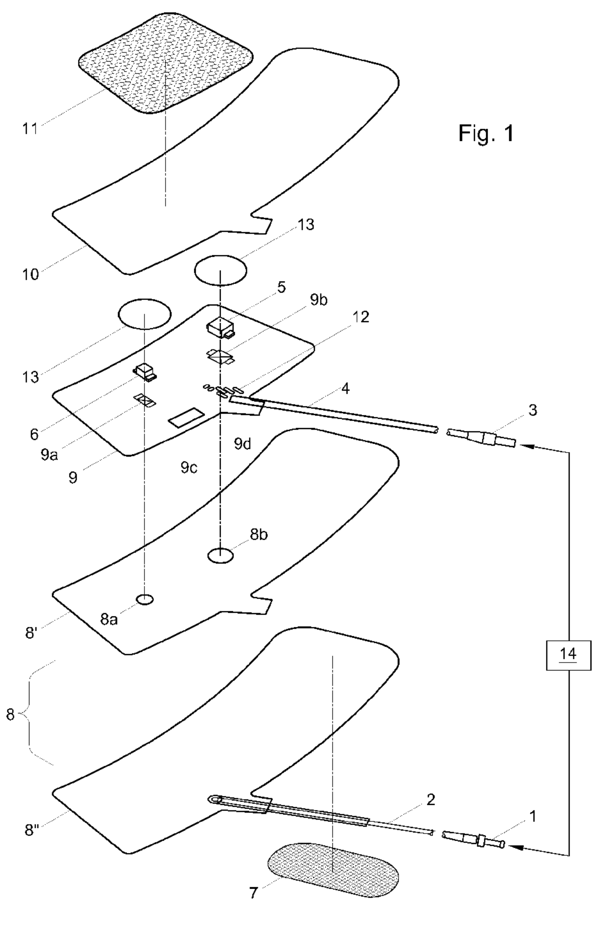

Fig. 1

(57) Abstract: The invention relates to a cuff (20) for determining a physiological parameter, said cuff comprising a photoplethysmograph arranged with an emitter (6) for emitting a radiation in a direction of a tissue to be investigated, a detector (5) for detecting the radiation from the tissue and an inflatable bladder (8) for transferring pressure to the tissue, said inflatable bladder comprising a back-layer (8") and a top-layer (8'), wherein the top-layer is conceived to be brought into contact with the tissue, the top-layer being substantially more flexible than the back-layer. The invention further relates to a measurement system.

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Title: A cuff for determining a physiological parameter

FIELD OF THE INVENTION

The invention relates to a cuff for determining a physiological parameter.

BACKGROUND OF THE INVENTION

An embodiment of a cuff as is set forth in the opening paragraph is known from US 4, 726, 382. The known cuff comprises an inflatable bladder formed from a thin flexible, translucent material. The inflatable bladder is connected to a tube enabling a suitable inflation and deflation of the inflatable bladder. In the known cuff the inflatable bladder is the innermost component of the cuff. The inflatable bladder is manufactured from two strips of film being heat sealed together about their periphery thereby forming a cavity. The known cuff is arranged to be fit about a person's finger. For this purpose the inflatable bladder is provided with a back-layer facing outwards from a tissue and a top-layer facing the tissue and being conceived to be brought into contact with the tissue. In order to implement a measurement of a physiological parameter, the known cuff comprises a photoplethysmograph.

In the inflatable bladder of the known cuff openings are provided so that a suitable light source and a light detector can be mounted therein. The inflatable bladder is mounted on a flexible printed circuit. The flexible circuit is used to feed components of the cuff and to supply measurement signals from the cuff to a suitable data processing unit.

It is a disadvantage of the known cuff in that both the back-layer and the top-layer of the inflatable bladder deform to some extent due to applied cuff pressure. This may result in inaccurate reading of physiological parameters such as blood pressure of the cuff due to a changing angle of reflection for a reflective set-up, or a displacement between, for example, the emitter and detector for a transmissive set-up.

SUMMARY OF THE INVENTION

An object of the invention may be to provide a cuff with improved operational characteristics. A further object may be to provide a cuff which can be manufactured in a simplified way. A still further object may be to provide an improvement of or an alternative for a cuff known from the prior art.

According to a first aspect of the invention the cuff may comprise:

- a photoplethysmograph arranged with
- an emitter for emitting a radiation in a direction of a tissue to be investigated;
- a detector for detecting the radiation from the tissue;

and

- an inflatable bladder for transferring pressure to the tissue, said inflatable bladder comprising a back-layer and a top-layer,

wherein the top-layer is conceived to be brought in contact with the tissue, the top-layer being substantially more flexible than the back-layer.

In accordance with this technical measure only the top-layer of the inflatable bladder undergoes deformation under application of a suitable internal cuff pressure. Thus, the internal pressure may be substantially applied to the tissue and substantially not towards internal components of the cuff by the back-layer. Because the back-layer substantially does not undergo any deformation, an emitter – detector, arranged beyond the back-layer, substantially preserve their respective geometry for different operational conditions, like different shapes of objects conceived to be received by the cuff. This substantially improves accuracy of the measurement of a physiological parameter, for example an arterial blood pressure and/or the blood flow and/or the blood oxygenation and may provide a great versatility for the cuff.

