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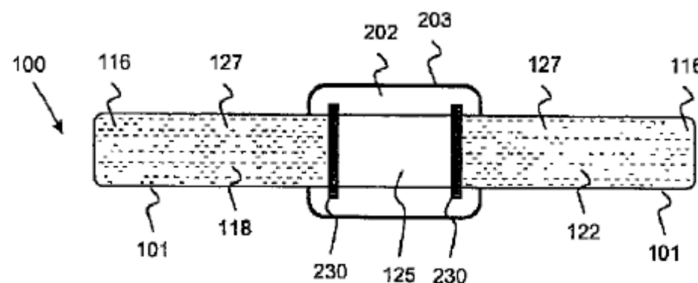
Electrode structure and pulse measurement arrangement

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US 4989607 A1, US 5314389 A, US 5511553 A, US 5702753 A, WO 93/00857 A1

(57) Abstract

15 The invention relates to an electrode structure and a pulse measurement arrangement
for measuring an ECG signal from skin of a person's chest. The electrode structure
(100) comprises a ribbon-like structural part (101) placed against the skin (102) of
the person's chest, the material of the ribbon-like structural part being flexible and
soft and molding itself to the shape of the skin surface. Electrodes (118, 122) are
20 provided at ends of the electrode structure (100). An inner surface (116) of the
electrode structure is a gripping surface for fastening the electrode structure (100)
to the skin (102) of the person's chest. The electrode structure (100) also comprises
ECG processing means (200) connected to the electrodes (118, 122); by means of
the ECG processing means, a potential difference caused by the ECG signal is
25 measured between the electrodes, and pulse information is formed on the basis of
the measured potential difference. The electrode structure (100) further comprises a
transmitter for transmitting pulse information to a wrist receiver (110), which
comprises a display (112) for displaying pulse information.



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Electrode structure and pulse measurement arrangement

Field of the invention

The field of application of the invention is a
5 device for measuring heart pulse information non-
invasively, in particular a pulse counter for use in the
context of exercise and sport.

Background of the invention

10 The measurement of heartbeat frequency is an
interesting field of application in the context of
exercise performance. Based on the beat frequency, i.e.
the pulse, information is obtained about, for example, a
person's exertion level, recovery, and condition
15 development, in which case the ratio of exercises to rest
can be better monitored and planned.

The measurement of pulse from a person's skin is
performed on the basis of an electrocardiographic (ECG)
signal caused by the heartbeat. Further information about
20 ECG can be obtained from the following source, which is
incorporated herein by reference: Guyton, Arthur C.:
Human Physiology and Mechanisms of Disease. Third
Edition. W. B. Saunders Company 1982. ISBN 4-7557-0072-
8. Chapter 13: The Electrocardiogram. The
25 electrocardiographic signal is an electromagnetic signal
caused by the heartbeat; this electromagnetic signal is
detected on the body of the person undergoing
measurement. The signal is measured with the aid of
electrodes, which are in contact with the body at at
30 least two points. In practice, the electrode which is
closest to the heart on the polarization vector often
acts as the actual measurement electrode, with the other
electrode providing the ground potential, to which the
voltage measured by the measurement electrode is compared
35 as a function of time.

As is known, the electrodes of a pulse counter,
which are placed on the chest, have been fitted to a
belt-like structure, i.e. to a so-called electrode belt.
In this case, the electrode belt is a ring-shaped

fastening device which is tightened around a person's chest, and surrounds the entire chest. Such a structure is shown in Fig. 1. As is known, the structure of electrode belts is such that there is an electronic unit in a middle part of the belt, with an electrode on each of two sides of the electronic unit. The electrodes measure an electrical pulse transmitted by the heart, and transmit their measurement result to the electronic unit via a connection joining the electrode to the electronic unit. The components contained in the electrode belt, such as the electronic unit and the electrodes, are generally covered with plastic or rubber, in order to protect the components from dampness, for example. Depending on the structure of the electrode belt, the electronic unit often also comprises means for transmitting an electrical pulse as an analogue burst to a receiver and display unit on the wrist, for example. Alternatively, the electrode belt may contain within itself means for storing and displaying electrical pulses.

Usually, the structure of electrode belts is such that a rubber or plastic support structure covering components of the electrode belt is relatively stiff. Such electrode belts are generally poorly suited to continuous use for a long period of time, and easily cause abrasions to the skin. The belt-like structure of the electrode belt also restricts its optimal positioning essentially at the position of the heart in people who have a lot of muscular or other tissue structure in the region of the chest. Also, in use, the stiff electrode belt is troublesome for slim adults and children, because it does not bend sufficiently according to the body of a person with a narrow chest. In some solutions according to the prior art, the problem has been approached in the following way: a plastic support structure between the electronic unit and the electrode is made like an accordion, in which case, bending of the electrode belt is achieved directly from outside the electronic unit. However, such a solution only reduces the bending

stiffness of the electrode belt, because the electrode belt is still ring-shaped, and fastened around the chest.

