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(54) **BIOLOGICAL LIGHT MEASURING APPARATUS AND METHOD**

BIOLOGISCHES LICHTMESSGERÄT UND VERFAHREN

APPAREIL ET PROCÉDÉ DE MESURE DE LUMIÈRE BIOLOGIQUE

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(73) Proprietor: **HITACHI MEDICAL CORPORATION**
Tokyo 101-0047 (JP)

(72) Inventor: **ASAKA, Yuichi**
2702231 (JP)

(74) Representative: **Strehl, Peter**
Patentanwälte
Strehl Schübel-Hopf & Partner
Maximilianstrasse 54
80538 München (DE)

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to an optical measurement apparatus for living body, in particular, an optical measurement apparatus for living body having an improved function of evaluating whether the settings of respective optical fiber probes of a probe device, which is attached to an inspection area of a subject, are adequate and which permits to evaluate correctly whether the settings of the respective optical fibers on a body surface of the subject, and a method thereof.

BACKGROUND ART

[0002] An optical measurement apparatus for living body is an apparatus which permits to measure simply and easily living body information inside a living body, for example, such as blood circulation, hemodynamics and variation of hemoglobin concentration with low restriction to a subject and in a non-invasive manner to the living body through irradiating light having frequencies of from visible to near infrared regions to the living body and detecting the light penetrating through inside the living body.

[0003] WO 02/063282 A1 discloses a conventional measurement appartus with the features according to the preamble of claim 1.

When performing an optical measurement for living body of a subject representing a living body with the optical measurement apparatus for living body, at first an optical fiber probe device including irradiation use optical fiber probes and light receiving use optical fiber probes which are arranged alternatively at respective lattice points of, for example, 4x4 is attached on an inspection area of the subject, for example, on the head portion. In the case of the optical fiber probe device including irradiation use optical fiber probes and light receiving use optical fiber probes which are arranged alternatively at respective lattice points of 4x4, a total of 24 measurement channels each including a measurement point between respective adjacent irradiation use optical fiber probes and light receiving use optical fiber probes are formed inside the living body of the subject.

[0004] Figs. 2~5 are diagrams showing schematically four manners of settings of mutually adjacent irradiation use optical fiber and light receiving use optical fiber which are set on a body surface of a living body representing a subject and between which a measurement channel including a measurement point is formed.

[0005] Fig.2 is an example where the setting of the optical fibers is adequate and shows a state in which inspection light 203 irradiated from irradiation use optical fiber 201 passes through inside of living body 205 and light 204 emerged outside from the living body makes incident into light receiving use optical fiber 202. Under this optical fiber setting condition, a sufficient near infrared light, which is subjected to absorption and reflection by hemoglobin inside the living body can be detected.

[0006] Fig.3 is an example where the setting of the irradiation use optical fiber is inadequate and shows a state in which inspection light 303 irradiated from an irradiation use optical fiber 301 passes through an obstacle 306 such as hair, light 307 of which intensity is weakened passes through inside living body 305 and penetrating light 304 emerged outside from the living body makes incident into light receiving use optical fiber 302. Under this optical fiber setting condition, since signals of the irradiation light 303 are disturbed by the obstacle 306, sufficient near infrared light subjected to absorption and reflection by hemoglobin inside the living body 305 can not be detected. Further, even in a case when no obstacle 306 such as hair is caught between the irradiation use optical fiber 301 and the surface of the living body, if the irradiation use optical fiber 301 is remote from the surface of the living body and the attenuation of the irradiation light is extreme, since sufficient inspection light which has penetrated through the subject can not be detected, the setting of the optical fiber is evaluated as inadequate.

[0007] Fig.4 is an example where the setting of the light receiving use optical fiber is inadequate and shows a state in which irradiation light 403 irradiated from an irradiation use optical fiber 401 passes through inside living body 405 and penetrating light 404 emerged outside from the living body passes through an obstacle 406 such as hair, light 407 of which intensity is weakened makes incident into light receiving use optical fiber 402. Under this optical fiber setting condition, since signals of the penetrating light 404 are disturbed by the obstacle 406, sufficient near infrared light subjected to absorption and reflection by hemoglobin inside the living body 405 can not be detected. Further, even in a case when no obstacle 406 such as hair is caught between the light receiving use optical fiber 401 and the surface of the living body, if the light receiving use optical fiber 402 is remote from the surface of the living body and the attenuation of the irradiation light is extreme, since sufficient inspection light which has penetrated through the subject can not be detected, the setting of the optical fiber is evaluated as inadequate.