Preferably, the back-layer and the top-layer are implemented from respective materials, having comparable thicknesses. In this case a material of the top-layer refers to a substantially elastic material, whereas a material of the back-layer refers to a substantially not-elastic material. It is noted that the term "elastic material" comprises at least any material having a tensile stress at 50% strain of less than 5 MPa. The term non-elastic material comprises at least any material having a yield strength of more than 50 MPa. Presented values hold for a measurement technique of, for example ASTM, DIN or NEN. Suitable materials for the top-layer comprise but are not limited to polyurethanes. Suitable materials of the back-layer can be chosen from but not limited to polyvinyl chloride. It will be appreciated that the back-layer may comprise a thickened layer of material or a multilayer structure. In this case the back-layer may be manufactured from the same material as the top-layer, however having an increased thickness. Alternatively, the back-layer may have substantially the same thickness as the top-layer, but may be enforced with a further material, like a mesh or wiring for reducing its flexibility in use. It is noted that suitable embodiments of the emitter comprise a light source, for example a red LED source, or an infrared LED source.

Photoplethysmographs are known per se. An operational principle of the photoplethysmograph is based on the fact that with each cardiac cycle the heart pumps blood to the periphery of the body.

A change in volume of the arteries or arterioles caused by the pressure pulse of the systolic wave is detected by illuminating the skin with a suitable light, notably emitted from a Light Emitting Diode (LED) and then measuring the amount of light either transmitted or reflected to a suitable detector, notably a photodiode. Each cardiac cycle appears as a peak in a signal from the photoplethysmograph. The shape of a signal waveform from the photoplethysmograph differs from subject to subject, and varies with a location and a manner in which the cuff is attached to the tissue. It is noted that the photoplethysmograph can be attached to a great plurality of areas on the human body, for example on a finger, on an ear, in a nostril, on the temples of the head. The photoplethysmograph may even be arranged in a body cavity.

In an embodiment of a cuff, a flexible printed circuit may be provided for feeding the photoplethysmograph and for acquiring measurement data from the detector, whereby the back-layer may be arranged on the flexible printed circuit. In case the back-layer is adhered to the flexible printed circuit the latter may serve as a substantially stable foundation, decreasing a risk of undesired deformation of the back-layer in use. This feature further improves accuracy of a measurement. The back-layer of the inflatable bladder may be directly attached to the flexible circuit thereby reducing a number of components of the cuff. In a further embodiment of the cuff the top-layer may be mounted directly airtight to the flexible printed circuit totally eliminating the back layer. This may reduce the manufacturing costs accordingly.

In an embodiment of the cuff the top-layer can be arranged to provide an electrical insulation between the tissue and electrical components of the cuff. In accordance with this technical measure the top-layer advantageously has an additional function which may obviate a necessity for a specific anti-dust or anti-sweat protective layer. This has an advantage in that an additional decrease in a number of functional elements of the cuff is provided. The top layer may further be arranged to protect suitable electrical components of the cuff from contamination, like dirt and/or sweat.

In a still further embodiment of the cuff, the top-layer at least partially comprises a biocompatible material. In particular, a surface of the top-layer conceived to contact the tissue may be provided with or may consist of a bio-compatible material. This has an advantage that a risk of irritating the tissue is minimized, which is advantageous for a long-term monitoring. Preferably, the top-layer extends further than a surface of the inflatable bladder conceived to come into contact with the tissue in use. Due to this feature other layers of the cuff do not have to be manufactured from a biocompatible material, reducing the production costs or providing a wider choice of materials which can be employed. Also the electrical components need not to be made of biocompatible materials if the top layer is arranged over it. The material of the top-layer preferably comprises at least a part which is transparent to the radiation emanated from the emitter of the photoplethysmograph. However, it is also possible that the material of the top-layer comprises at least a part which is reflective to the said radiation. Preferably, the radiation is in the infra-red range.

In a further embodiment of the cuff the back-layer may be provided with cut-away areas for transmitting incident radiation from the emitter to the tissue and/or for transmitting the radiation from the tissue to the detector. It should be understood that the radiation from the tissue refers to either a transmitted radiation or a reflected radiation. Preferably, the emitter and the detector are arranged in the cuff so that respective external surfaces of the emitter and the detector lie substantially in a plane of the back-layer. The emitter and the detector can be mounted directly in the cut-away areas allowing easy and reliable automatic attachment, for example, soldering, of the cuff components. For this purpose the flexible printed circuit may be provided with similar cut-away areas which cooperate with the cut-away areas of the back-layer. Such arrangement of the emitter and the detector can have an additional advantage in that a height of the emitter and the detector with respect to a surface of the flexible printed circuit facing the back-layer can be adjusted, causing a reduction of a pressure applied by the emitter and the detector to the tissue, which is more comfortable in use. Simultaneously, the emitter and the detector are arranged in the cuff so that they substantially contact the tissue in use for enabling optimal coupling of the radiation with the tissue.

The material of the flexible printed circuit may be substantially flexible having low elasticity. It is found to be advantageous to provide the flexible printed circuit as a somewhat stiff structure, which may be bendable with a certain radius. This feature may be used to improve stiffness of a flap, which is a part of the cuff wrapped around a body portion, notably a finger, outside the inflatable bladder. The flexible circuit may be made of an infrared opaque material, alternatively, the flexible circuit may be reflective to infrared radiation.