The solution according to the prior art contains a serious drawback: the stiff electrode belt is difficult
5 to position on the chest optimally for achieving the best measurement result, especially in continuous use for a long period of time, in which case the electrode belt also easily causes abrasions to the skin.

10 **Summary of the invention**

The objective of the invention is to realize an improved electrode structure and pulse measurement arrangement for measuring an electrical pulse signal of the heart from a person's body, in such a way that the
15 abovementioned problems are resolved. This is achieved by means of the electrode structure presented below for measuring an ECG signal from skin of a person's chest, the electrode structure comprising a ribbon-like structural part, comprising an inner surface placed
20 against the skin of the person's chest and an outer surface opposite thereto, a first electrode being provided at a first end of the electrode structure and a second electrode being provided at a second end of the electrode structure, the electrode structure being
25 adapted to measure a potential difference caused by the ECG signal between the first electrode and the second electrode, the inner surface of the electrode structure being a gripping surface for fastening the electrode structure to the skin of the person's chest, the
30 electrode structure comprising an electronic unit connected to the electrodes, for forming pulse information on the basis of the ECG signal measured by means of the electrodes. The electronic unit is fitted to a case, wherein the case comprises one or more gripping
35 element for connecting the electronic unit to the ribbon-like structural part of the electrode structure, the gripping elements being situated on a surface of the case of the electronic unit that faces toward a surface of the person's skin, and the gripping elements forming an

electrical connection between the electronic unit and the electrodes.

The invention also relates to a pulse measurement arrangement for measuring an ECG signal from skin of a person's chest, the pulse measurement arrangement comprising an electrode structure placed on the person's chest, and a wrist receiver unit, the electrode structure comprising a ribbon-like structural part, comprising an inner surface placed against the skin of the person's chest and an outer surface opposite thereto, a first electrode being provided at a first end of the electrode structure and a second electrode being provided at a second end of the electrode structure, the electrode structure being adapted to measure a potential difference caused by the ECG signal between the first electrode and the second electrode, wherein the electrode structure further comprises ECG processing means connected to the electrodes to measure the potential difference caused by the ECG signal in the first and second electrodes and form pulse information on the basis of the measured potential difference, the electrode structure further comprises a transmitter for transmitting pulse information to the wrist receiver, the wrist receiver comprising a receiver for receiving pulse information transmitted from the electrode structure, the wrist receiver further comprising a display for displaying pulse information, the inner surface of the electrode structure is a gripping surface for fastening the electrode structure to the skin of the person's chest, and the ECG processing means connected to the electrodes of the electrode structure comprise an electronic unit for forming pulse information on the basis of the ECG signal measured by means of the electrodes. The electronic unit is fitted to a case, wherein the case comprises one or more gripping element for connecting the electronic unit to the ribbon-like structural part of the electrode structure, the gripping elements being situated on a surface of the case of the electronic unit that faces toward a surface of the person's skin, and the

gripping elements forming an electrical connection between the electronic unit and the electrodes.

The advantageous embodiments of the invention are the subject of the dependent claims.

5 The electrode structure used in the solution according to the invention is intended to be placed on the skin of the user's chest. In an embodiment, the ribbon-like structural part of the electrode structure is of a material that is flexible and soft and molds
10 itself to the shape of the surface of the skin, in which case, in use, it is agreeable and inconspicuous and does not cause abrasions, and is thus also well suited to use in ECG measurement for a long period of time. In an embodiment, the ribbon-like structural part of the
15 electrode structure is uniform, in which case both electrodes and a fastening device thereof are integrated in the ribbon-like structural part. The ribbon-like structural part of the electrode structure is single-use, with reasonable manufacturing costs. In terms of design,
20 it is a sticker in the style of a plaster, for example.

 The first electrode is at the first end of the electrode structure, and the second electrode is at the second end of the electrode structure. The first electrode and second electrode of the electrode structure
25 are electrically isolated from one another to enable the measurement of a potential difference between the electrodes. For optimal measurement of a pulse signal, the first and second electrodes must be situated sufficiently far from each other to detect the electrical
30 ECG signal caused by the heartbeat. In this case, the electrodes are advantageously positioned at the ends of the electrode structure. Of course, there may be a greater number of electrodes than the two mentioned.