[0008] Fig.5 is an example where the setting of both irradiation use and light receiving use optical fibers is inadequate because both are inadequately remote from a living body representing a measurement object and shows a state in which since irradiation use optical fiber 501 is remote from a living body, irradiation light 503 of which intensity is weakened passes through inside living body 505 and penetrating light emerged outside from the living body of which intensity is weakened makes incident into light receiving use optical fiber 502. On the other hand, since the light receiving use optical fiber 502 is also remote from the surface of the living body, light from the irradiation use optical fiber 501 of which intensity is high in comparison with that of the light passed through inside the living body is directly makes incident to the light receiving use optical fiber 502. Under this condition, since the penetrating light 504 passed through inside the living body 505 mixes with the direct light 506 from outside the living body, the amount of received light is much, however, sufficient near infrared light which is subjected to absorption and reflection by hemoglobin inside the living body 505 representing measurement object can not be detected.

[0009] In a conventional optical measurement apparatus for living body as, for example, disclosed in JP-A-11-311599, an evaluation and judgment is performed whether the setting of respective pairs of adjacent optical fibers each constituting a measurement channel of a probe device which is attached on a body surface of an inspection area of a subject is adequate or not in such a manner that after setting the respective optical fibers, a short time preparatory measurement is performed prior to beginning an actual measurement, in which gains of irradiation light amount from respective irradiation use optical fibers and received light amount of respective paired light receiving use optical fibers are detected, more specifically, a gain adjustment is performed for the respective measurement channels and for a measurement channel of which gain adjustment has failed the setting of the optical fibers is evaluated and judged as inadequate and resetting work of the optical fibers is performed for the respective concerned channels.

[0010] However, with the method as disclosed in the conventional optical measurement apparatus for living body, the inadequate optical fiber setting state as shown in Fig.5 was evaluated and judged as adequate optical fiber setting because the amount of light received by the light receiving use optical fiber is sufficient, although the amount of light penetrated inside the living body containing hemoglobin signals is insufficient.

[0011] For this reason, even though the measurement data of such measurement channels is erroneous measurement data, the erroneous measurement data are treated as correct measurement data, operated and processed, of which result possibly causes an erroneous diagnosis or reduction of diagnosis efficiency.

[0012] An object of the present invention is to provide an optical measurement apparatus for living body having a function which performs a correct evaluation and judgment whether the setting of respective pairs of adjacent optical fibers each constituting a measurement channel of a probe device which is attached on a body surface in an inspection area of a subject is adequate or not and a method thereof.

[0013] Another object of the present invention is to provide an optical measurement apparatus for living body, which can prevent an erroneous diagnosis or reduction of diagnosis efficiency due to an inadequate setting of respective pairs of adjacent optical fibers each constituting a measurement channel of a probe device which is attached on a body surface in an inspection area of a subject and a method thereof.

SUMMARY OF THE INVENTION

[0014] An optical measurement apparatus for living body according to the present invention being provided with a light irradiation means including an irradiation use optical fiber which irradiates light subjected to different modulation from a light irradiation position to a living body, a light detection means including a light receiving use optical fiber which detects light penetrated inside the living body at a detection position and outputs an electrical signal corresponding to the amount of light detected at a measurement portion which is determined in relation to the light irradiation position, a signal processing means which calculates hemoglobin concentration at every measurement portion based on the electrical signal from the light detection means and display means which displays a calculation result of the signal processing means, is characterized in that the signal processing means includes an evaluation and judgment means which evaluates and judges an intensity of pulse wave contained in the hemoglobin signals and performs an evaluation and judgment of adequacy of the setting state of the irradiation use and/or light receiving use optical fiber on the body surface of the living body based on the evaluation and judgment.

[0015] Further, the evaluation and judgment means according to the present invention is characterized by performing the evaluation and judgment based on the peak magnitude of a center frequency in the statistic of the hemoglobin signal.

[0016] With the optical measurement apparatus for living body according to the present invention, an adequacy of the setting state of the irradiation use and/or light receiving use optical fiber on the body surface of the living body can be correctly evaluated and judged.