In a further embodiment of the cuff according to the invention, a surface of the flexible printed circuit conceived to face the tissue in use comprises an electrically conductive coating. In case the emitter comprises a light source the coating may also be optically opaque and reflective. In accordance with this technical measure the light impinging on the coating will be reflected back towards the tissue improving signal-to-noise ratio. In addition proper electrical shielding is enabled. In addition, the opacity of the flexible circuit material advantageously prevents the detector of the photoplethysmograph from interference of ambient light. It is noted that in this case a usually envisaged protective layer for covering suitable metallic traces of the flexible printed circuit can be left out on the inner surface of the flexible printed circuit, which may further reduce manufacturing costs of the cuff and improves reflectivity and flexibility.

In a further embodiment of the cuff, the flexible printed circuit may be shaped with a tail-end for relieving fastening strain in use. Preferably, strain of an electric cable of the cuff and/or strain of an air tube of the cuff is relieved. This feature advantageously improves endurance of the cuff, in particular when the cuff is conceived to be repetitively fastened and removed.

In a further embodiment of the cuff, the flexible printed circuit may be arranged with an identifying unit and/or a signal processing unit for processing the measurement data. Suitable known per se circuits may be used for performing signal conditioning, like filtering, and amplifying. The identifying unit can, for example, be used to determine which size cuff is attached. This information can be used, for example, for the optimisation of servo parameters.

In a further embodiment of the cuff, the flexible printed circuit may comprise metal traces to solder positions being oriented substantially axially to a bending curve of the flexible print circuit. Preferably copper is used for this purpose. Due to this technical measure a chance of fracturing the traces upon bending is minimized.

In a still further embodiment of the cuff, the emitter may be arranged for emitting a focused beam of radiation. It is found to be advantageous to provide the focused radiation beam for avoiding pulsations or lack of pulsations from areas distant to a central location underneath the cuff, as such pulsations may cause an erroneous reading of the detector; lack of pulsations may compromise signal strength. Preferably, the emitter comprises a built-in opaque shield. This feature has an advantage in that stray light is minimized. The emitter may preferably be arranged to emit radiation with a wavelength in a range of 660 – 1000 nm. Preferably, the detector comprises a photodiode arranged to be sensitive at least to a portion of radiation emanating from the emitter.

In a still further embodiment of the cuff according to the invention, the cuff further may comprise means for preventing blockage of an airflow in an air tube communicating with the inflatable bladder. For example, the air tube may be cut at an angle less than 90 degrees and may be mounted in the inflatable bladder with the longest projection towards the top-layer.

These and other aspects of the invention will be discussed in more detail with reference to drawings, wherein like reference signs refer to like elements.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 presents a schematic elevated view of a cuff according to the invention.

Figure 2 presents a schematic view of the cuff of Figure 1 in a flat condition.

Figure 3 presents a schematic view of the cuff of Figure 1 in use.

Figure 4 presents a schematic view of a measurement system according to the invention.

DETAILED DESCRIPTION

It will be appreciated that the drawings, setting out some aspects of the cuff according to the invention, are not limitative. Figure 1 presents a schematic elevated view of a cuff according to the invention. The cuff comprises an inflatable bladder 8 provided with an air supply channel 2 for inflating the bladder and for evacuating it. For this purpose the air supply channel 2 may comprise a suitable fitting 1 for connecting to a pump, notably a gas pump. The inflatable bladder 8 comprises a top-layer 8'' conceived to be brought into contact with a portion of a person, notably with a finger of the person. The inflatable bladder further comprises a back-layer 8' attached to a flexible printed circuit 9. The top-layer is at least more elastic than the back-layer. Elastic should be understood as at least but not limited to any material having a tensile stress at 50% strain of less than 5 MPa. Preferably, the back-layer is substantially or entirely not-elastic. The term non-elastic material refers to at least any material having a yield strength of more than 50 MPa. Presented values hold for a measurement technique of ASTM, DIN or NEN. It is noted that the back-layer is preferably directly attached to the flexible printed circuit 9 without using any additional adhesive inter-layers for reducing a number of components of the cuff. The top-layer 8'' may comprise a substantially flexible and elastic material, like polyurethane. The back-layer 8' may comprise a substantially flexible non-elastic material, like polyvinyl chloride. The back-layer 8' may be attached to the top-layer 8'' by any suitable technique, preferably a sealing method is used. The back-layer, the flexible printed circuit 9 or the label may be non-elastic. Or two or all of these, whereas the non-elasticity may be provided for or enhanced by other means, such as non-elastic wires incorporated in a longitudinal direction L of the cuff.

The inflatable bladder 8 may further comprise cut-away areas 8a and 8b, wherein a light source 6, such as a light emitting device (LED) and a light detector 5 are positioned, respectively. The back-layer 8' of the inflatable bladder 8 can be attached to the flexible printed circuit 9, which comprises corresponding cut-away areas 9a, 9b for accommodating the light source 6 and the light detector 5. The flexible printed circuit 9 may further comprise suitable blockers 13 for shielding the light source 6 and the detector 5 from interference with other light sources or detectors. Preferably, the blockers 13 comprise opaque flexible material. A signal from the light detector 5 is picked up by one or more suitable electronic components (not shown) of the flexible printed circuit 9. The flexible printed circuit 9 is electrically connectable to a cable 4 provided with a suitable electric connector 3. It is possible that the cable 4 and the air supply 2 are housed in a joint housing having a single outside connector 14. The flexible printed circuit may comprise an identifying unit 12. Preferably, the flexible printed circuit 9 further comprises a module 9c for processing the signal from the detector 5. Suitable signal processing steps performed by the computers and/or a processing unit to be connected to the cable 4 may comprise a filtering, amplification, or the like.