 According to an advantageous embodiment, the inner
35 surface of the electrode structure is a gripping surface for fastening the electrode structure to the skin of the person's chest. An advantageous way of realizing the gripping surface and electrodes is an embodiment in which the electrodes at the ends of the ribbon-like structural

part of the electrode structure are formed of an electrically conductive gripping material. The gripping material thus fastens the electrode structure to the skin of the person's chest. In another embodiment, the first
5 electrode and second electrode of the electrode structure are formed of an electrically conductive film at the position of the electrodes at both ends of the electrode structure, and an electrically conductive gripping material is present on an inner surface of the film that
10 is placed against the surface of the person's skin. The gripping material is advantageously electrically conductive glue. Further, a third way of realizing the electrodes and gripping surface is an embodiment in which the first electrode and second electrode of the electrode
15 structure are formed of an electrically conductive film at the position of the electrodes at both ends of the electrode structure, wherein a width of the electrode at each end of the electrode structure is narrower than a width of the ribbon-like structural part. Gripping
20 material is present on the inner surface of the ribbon, around the electrode, at outer edges of the ribbon, and the electrode structure is fastened to the user's skin by means of the gripping material. In this case, the gripping material need not be electrically conductive.
25 Since the inner surface of the electrode structure is the part of the electrode structure that comes toward the surface of the person's skin, the electrodes are advantageously situated on the inner surface of the ribbon. The electrode structure may also be designed so
30 that the electrodes are situated partially or completely on both the inner and outer surfaces of the ribbon. Further, the electrode structure may be designed so that the electrodes are situated on the inner surface of the ribbon, but also with connection surfaces from them to
35 the outer surface of the ribbon.

The electrode structure comprises, as a part thereof, the electronic unit connected to the electrodes. The electronic unit is an electronic component connected to the ribbon-like part of the electrode structure by one

or more gripping element. The electrodes of the electrode structure are connected to the electronic unit. The electronic unit comprises ECG processing means, by means of which, the potential difference caused by the ECG signal is measured in the first and second electrodes, and an estimate of detected heartbeat moments is formed from pulse signals measured by the electrodes, and further, a heart pulse is calculated on the basis of the detected beat moments. In addition, the electronic unit comprises the transmitter for transmitting pulse information to the wrist receiver, which comprises the receiver for receiving pulse information transmitted from the electrode structure and the display for displaying pulse information.

The wrist receiver is situated, for example, in a watch-like device worn on the user's wrist, such as a pulse counter or wrist computer. In this case, the transfer of information between the electrode structure and the pulse counter is performed using known methods, such as, for example, by means of a connecting cable, optically or electromagnetically. Advantageously, the display for displaying pulse information is similarly situated in the wrist receiver in the embodiment in question.

The electronic unit is advantageously fitted to the case, which comprises one or more gripping element for connecting the electronic unit to the ribbon-like structural part of the electrode structure. The gripping elements are, most advantageously, situated on the surface of the case of the electronic unit that faces toward the surface of the person's skin. In terms of structure, the gripping elements are advantageously fastening adjustable attachment points, a hinged pressing clip or similar, within the case of a center unit. Within the gripping elements or the case of the center unit, there are electrically conductive connection elements, by means of which the ECG signal measured with the electrodes is conducted from the electrodes to the electronic unit.

Further advantages of the invention are the electrode structure's inconspicuousness, ease of use and good suitability for use for a rather long period of time in comparison with known solutions.

5

Brief description of the figures

The invention is explained in more detail below with reference to the accompanying drawings, in which

10 Fig. 1 shows a transmitter electrode belt according to the prior art, placed on a person's chest, and a receiver unit fitted to a wrist;

Fig. 2 shows a pulse measurement arrangement according to an embodiment, placed on a person's chest, according to the invention;

15 Fig. 3 shows an embodiment of the electrode structure according to the invention, viewed from the side of its outer surface;

Fig. 4 shows the electrode structure according to Fig. 3, viewed from the side of its inner surface;

20 Fig. 5 shows the electrode structure according to Fig. 3, viewed from its transverse direction;

Fig. 6 shows the ribbon-like part of the electrode structure according to Fig. 3;

25 Fig. 7 shows another embodiment of the electrode structure according to the invention, viewed from the side of its inner surface;

Fig. 8 shows the ribbon-like part of the electrode structure according to Fig. 7;

30 Fig. 9 shows the electrode structure according to Fig. 7, viewed from its transverse direction at the position of the electrode;

Fig. 10 shows an embodiment of the electrode structure according to the invention, viewed from its lateral direction;

35 Fig. 11 shows an embodiment of the center unit of the electrode structure according to the invention, viewed from its transverse direction, and

Fig. 12 shows a device arrangement for forming a pulse according to a form of application of the invention.