[0017] With the optical measurement apparatus for living body according to the present invention, since a possible mixture of erroneous measurement data from a measurement channel constituted by a pair of inadequately set irradiation use and light receiving use optical fibers of the probe device is eliminated, an erroneous diagnosis or reduction of diagnosis efficiency can be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig.1 is a block diagram showing a schematic constitution of an optical measurement apparatus for living body according to the present invention.

Fig. 2 is a view for explaining a manner of attenuation of inspection light from an irradiation use optical fiber to a light receiving use optical fiber at a measurement channel when the irradiation use optical fiber and the adjacent light receiving use optical fiber are adequately set on a body surface of a living body representing a subject.

Fig. 3 is a view for explaining a manner of attenuation of inspection light from an irradiation use optical fiber to a light receiving use optical fiber at a measurement channel when the irradiation use optical fiber and the adjacent light receiving use optical fiber are inadequately set on a body surface of a living body representing a subject, in that the irradiation use optical fiber is set remote from the body surface of the living body as well as hair is caught therebetween.

Fig. 4 is a view for explaining a manner of attenuation of inspection light from an irradiation use optical fiber to a light receiving use optical fiber at a measurement channel when the irradiation use optical fiber and the adjacent light receiving use optical fiber are inadequately set on a body surface of a living body representing a subject, in that the light receiving use optical fiber is set remote from the body surface of the living body as well as hair is caught therebetween.

Fig. 5 is a view for explaining a manner of attenuation of inspection light from an irradiation use optical fiber to a light receiving use optical fiber at a measurement channel when the irradiation use optical fiber and the adjacent light receiving use optical fiber are inadequately set on a body surface of a living body representing a subject, in that both irradiation use optical fiber and light receiving use optical fiber are set remote from the body surface of the living body.

Fig.6 is a flowchart for explaining a sequence in an embodiment for evaluating setting adequacy of respective pairs of irradiation use optical fibers and light receiving use optical fibers set on the body surface of a living body representing a subject, which is executed in a signal calculation and processing unit of an optical measurement apparatus for living body according to the present invention.

Fig.7 is a graph showing oxyhemoglobin variation signal calculated according to step 601 in Fig.6 at a certain channel for which the irradiation use optical fiber and/or the light receiving use optical fiber are adequately set.

Fig.8 is a graph showing oxyhemoglobin variation signal in a frequency band containing pulse wave due to heartbeat extracted by applying an HPF (high frequency band pass filter) to the oxyhemoglobin variation signal as shown in Fig.7 according to step 602 in Fig.6.

Fig.9 is a graph showing signal intensity P(f) determined for respective frequencies by performing frequency analysis on the oxyhemoglobin variation signal as shown in Fig. 8 according to step 603 in Fig.6.

Fig.10 is a graph showing oxyhemoglobin variation signal calculated according to step 601 in Fig.6 at another channel for which the irradiation use optical fiber and/or the light receiving use optical fiber are inadequately set.

Fig.11 is a graph showing oxyhemoglobin variation signal in a frequency band containing pulse wave due to heartbeats extracted by applying an HPF (high frequency band pass filter) to the oxyhemoglobin variation signal as shown in Fig.10 according to step 602 in Fig.6.

Fig.12 is a graph showing signal intensity P(f) determined for respective frequencies f by performing frequency analysis on the oxyhemoglobin variation signal as shown in Fig. 11 according to step 603 in Fig. 6.

Fig.13 is a flowchart for explaining a sequence in an embodiment of optical measurement for living body with an optical measurement apparatus for living body according to the present invention having a function of evaluating a setting adequacy of optical fibers for the respective measurement channels as shown in Fig.6 embodiment.

Fig.14 is a flowchart for explaining a sequence in another embodiment of optical measurement for living body with an optical measurement apparatus for living body according to the present invention having a function of evaluating a setting adequacy of optical fibers for the respective measurement channels as shown in Fig.6 embodiment.

Fig.15 is a flowchart for explaining a sequence in still another embodiment of optical measurement for living body with an optical measurement apparatus for living body according to the present invention having a function of evaluating a setting adequacy of optical fibers for the respective measurement channels as shown in Fig.6 embodiment.