A cuff 20 according to the invention may further comprise a sticker 10, which may comprise or form a suitable label. Fastening means, such as loop 11 and hook 7 material, for example Velcro® may be arranged on the cuff 20 to fasten the cuff about a portion of a recipient, for example around a finger of a person. Preferably, the top-layer 8'' is manufactured from a biocompatible material and extends substantially over the same length as the back-layer 8' or the sticker 10. Due to the fact that only the biocompatible top-layer is in contact with the tissue, the label or the back-layer does not have to be manufactured from a biocompatible material reducing the production costs of the cuff.

Preferably, a surface of the flexible printed circuit conceived to face the tissue in use comprises a coating, preferably a coating which is electrically conductive and optically opaque and/or reflective. This can have an effect that the light that may be reflected from the tissue and impinges on the coating, will be reflected back towards the tissue, improving signal-to-noise ratio of the measurement signal. In addition, such coating may enable proper electrical shielding of the components of the flexible printed circuit. The opacity of the flexible circuit material may advantageously prevent the detector of the photoplethysmograph from interference of ambient light with the photoplethysmograph, which also contributes to an improvement of the signal-to-noise ratio of the cuff according to the invention. Preferably, metal traces, notably copper traces, are used in the flexible printed circuit to connect the electrical cable 4 to the components of the flexible printed circuit, which makes wiring redundant, further decreasing manufacturing costs of the cuff according to the invention.

In a further embodiment of the cuff, the flexible printed circuit is shaped with a tail-end 9d, such as a projection, for relieving fastening strain applied to the cabling 4 and the air duct 2 in use. This improves durability of the cuff, particularly when it is conceived to be repetitively fastened and removed.

The cuff 20 is conceived to be arranged on a suitable portion of a body, for example around a finger, on an ear or the temples of the head, in a nostril, or in a body cavity. The cuff 20 comprises a photoplethysmograph arranged with an emitter 6, for example a LED or an infra-red source, and a light detector 5, for example a photodiode. This emitter-receiver pair is used to determine a blood flow in said portion of the body. In case a transmissive set-up is used, a light emitting diode may be used to transmit light through the skin. The detector 5 picks up the transmitted signal, which can then be analyzed using suitable signal processing techniques. A signal from the photoplethysmograph comprises a pulse wave corresponding to changes in blood volume in the arteries or capillaries receiving the light from the emitter 6. Changes in blood volume produce changes in optical absorption of the emitted light. The light transmitted through the tissue can be highly scattered or absorbed depending on the tissue. The detector, which is positioned on the surface of the skin, can detect the transmission of waves from various depths and from highly absorbing or weakly absorbing tissues. Regardless of the absorbency of the tissues and skin, it is generally assumed that the amount of light absorbed and/or reflected by these tissues will remain constant. With this assumption in mind, it can then be assumed that the only change in the absorption or reflection of the transmitted light will be from the increase or decrease of the blood volume in the arteries and capillaries. The measured volume change is actually an average of all of the arteries and capillaries in the space being irradiated. For a transmissive set-up infrared radiation may be chosen for the emitter 6 because infrared is well absorbed by blood and very weakly absorbed by other tissues and fluids in the body. This means that the blood volume changes can be very easily observed. Preferably, for detecting the signal an infrared receiver is chosen, sensitivity of which matches at least partially the spectrum of the infrared emitter. It may also be beneficial to use an infrared emitter because changes in blood oxygen content are very prominent in the visible light region. Due to the fact that the inflatable bladder comprises a top-layer which is more elastic than the back-layer, measurements of a physiological parameter such as blood pressure are obtained with improved accuracy, because less or no distortion of a light path between the light source and the light detector is caused by a deformation of the back-layer.

The placement of the emitter and receiver on the body is also an important aspect of the photoplethysmograph. It may be chosen to position the photoplethysmograph at an earlobe or at the fingers, because of the consistency of the tissues. These areas on the body can also be held relatively still to reduce motion artifact which would otherwise distort the output signal. Still another applicable area may be the nasal septum. However, different positions are possible.

Figure 2 presents a schematic view of the cuff of Figure 1 in a flat condition. The cuff 20 is shown in a top view, revealing a substantially transparent top-layer 8” where through a back-layer 8’ is seen provided with cut-way areas for accommodating respective parts of the photoplethysmograph, notably the light source 6 and the light detector 5. The cuff 20 can be inflated using air supply duct 2. Measurement data from the photoplethysmograph can be collected using a suitable electric cable 4. The electric cable 4 and the air supply channel 2 may be arranged in a suitable tube 14 which is attached to the cuff 20 by means of a tail portion 9d. The cuff 20 may be conceived to be wrapped around a body portion, for example a finger, in this case the cuff 20 may comprise fastening means, for example hooks 7 cooperating with loops 17.

Figure 3 presents a schematic view 30 of the cuff of Figure 1 in use, wherein the cuff 20 is wound about a finger 25 of a person under investigation. It is noted that especially when the top-layer of the cuff 20 comprises a bio-compatible material, the cuff 20 may be used for substantially prolonged period of time on the person, for example for purposes of durable monitoring of a vital sign, notably of pressure and/or cardiac output.