5 Detailed description of the invention

The invention is described below with the aid of some advantageous embodiments, with reference to accompanying Figures 2 - 12.

Fig. 2 shows a person, whose heart pulse is measured with the aid of an electrode structure 100 placed on the chest 102. The pulse is measured with the aid of two or more electrodes 118, 122 in the electrode structure 100; a measurable potential difference forms between these electrodes as the heart beats.

15 The electrode structure 100 shown comprises a ribbon-like structural part 101. It is advantageously a uniform ribbon 101, comprising an inner surface 116 placed against skin 102 of the person's chest, and an outer surface 120 opposite thereto. A first electrode 118 is provided at a first end of the electrode structure 20 100, and a second electrode 122 is provided at a second end of the electrode structure 100. The first electrode 118 and second electrode 122 of the electrode structure 100 are electrically isolated from one another by means of an isolating zone 125 between the electrodes in the 25 ribbon 101, to enable measurement of the potential difference between the electrodes. A measurable potential difference, i.e. an ECG signal, which is measured by means of the electrode structure 100, thus arises between 30 the first electrode 118 and the second electrode 122.

The inner surface 116 of the electrode structure is a gripping surface, with the aid of which the electrode structure 100 is fastened to the skin 102 of the person's chest. The material of the ribbon 101 of the electrode 35 structure 100 is flexible and soft, and molds itself to the shape of the skin surface. The material of the ribbon 101 may for example be plastic, textile fiber, a combination thereof, or some similar material. The ribbon 101 is advantageously single-use.

According to an embodiment, as shown in Figs. 7 - 9, the electrodes 118, 122 of the electrode structure 100 are formed on the inner surface 116 of the ribbon 101, at both ends of the ribbon 101, from electrically
5 conductive gripping material 127. The gripping material 127 is advantageously electrically conductive glue, such as electrically conductive Solgel or conductive silicone glue.

According to another embodiment, as shown in Figs.
10 3 - 6, the electrodes 118, 122 of the electrode structure 100 are formed of an electrically conductive film 119 at the position of the electrodes 118, 122 at both ends of the electrode structure 100; for example, the film is metal, electrically conductive plastic, or a comparable
15 electrically conductive material. In this case, the width of the electrode 118, 122 at each end of the electrode structure 100 may be as wide as the ribbon-like structural part 101, or narrower than the width thereof. The film 119 may in this case directly touch the surface
20 102 of the person's skin, or there may be electrically conductive gripping material 127 on an inner surface 116 of the film 119 that is placed against the surface of the person's skin. The gripping material 127 is advantageously electrically conductive glue, such as
25 conductive Solgel or conductive silicone glue. If the width of the electrode 118, 122 is narrower than the width of the ribbon-like structural part 101, gripping material 127 may be used on an inner surface of the ribbon at outer edges of the ribbon 101, outside the electrodes
30 118, 122, and 127 need not be electrically conductive.

Since the inner surface 116 of the electrode structure 100 is the part of the electrode structure 100 that comes toward the surface of the person's skin, the electrodes 118, 122 are advantageously situated on the
35 inner surface 116 of the ribbon 101. The electrode structure 100 may also be designed so that the electrodes 118 and 122 are situated partially or completely on both the inner surface 116 and the outer surface 120 of the ribbon. Further, the electrode structure 100 may be

designed so that the electrodes 118, 122 are situated on the inner surface 116 of the ribbon, but also with connection surfaces from them to an upper surface 120 of the ribbon 101.

5 As shown in Figs. 2, 3, 4, 7, 10 and 11, the electrode structure 100 also comprises a center unit 202 connected to the electrodes 118, 122. The center unit 202 is a separate electronic part, which is connected to the ribbon-like part 101 of the electrode structure 100 with
10 one or more gripping element 230. The electronic unit 202 is fitted to a case 203, which comprises one or more gripping element 230 for connecting the electronic unit 202 to the ribbon-like structural part 101 of the electrode structure 100. In this case, the gripping
15 elements 230 are advantageously situated on a surface of the case 203 of the electronic unit 202 that faces toward the surface of the person's skin.

 The electrodes of the electrode structure 100 are in electrically conductive connection with the center
20 unit 202. The connection is advantageously realized in such a way that the gripping elements 230 form an electrical connection between the electronic unit (202) and the electrodes 118, 122. In terms of structure, the gripping elements 230 are fastening adjustable attachment
25 points, a hinged pressing clip or similar, within the case of the center unit. There are electrically conductive connecting elements in the gripping elements 230 or on a lower surface of the center unit 202; an ECG signal measured with the electrodes 118, 122 is conducted
30 from the electrodes 118, 122 to the center unit 202 by means of the electrically conductive connecting elements.