BEST MODES FOR CARRYING OUT THE INVENTION

[0019] Herein below, embodiments of the present invention will be explained in detail. Fig.1 is a constitutional diagram of an optical measurement apparatus for living body according to the present embodiment. An optical measurement apparatus for living body 100 is constituted by an optical measurement unit for living body 101 and an optical signal for living body calculation and display unit 108, the optical measurement unit for living body 101 includes a laser generation unit102 which generates near infrared light having frequencies of about 600-1200nm which easily penetrates through a human body, a fiber unit 103 which guides and irradiates the laser beam generated from the laser generation unit 102, for example, toward a scalp portion, another fiber unit 103' which receives and detects the near infrared light subjected to absorption and reflection by hemoglobin at the brain surface, a probe 104 for attaching the fiber units 103 and 103' to the head portion, an avalanche diode 105 for converting the inputted near infrared light into electrical signals, a lock-in amplifier 106 for amplifying the electrical signals and a continuously variable amplifier 107, and the optical signal for living body calculation and display unit 108 is constituted by a memory 109 for recording the electrical signals from the continuously variable amplifier 107, a central processing unit CPU 110 for converting the electrical signals into hemoglobin signals, a hard disk

111 for recording the hemoglobin signals and a monitor 112 for displaying the hemoglobin signals.

[0020] In addition to a hemoglobin signal calculation unit 113, which is provided conventionally, the central processing unit CPU 110 includes a pulse wave calculation unit 114 which calculates pulse wave components due to heartbeats and a setting evaluation unit 115 which evaluates and judges setting adequacy of each pair of an irradiation use optical fiber and a light receiving use optical fiber set at both ends of respective measurement channels, both of which are for realizing the present invention.

[0021] Now, a sequence of evaluating adequacy of a setting state of an irradiation use optical fiber and/or a light receiving use optical fiber on a surface of a living body representing a subject as explained, for example, with reference to Fig.2-Fig.5, which is performed with the optical measurement apparatus for living body according to the present invention provided with the pulse wave calculation unit 114 and the setting evaluation unit 115, will be explained according to Fig.6 flowchart which is one embodiment of the present invention.

[0022] At first, at step 601, for example, oxy-Hb values due to hemoglobin oxidation of respective measurement channels for every measurement are determined from the measurement result of the optical measurement for living body. In the present embodiment, although the oxy-Hb values are used, deoxy-Hb values due to deoxidation or total-Hb values relating to total hemoglobin can be used.

[0023] Subsequently, at step 602, in order to extract pulse wave components due the heartbeats, a HPF (High frequency band Pass Filter) using a proper frequency value performed by a program provided in the pulse wave calculation unit 114 is applied to the measurement result. Although the HPF (High frequency band Pass Filter) is usually used for the purposes of extracting pulse wave components due the heartbeats and of removing a low frequency band containing target components of the optical measurement for living body, when a component different from the pulse wave component due to heartbeats is contained in the high frequency band, for example, when mixing of noises having a specific frequency is presumed, an LPF (Low Frequency band Pass Filter) or a BPF (Band Pass Filter) performed by a program provided in the pulse wave calculation unit 114 is used. When the subject is a newborn, the frequency component used for the HPF is, for example, 1Hz. This is because when a subject is a newborn, the pulse wave component due to heartbeats appears in a frequency band of 1.6~2.1Hz and in a frequency band below 1Hz living body information inside the living body (for example, such as functional signal representing hemoglobin concentration variation at a specific portion in the brain caused by moving a part of the human body) which is the primary target of the measurement appears. Therefor, in order to extract pulse wave components due the heartbeats it is proper to use a HPF of 1Hz. Further, when the subject is an adult, it is proper to use a HPF, for example, of 0.5Hz. However, a band threshold value (which frequency is to be used) for the band pass filter (such as HPF and LPF and a combination thereof) can be arbitrarily input by an operator via an input unit (not shown).

[0024] After extracting from the measurement result signal components in the frequency band which are presumed as containing the pulse wave components due the heartbeats at step 602, a frequency analysis is performed with a program provided in the pulse wave calculation unit 114 at step 603 and the signal intensity P (f) for the respective frequency components f is calculated. Then, at step 604 a frequency having the maximum signal intensity among the signal components in the frequency band which are presumed as containing the pulse wave components due the heartbeats is detected as a center frequency fo from the result of performing the frequency analysis.