Figure 4 presents a schematic view of a measurement system according to the invention. The system 40 comprises a processor 41 and a measurement unit 46, which may preferably comprise the cuff for carrying measurements of the arterial pressure waveform, as is set forth with reference to Figure 1. Data collected by the measurement unit 46 is provided to the input 43 of the processor 41. It is noted that using the measurement unit 46, for example the cuff as is discussed with reference to Figure 1, a plurality of useful signals may be acquired. For example, plethysmogram and blood pressure data may be used for determining in non-invasive way additional information, for example using suitable models applicable to said data. For example, cardiac output can be determined non-invasively using arterial data provided by the measurement unit 46. The processor 41 further comprises storage 42 for storing a suitable model, for example a non-linear model approximating a relation between an aortic cross-section and applied pressure. Preferably, for the non-linear model an arctangent model is selected.

The aortic mechanical properties approximate a response of the internal cross-sectional area of the aorta to an increase in pressure by an arctangent:

$$A(p) = Am\ (0.5 + (1/\pi)\ \arctan((p-p0)/p1))$$

in which A the cross-sectional area in cm^2;
Am the maximal area at very high pressure;
p0 indicating the inflexion point of a pressure curve;
p1 indicating a halfwidth of a pressure pulse.

The processor 41 further comprises a computing unit 45 arranged for computing a compliance and/or an impedance of an aortic portion from the acquired arterial pressure data. For obtaining the compliance or the impedance the non-linear model, notably the arctangent model, is differentiated. The thus obtained value of the compliance or impedance may be incorporated into per se known pulse contour method, like for example the Waterhammer model or Windkessel model, for determining the beat-to-beat stroke volume and/or cardiac output based on the measured arterial pressure data, notably the waveform.

Windkessel model is a linear model pulse contour model that describes a relation between a stroke volume Vs, aortic compliance and characteristics of the waveform of arterial pressure.

$$Vs = C\ (p2 - p1)\ (1 + As/Ad)$$

with Vs - a stroke volume, C – an aortic compliance, defined as dV/dP, p2 - a pressure at a dicrotic notch, p1 the diastolic pressure, As the integrated area under the systolic portion of the blood pressure curve, and Ad similarly the diastolic area. The dicrotic notch is a pulse that precedes a dicrotic wave, it being a pulse sequence comprising a double-beat sequence wherein a second beat is weaker than a first beat.

Waterhammer model is another linear pulse contour model that describes a relation between impedance Zc, density of blood, aortic cross-sectional area and aortic compliance:

$$Zc = \sqrt{(r / (A\ C'))}$$

with r the density of blood, A the aortic cross-sectional area and C' the compliance per unit length.

It is noted that the cardiac output equals the stroke volume multiplied by a heart beat frequency. In this way a system is provided for determining beat-to-beat stroke volume and/or cardiac output based on the measurement of an arterial pressure waveform with increased accuracy compared to prior art.

It is found to be advantageous to provide a-priori tabulated relationships between theses parameters and patient characteristics, like age and gender. The computing unit 45 may be arranged to use these tabulations to calculate the compliance data from the arctangent model, yielding:

$$C(p) = Cm / (1 + ((p-p0)/p1)^2)$$

with

$$Cm = Am / (\pi\ p1),$$

wherein

C(p) is a pressure-dependent compliance;

Cm – is a maximum compliance or the aortic portion.

The computing means 45 is then arranged to incorporate the calculated value of the compliance in a linear model to calculate the beat-to beat stroke volume and/or cardiac output.

While specific embodiments have been described above, it will be appreciated that the invention may be practiced otherwise than as described. The descriptions above are intended to be illustrative, not limiting. Thus, it will be apparent to one skilled in the art that modifications may be made to the invention as described in the foregoing without departing from the scope of the claims set out below.

Claims

1. A cuff for determining a physiological parameter, comprising:

- a photoplethysmograph arranged with
- an emitter for emitting a radiation in a direction of a tissue to be investigated;
- a detector for detecting the radiation from the tissue;

and

- an inflatable bladder for transferring pressure to the tissue, said inflatable bladder comprising a back-layer and a top-layer, wherein

the top-layer is conceived to be brought into contact with the tissue, the top-layer being substantially more flexible than the back-layer.

2. A cuff for determining a physiological parameter, according to claim 1 further comprising a flexible printed circuit for feeding the photoplethysmograph and for acquiring measurement data from the detector, the back-layer being arranged on the flexible printed circuit.

3. A cuff according to claim 1 or 2, wherein the top-layer is arranged to provide an electrical insulation between the tissue and electrical components of the cuff.

4. A cuff according to any preceding claim, wherein the top-layer is arranged to protect electrical components of the cuff from contamination, like dirt and/or sweat.

5. A cuff according to any one of the preceding claims, wherein the top-layer is at least partially manufactured from a biocompatible material.

6. A cuff according to claim 5, wherein the top-layer extends further than an area of the inflatable bladder conceived to come into contact with the tissue in use.

7. A cuff according to any one of the preceding claims, wherein the back-layer is provided with cut-away areas for transmitting the radiation from the emitter to a tissue and/or for transmitting a further radiation from the tissue to the detector.

8. A cuff according to any one of the preceding claims, wherein the flexible printed circuit is provided with cut-away areas for transmitting the radiation from the light source to the tissue and/or for transmitting a further radiation from the tissue to the detector.

9. A cuff according to any one of the preceding claims, wherein the height of the optical components (LED and photo diode) is adjustable.

10. A cuff according to any one of the preceding claims, wherein a surface of the flexible printed circuit conceived to face the tissue in use comprises a coating, preferably an electrically conductive and optically opaque and reflective coating.

11. A cuff according to any one of the preceding claims, wherein the flexible printed circuit is shaped with a tail-end for relieving fastening strain in use.

12. A cuff according to any one of the preceding claims, wherein the flexible print circuit is arranged with an identifying unit and/or a signal processing unit for processing measurement data.