 The center unit 202 contains ECG processing means, by means of which a potential difference caused by an ECG signal is measured between the first and second
35 electrodes, and pulse information is formed from pulse signals measured by the electrodes, the pulse information including pulse, identification and calculation of pulse intervals, or pulse rate, i.e. pulse. In addition, the center unit 202 comprises a transmitter 208 for

transmitting the pulse information to a wrist receiver 110, which comprises a receiver for receiving the pulse information transmitted from the center unit 202 and a display 112 for displaying the pulse information to the user.

The wrist receiver 110 is situated in a watch-like device worn on the user's wrist, such as a pulse counter or wrist computer. In this case, the transfer 108 of information between the electrode structure 100 and the pulse counter is performed using known methods, such as, for example, by means of a connecting cable, optically or electromagnetically. Advantageously, the display 112 for displaying pulse information is similarly situated in the wrist receiver 110 in the embodiment in question.

Advantageously, the measured ECG signal is processed, i.e. filtered, amplified and identified using known methods in the electrode structure 100 in such a way that heart beats can be identified from the ECG signal, for transmission to the receiver unit 110. In the identification of heart beat, the electrode structure 100 measures the potential difference or voltage between the electrodes. Pulse identification is based, for example, on the QRS complex identified from the heart signal, in which the letters Q, R and S refer to potential phases in the electrical signal which are caused by electrical activation of the heart. In an embodiment, the identification of QRS may be performed with the aid of a matched filter, in which case a model complex is compared with the measured QRS complex in the electrode structure, and when the comparison exceeds a given threshold, the measured complex is accepted as the heart beat.

The pulse information measured by the electrode structure 100 is transmitted telemetrically 108 to the watch-like receiver unit 110 worn on the wrist, such as the pulse counter, wrist computer or similar. In this case, the electrode structure 100 comprises a transmitter for transmitting the pulse information to the receiver unit 110, which in turn comprises a receiver for receiving information. For example, in the case of

telemetric inductive transmission, the transmitter and receiver comprise a coil, in which case transmission is performed as one or more magnetic pulse for each beat of the heart. Instead of transmission 108 by magnetic pulses, pulse signal information measured by the electrodes of the electrode structure 100 may be transmitted to the receiver unit 110, for example, optically, by RF transmission, by means of a connecting cable, or in another similar known way.

10 In an embodiment, the receiver unit 110 comprises input means 114 for giving commands to hardware. The commands may be, for example, commands to start/stop pulse measurement, setting of pulse limits, light source activation or other similar functions in pulse counters.

15 Clearly, the necessary commands may be transmitted to the electrode structure correspondingly using the connection 108, as described above in the case of pulse information transmission from the electrode structure 100 to the receiver unit 110. In an embodiment, the receiver unit

20 100 comprises a display 112 for displaying the pulse information formed. Here, pulse information means information that is formed from heart beat frequency or that relates to sports performance via pulse, such as, for example, pulse/minute, pulse variance, set pulse

25 limits, or duration of sports performance in a given pulse region.

The strength of the ECG signal on the person's skin varies mostly by means of a vector, whose maximum value is attained at the starting point of the vector at the position of the right shoulder, and whose minimum point is attained at the end point of the vector in the left heel. In general, the maximal ECG signal is measured from a person by placing the electrodes at the endpoints of the abovementioned vector.

35 Fig. 12 shows the structure of a device solution according to an advantageous embodiment of the invention, in which all functions and structures required for pulse measurement, processing and display are in the electrode structure 100 on the skin 102 of the chest. By means of

the electrode structure 100 and in particular the electrodes 118, 122 comprised therein, an ECG signal is measured from the user's skin, and signals are transmitted to an ECG processing unit 200. In the ECG processing unit 200, necessary signal processing operations are performed on the ECG signal, such as filtering and amplification. Pulse detection from the ECG signal is also performed in the processing unit 200 by identifying, for example, the R spike of the QRS complex as strongest in the signal, or identifying the timing point of the QRS complex with the aid of a matched filter. Formed pulse indications are transmitted to a center unit 202 which coordinates the operation of the electrode structure 100, and the pulse rate is calculated from these pulse indications. Other calculated quantities, i.e. pulse information, can be formed in a calculation unit 206 connected to the center unit 202, on the basis of the heart beat frequency, i.e. pulse. Here, pulse information thus means, for example, pulse rate, pulse variance, rate of change of pulse, pulse limit or a similar quantity. The electrode structure 100 functioning as a pulse counter also comprises input means 114 for giving input data, such as, for example, for indicating start and stop times for pulse measurement. The input means 114 may be realized, for example, as push buttons, a touch surface on a display, voice control, or in another similar way. The electrode structure 100 also comprises a memory 204, consisting of short-term RAM memory for storing pulse information and similar, and ROM memory intended for the storage of required programs.