[0025] Subsequently, at step 605 a fourth order statistic Kfo around the detected center frequency fo and as shown in the drawing is calculated and used as a parameter for judging the setting adequacy of optical fibers. The fourth order statistic Kfo represents the peak steepness of the signal intensity at the center frequency fo and when pulse wave signals due to heartbeats are contained many, the value becomes large and when pulse wave signals due to heartbeats are contained less, the value becomes small. Therefore, if the setting of the optical fibers is adequate, since the light used for the measurement passes inside the living body, in particular, through a blood vessel and makes incident to a light receiving use optical fiber, the measurement result always contains the pulse wave signals due to heartbeats. Contrary, if the setting of the optical fibers is inadequate, since the inspection light used for the measurement has not sufficiently passed through the blood vessel inside the living body, the measurement result hardly contains the pulse wave signals due to heartbeats, when the setting of the optical fibers is inadequate.

[0026] In the present invention, the signal components relating to the pulse wave due to heartbeats are extracted via the pulse wave calculation unit 114 from the hemoglobin signal information stored in the memory 109 and the hard disk 111 and through calculation and evaluation of the peak magnitude at the center frequency fo of the fourth order statistic Kfo with the setting evaluation unit 115, the judgment of setting adequacy of the optical fibers is enabled. Since the value of fourth order statistic Kfo under normal distribution is 3, when as the threshold value, for example, 3 is used, it is judged that when the fourth order statistic Kfo is more than 3, the setting of the optical fibers is adequate and when less than 3 the setting is inadequate. However, the threshold value can be arbitrarily input by an operator via an input unit (not shown).

[0027] Since the judgment of the present invention which uses the magnitude of the value of the fourth order statistic Kfo depends on the amount of inspection light used for the measurement passed through inside the living body, the case (Fig.2) in which the setting of the optical fibers is adequate and the case (Fig.5) in which the optical fibers are inadequately remote from the surface of the living body representing the measurement object can be discriminated. Further at the same time, the judgment of the present invention, which uses the magnitude of the value of the fourth order statistic Kfo can discriminate between the case (Fig. 2) in which the setting of the optical fibers is adequate, the case (Fig.3) in which setting of the irradiation use optical fiber is inadequate and the case (Fig.4) in which setting of the light receiving use optical fiber is inadequate.

[0028] Now, a specific example of hemoglobin signal processing according to Fig.6 embodiment will be explained. By making use of Figs.7-9 a case when a setting of an optical fiber is adequate will be explained. Fig.7 shows a measurement result of one channel for the optical measurement for living body, which is the result according to step 601 in Fig.6 flowchart. Fig.8 is a processed result in which the processing in Fig.6 step 602,in that the HPF (High frequency band Pass Filter) is applied to the measurement result of one channel for the optical measurement for living body as shown in Fig.7. Fig.9 is a processed result in which the processing in Fig. 6 step 603,in that the frequency analysis is performed to the measurement result of one channel for the optical measurement for living body as shown in Fig.8. According to the processed result as shown in Fig. 9, from signals in the frequency band representing the pulse wave components due to the heartbeats the frequency having the maximum power is detected as the center frequency fo. Since the present example is a measurement result of a newborn, a center frequency (901) of 1.9Hz is detected among the frequency band signals of 1.6~2.1Hz.

[0029] Since the fourth order statistic Kfo determined by making use of the center frequency fo is 7.43, when the threshold value 3 is used which is the value of fourth order statistic Kfo under normal distribution, the measurement result of the present example contains a substantial amount of pulse wave signals and the setting of the optical fibers is judged as adequate. Further, in an example when the subject is an adult, 0.8-1.2 Hz is used as a frequency band representing pulse wave due to heartbeats.