13. A cuff according to any one of the preceding claims, wherein the flexible printed circuit comprises metal traces to solder positions being oriented substantially axially to a bending curve of the flexible printed circuit.

14. A cuff according to any one of the preceding claims, wherein the emitter is arranged for emitting a focused beam of radiation.

15. A cuff according to any one of the preceding claims, wherein the emitter comprises a built-in opaque shield.

16. A cuff according to any one of the preceding claims, wherein the emitter is arranged to emit radiation with a wavelength in a range of 660 – 1000 nm.

17. A cuff according to any one of the preceding claims, wherein the detector comprises a photodiode arranged to be sensitive for a radiation with a wavelength matching at least part of a spectrum of the emitter.

18. A cuff according to any one of the preceding claims, further comprising:
- an air tube communicating with the inflatable bladder;
- means for preventing blockage of an airflow in the air tube.

19. A cuff according to claim 18, wherein the air tube is cut at an angle less than 90 degrees and is mounted in the inflatable bladder with the longest projection towards the top-layer.

20. A cuff according to any one of the preceding claims, wherein at least a part of the top layer is transparent for the said light.

21. A measurement system comprising a cuff according to any one of the preceding claims and a data processing unit.

22. A measurement system according to claim 21, wherein the data processing unit is arranged to:
- compute a compliance or impedance in dependence of at least one measurement of arterial pressure data and patient data using a non-linear model;
- use said compliance or impedance in a pulse contour method for determining the beat-to-beat stroke volume and/or cardiac output based on the measured arterial pressure data.

23. A measurement system according to claim 22, wherein for the arterial pressure data an arterial pressure waveform is selected.

24. A measurement system according to claim 23, wherein said non-linear model is conceived to approximate a pressure dependency of a cross-sectional area of apportion of aorta.

25. A measurement system according to claim 24, wherein the said non-linear model is given by an equation, such as:

$$A(p) = Am\ (0.5 + (1/\pi)\arctan((p-p0)/p1),$$

wherein A is the cross-sectional area of the aorta in cm^2,

Am is the maximal area of the aorta at very high pressure;

p0 is a parameter indicating an inflection point of a pressure curve A(p);

p1 is a parameter describing a half-width of the pressure curve.