Means required in parts of the device, such as, for example, the center unit 202, the calculation unit 206 and a control unit, are advantageously realized by means of a general-purpose microprocessor with a program, but various hardware implementations are also possible, for example, a circuit built from separate logic components, or one or more ASIC (Application Specific Integrated Circuit).

Although the invention has been described above with reference to examples in accordance with the accompanying drawings, it is clear that the invention is not limited to these, and can be varied in many ways within the limits
5 of the inventive concept presented in the attached claims.

Claims

1. An electrode structure for measuring an ECG signal from skin of a person's chest,

5 - the electrode structure (100) comprising a ribbon-like structural part (101), comprising

 - an inner surface (116) placed against the skin (102) of the person's chest, and an outer surface (120) opposite thereto,

10 - a first electrode (118) being provided at a first end of the electrode structure (100) and a second electrode (122) being provided at a second end of the electrode structure (100), the electrode structure (100) being adapted to measure a potential difference caused
15 by the ECG signal between the first electrode (118) and the second electrode (122),

 - the inner surface (116) of the electrode structure being a gripping surface for fastening the electrode structure (100) to the skin (102) of the person's chest,

20 the electrode structure (100) comprising an electronic unit (202) connected to the electrodes (118, 122), for forming pulse information on the basis of the ECG signal measured by means of the electrodes,

 characterized in that the electronic unit (202) is
25 fitted to a case (203), wherein the case (203) comprises one or more gripping element (230) for connecting the electronic unit (202) to the ribbon-like structural part (101) of the electrode structure (100),

30 the gripping elements (230) being situated on a surface of the case (203) of the electronic unit (202) that faces toward a surface of the person's skin,

 the gripping elements (230) forming an electrical connection between the electronic unit (202) and the electrodes (118, 122).

35

2. The electrode structure as claimed in claim 1, characterized in that the ribbon-like structural part (101) of the electrode structure (100) is a uniform

ribbon (101), of a material that is flexible and soft and molds itself to the shape of the surface of the skin.

3. The electrode structure as claimed in claim 1,
5 characterized in that the first electrode (118) and second electrode (122) of the electrode structure (100) are electrically isolated from one another.

4. The electrode structure as claimed in claim 1,
10 characterized in that the electrodes (118, 122) of the electrode structure (100) are formed of an electrically conductive gripping material (127).

5. The electrode structure as claimed in claim 1,
15 characterized in that the first electrode (118) and second electrode (122) of the electrode structure (100) are formed of an electrically conductive film (119) at the position of the electrodes (118, 122) at both ends of the electrode structure (100).

20 6. The electrode structure as claimed in claim 5, characterized in that a width of the electrode (118, 122) at each end of the electrode structure (100) is narrower than a width of the ribbon-like structural part.

25 7. The electrode structure as claimed in claim 5, characterized in that an electrically conductive gripping material (127) is present on the inner surface (116) placed against the surface of the person's skin at the
30 position of the electrode (118, 122).

8. The electrode structure as claimed in claim 4 or 7, characterized in that the gripping material (127) is electrically conductive glue.

35 9. The electrode structure as claimed in any of the preceding claims, characterized in that the ribbon-like structural part (101) of the electrode structure (100) is single-use.

10. A pulse measurement arrangement for measuring an ECG signal from skin of a person's chest,
- the pulse measurement arrangement comprising an electrode structure (100) placed on the person's chest (102), and a wrist receiver unit (110),
 - the electrode structure (100) comprising a ribbon-like structural part (101), comprising
 - an inner surface (116) placed against the skin (102) of the person's chest, and an outer surface (120) opposite thereto,
 - a first electrode (118) being provided at a first end of the electrode structure (100) and a second electrode (122) being provided at a second end of the electrode structure (100),
 - the electrode structure (100) being adapted to measure a potential difference caused by the ECG signal between the first electrode (118) and the second electrode (122), wherein
 - the electrode structure (100) further comprises ECG processing means (200) connected to the electrodes (118, 122) to measure the potential difference caused by the ECG signal in the first and second electrodes and form pulse information on the basis of the measured potential difference,
 - the electrode structure (100) further comprises a transmitter for transmitting pulse information to the wrist receiver (110), the wrist receiver (110) comprising a receiver for receiving pulse information transmitted from the electrode structure (100), the wrist receiver (100) further comprising a display (112) for displaying pulse information,
 - the inner surface (116) of the electrode structure is a gripping surface for fastening the electrode structure (100) to the skin (102) of the person's chest,
 - the ECG processing means (200) connected to the electrodes (118, 122) of the electrode structure (100) comprise an electronic unit (202) for forming pulse