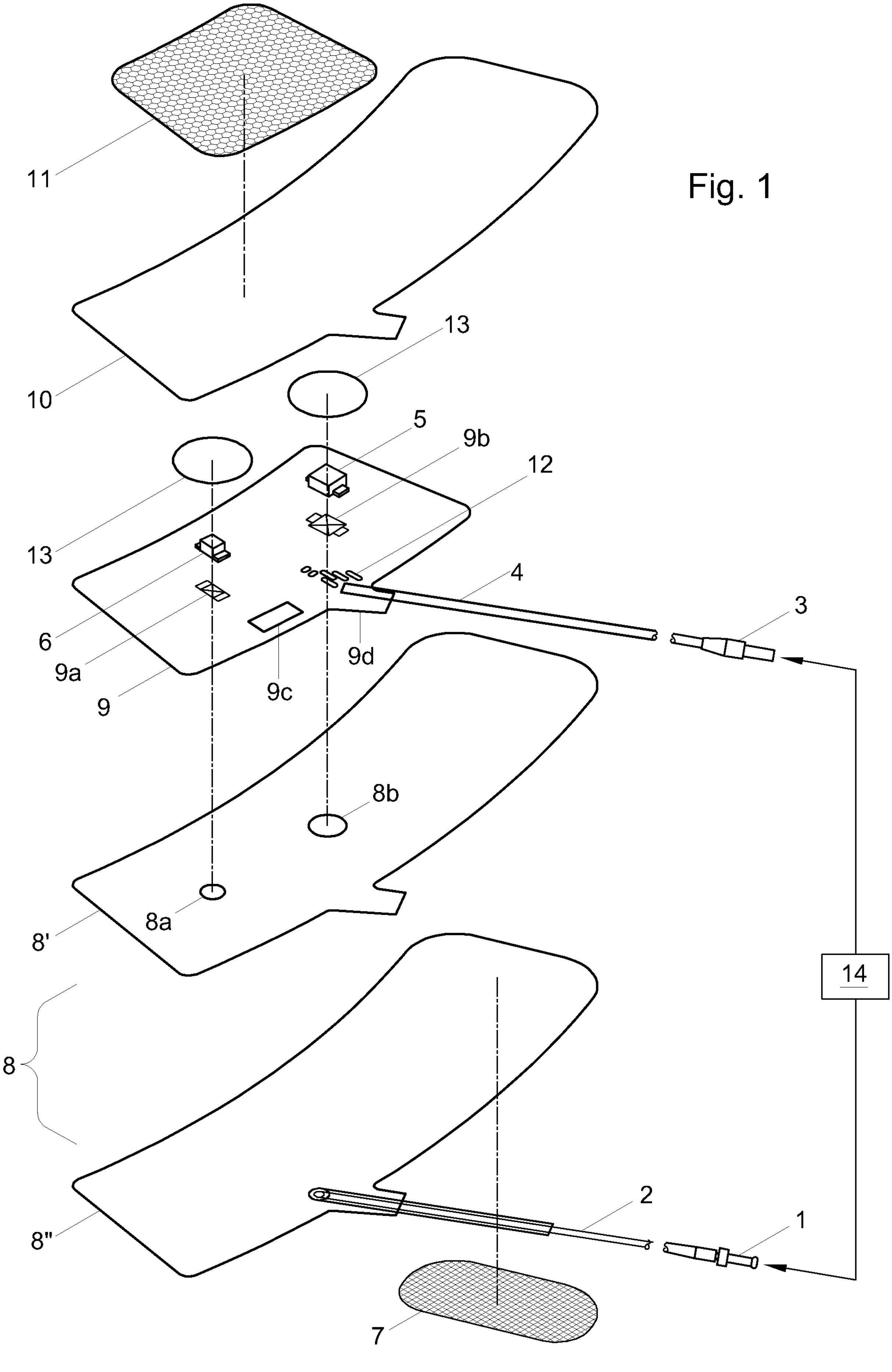

Fig. 1

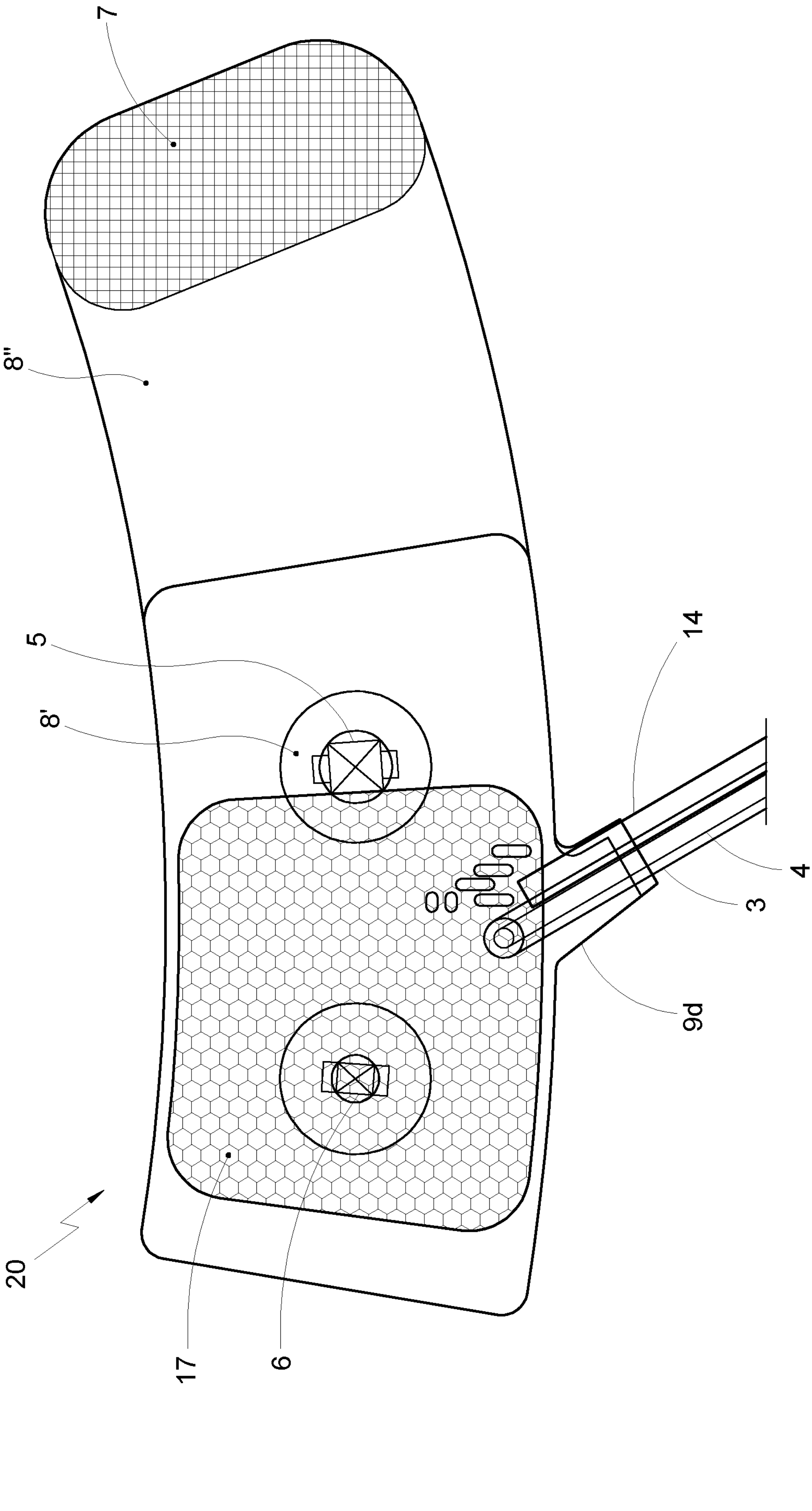

Fig. 2

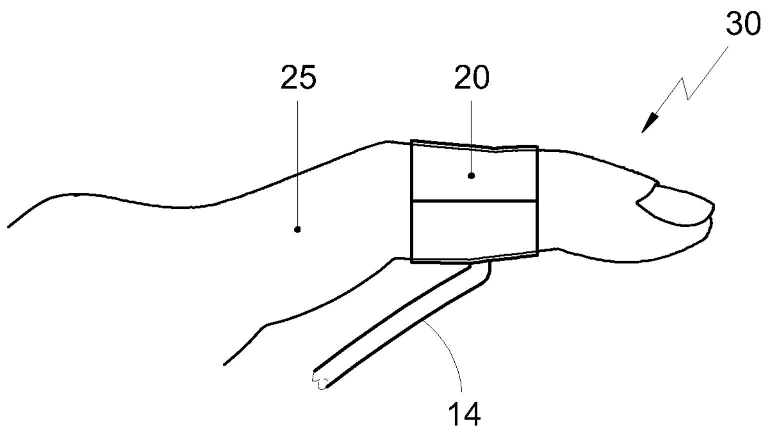

Fig. 3

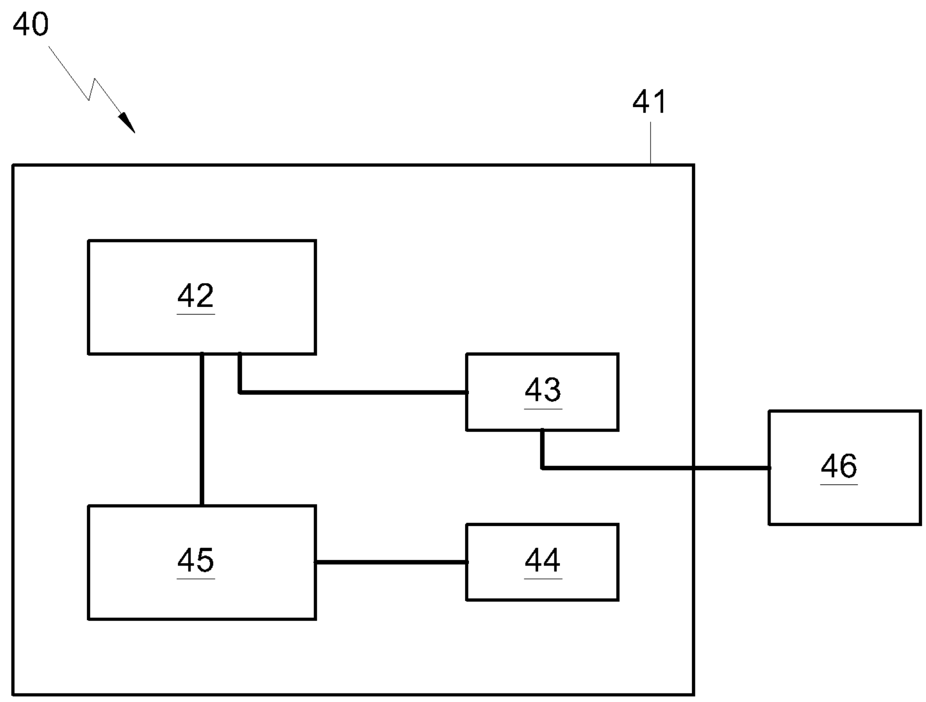

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2007/050361

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/00 A61B5/022
ADD. A61B5/029

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	US 4 726 382 A (BOEHMER ROBERT D [US] ET AL) 23 February 1988 (1988-02-23) cited in the application columns 1-3; figure 1	1-14, 17-20
A		15
X	WO 96/39926 A (MASIMO CORP [US]) 19 December 1996 (1996-12-19) pages 8,30; figures 10-12	1,4-7,9, 14,16,17
A		15

☐ Further documents are listed in the continuation of Box C.

☒ 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
10 March 2008	09/06/2008

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	Aronsson, Fredrik

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NL2007/050361

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 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. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

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 No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search reportcovers 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.:

see annex

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-20

An emitter with a built-in opaque shield

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2. claims: 21-25

A data processing unit

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/NL2007/050361

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 4726382	A	23-02-1988	CA	1293624	C	31-12-1991
			EP	0260807	A1	23-03-1988
			JP	63077433	A	07-04-1988
WO 9639926	A	19-12-1996	AT	265176	T	15-05-2004
			AU	712825	B2	18-11-1999
			AU	5973096	A	30-12-1996
			CA	2221864	A1	19-12-1996
			CN	1192665	A	09-09-1998
			DE	69632320	D1	03-06-2004
			DE	69632320	T2	17-02-2005
			EP	0831738	A1	01-04-1998
			HK	1009734	A1	07-01-2005
			JP	11506652	T	15-06-1999
			JP	3705817	B2	12-10-2005
			US	5638816	A	17-06-1997
			US	5860919	A	19-01-1999

patsnap

专利名称(译)	用于确定生理参数的袖带		
公开(公告)号	EP2182839A1	公开(公告)日	2010-05-12
申请号	EP2007793862	申请日	2007-07-20
[标]申请(专利权)人(译)	BMEYE		
申请(专利权)人(译)	BMEYE B.V.		
当前申请(专利权)人(译)	BMEYE B.V.		
[标]发明人	SCHRAA OLAF SCHRAA BOB SETTELS JOS J G M		
发明人	SCHRAA, OLAF SCHRAA, BOB SETTELS, JOS, J., G., M.		
IPC分类号	A61B5/00 A61B5/022 A61B5/029		
CPC分类号	A61B5/02241 A61B5/02422 A61B5/029 A61B5/1455 A61B5/6826 A61B5/6838		
其他公开文献	EP2182839B1		
外部链接	Espacenet		

摘要(译)

本发明涉及一种用于确定生理参数的袖带（20），所述袖带包括光电容积描记器，所述光电容积描记器设置有用于在待研究组织的方向上发射辐射的发射器（6），用于检测辐射的检测器（5）从组织和用于将压力传递到组织的可充气气囊（8），所述可充气气囊包括背层（8“）和顶层（8'），其中顶层被认为是带来的与组织接触时，顶层比背层显着更柔韧。本发明还涉及一种测量系统。