information on the basis of the ECG signal measured by means of the electrodes,

characterized in that

- the electronic unit (202) is fitted to a case (203), wherein the case (203) comprises one or more gripping element (230) for connecting the electronic unit (202) to the ribbon-like structural part (101) of the electrode structure (100),
- the gripping elements (230) being situated on a surface of the case (203) of the electronic unit (202) that faces toward a surface of the person's skin,
- the gripping elements (230) forming an electrical connection between the electronic unit (202) and the electrodes (118, 122).

15

11. The pulse measurement arrangement as claimed in claim 10, characterized in that the ribbon-like structural part (101) of the electrode structure (100) is a uniform ribbon (101), of a material that is flexible and soft and molds itself to the shape of the surface of the skin.

20

12. The pulse measurement arrangement as claimed in claim 10, characterized in that the electrode structure (100) comprises an electrically isolating part (125) between the first electrode (118) and the second electrode (122), for electrically isolating the first electrode (118) and the second electrode (122) from each other.

25

13. The pulse measurement arrangement as claimed in claim 10, characterized in that the electrodes (118, 122) of the electrode structure (100) are of an electrically conductive gripping material (127).

30

14. The pulse measurement arrangement as claimed in claim 10, characterized in that the first electrode (118) and second electrode (122) of the electrode structure (100) are formed of an electrically conductive film (119) at the position of the electrodes (118, 122) at both ends of the electrode structure (100).

35

15. The pulse measurement arrangement as claimed in claim
14, characterized in that a width of the electrode (118,
122) at each end of the electrode structure (100) is
5 narrower than a width of the ribbon-like structural part.

16. The electrode structure as claimed in claim 14,
characterized in that an electrically conductive gripping
material (127) is present on the inner surface (116)
10 placed against the surface of the person's skin at the
position of the electrode (118, 122).

17. The pulse measurement arrangement as claimed in claim
13 or 16, characterized in that the gripping material
15 (127) is electrically conductive glue.

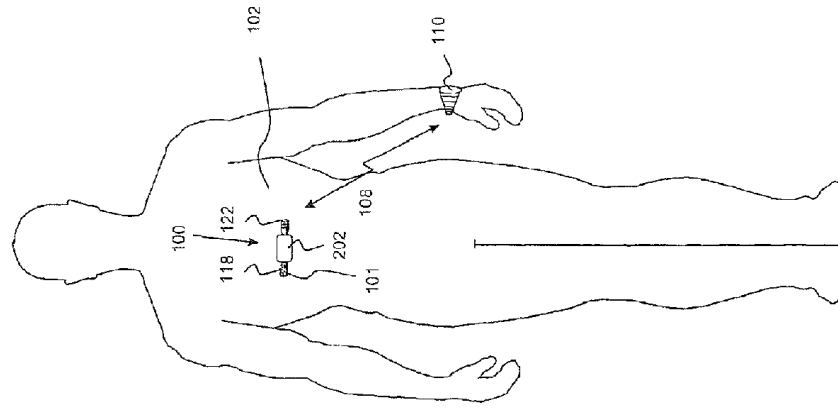


FIG.2

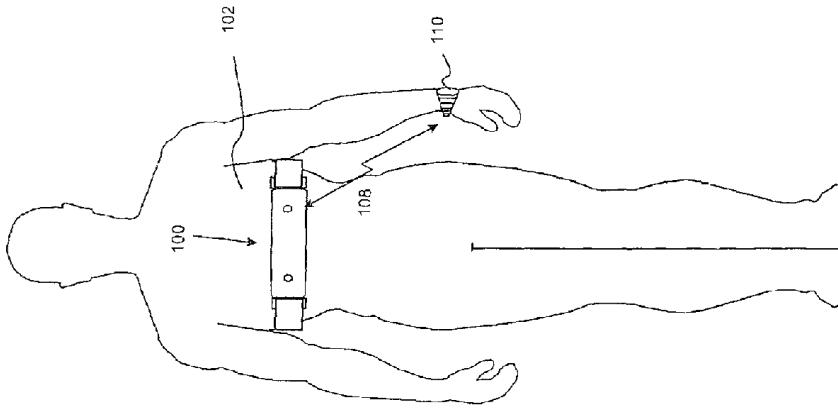


FIG.1

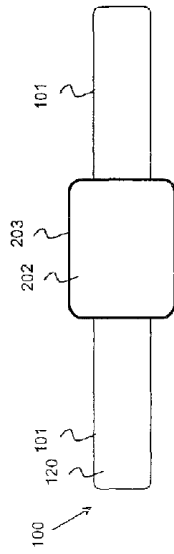


FIG. 3

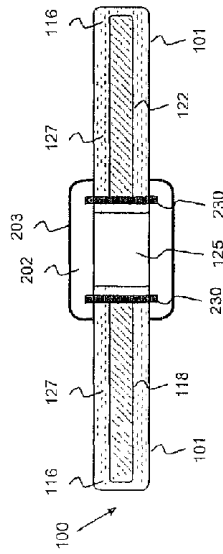


FIG. 4

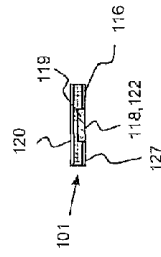


FIG. 5

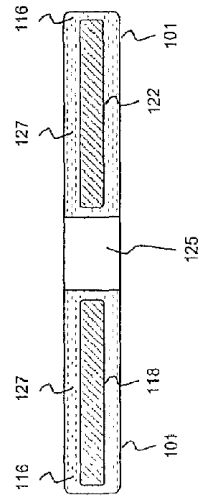


FIG. 6

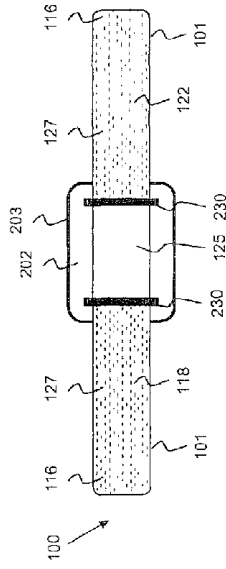


FIG. 7

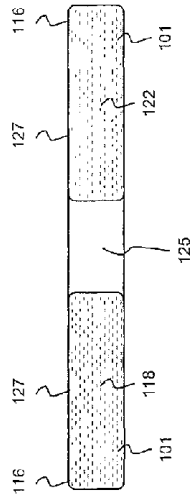


FIG. 8

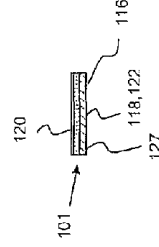


FIG. 9

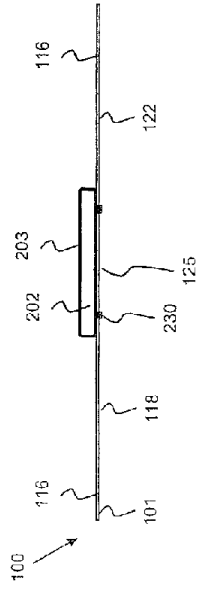


FIG. 10

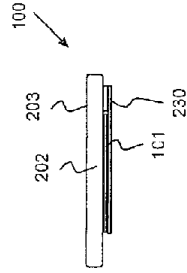


FIG. 11

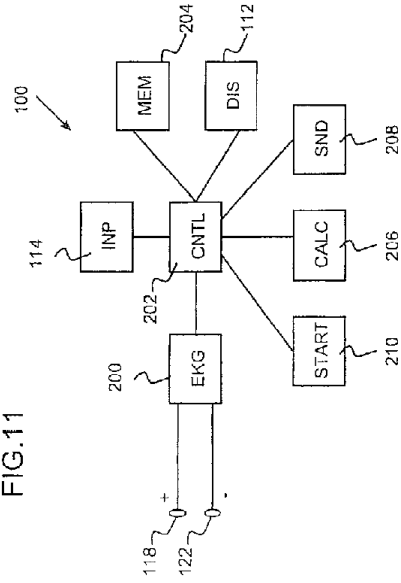


FIG. 12

UNITED STATES PATENT AND TRADEMARK OFFICE

I, Stephen Robert MURRAY BSc (Hons), Dip. Trans. IoL,
translator to RWS Translations Ltd, of Europa House, Chiltern Park, Chiltern Hill, Chalfont
St Peter, Buckinghamshire, United Kingdom, declare;

1. That I am a citizen of the United Kingdom of Great Britain and Northern Ireland.
2. That I am well acquainted with the Finnish and English languages.
3. That the attached is, to the best of my knowledge and belief, a true translation into the English language of the accompanying document "FI 119716 B".
4. That I believe that all statements made herein of my own knowledge are true and that all statements made on information and belief are true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the patent application in the United States of America or any patent issuing thereon.

Date: March 7, 2024



S. R. MURRAY

For and on behalf of RWS Translations Ltd