[0030] By making use of Figs .10-12 a case when a setting of an optical fiber is inadequate will be explained. Fig.10 shows a measurement result of another channel than that of Fig.7 for the optical measurement for living body in an example when the subject is a newborn and which is the result according to step 601 in Fig.6 flowchart. Fig.11 is a processed result in which the processing in Fig.6 step 602,in that the HPF (High frequency band Pass Filter) is applied to the measurement result of one channel for the optical measurement for living body as shown in Fig.10. Like the processing used in Fig.8, the frequency component used for the HPF is, for example, 1Hz in an example when the subject is a newborn. Fig. 12 is a processed result in which the processing in Fig. 6 step 603,in that the frequency analysis is performed to the measurement result of one channel for the optical measurement for living body as shown in Fig.11. According to the processed result as shown in Fig.12, from signals in the frequency band representing the pulse wave components due to the heartbeats the frequency having the maximum power is detected as the center frequency fo. Since the present example is a measurement result of a newborn, a center frequency (1201) of 1.8Hz is detected among the frequency band signals of 1. 6~2.1Hz.

[0031] Since the fourth order statistic Kfo determined by making use of the center frequency fo is 2.74, when the threshold value 3 is used which is the value of fourth order statistic Kfo under normal distribution, the measurement result of the present example contains no substantial amount of pulse wave signals and the setting of the optical fibers is judged as inadequate.

[0032] Figs.13-15 are flowcharts for explaining respective sequences of optical measurement for living body of embodiments of optical measurement apparatus for living body according to the present invention provided with a setting adequacy evaluation and judgment function of the irradiation use optical fibers and/or the light receiving use optical fibers of which function has been explained with reference to Fig.6 flowchart.

[0033] In Fig.13 embodiment, at first in step 1301, optical fibers are set on the body surface in the inspection area of the subject, subsequently, in step 1302 a short time preparatory measurement of about 10 seconds is performed. Then, in step 1303, by making use of the preparatory measurement at step 1302 the evaluation and judgment according to Fig.6 on the setting adequacy of the optical fibers is performed for respective measurement channels, and when there are measurement channels of which setting are judged inadequate, the process returns to step 1301, the optical fibers of the measurement channels of which setting are judged inadequate are reset, the steps 1302 and 1303 are repeated, and when no measurement channels of inadequate setting is reached, the process advances to step 1304 of an actual measurement.

[0034] In Fig.14 embodiment, at first in step 1401 like step 1301 in Fig.13, optical fibers are set on the body surface in the inspection area of the subject, and omitting the preparatory measurement in Fig .13, at step 1402 the actual measurement is directly performed. After completing the actual measurement, at step 1403, by making use of the actual measurement at step 1402 the evaluation and judgment according to Fig.6 on the setting adequacy of the optical fibers is performed for respective measurement channels, and the measurement data of measurement channels of which settings are judged adequate are accepted as hemoglobin signals to be used for obtaining living body information inside the living body which is the primary target of the optical measurement for living body at step 1404 and on the other hand, the measurement data of measurement channels of which settings are judged inadequate are rejected as hemoglobin signals to be used for obtaining living body information inside the living body which is the primary target of the optical measurement for living body at step 1405 by a rejecting means.

[0035] Fig.15 is a combination of concepts of the measurement sequences of Figs.13 and 14, at first in step 1501, optical fibers are set on the body surface in the inspection area of the subject, subsequently, in step 1502 a short time preparatory measurement of about 10 seconds is performed, then, in step 1503, by making use of the preparatory measurement at step 1502 the evaluation and judgment according to Fig.6 on the setting adequacy of the optical fibers is performed for respective measurement channels, and when there are measurement channels of which setting are judged inadequate, a simple resetting work such as moving the entire probe a little is performed, and the steps 1502 and 1503 are repeated, and the settings are reached mostly OK, the process advances to step 1504 of an actual measurement. This is for the purpose of avoiding useless long time restriction of the subject by repeating the optical fiber resetting, the preparatory measurement and the setting adequacy evaluation of the optical fibers. After the above process, the measurement data of measurement channels of which settings are judged adequate at the last preparatory measurement are accepted as hemoglobin signals to be used for obtaining living body information inside the living body which is the primary target of the optical measurement for living body at step 1505 and on the other hand, the measurement data of measurement channels of which settings are judged inadequate are rejected as hemoglobin signals to be used for obtaining living body information inside the living body which is the primary target of the optical measurement for living body at step 1506 by a rejecting means. According to Fig.15 method, even when a setting fault of an optical fiber is caused during the actual measurement, the measurement data from the optical fiber at which the fault is caused are prevented from being accepted as data for obtaining the living body information inside the living body of the subject.

[0036] Further, any of the sequences of the optical measurement for living body according to Figs. 13~15 can be used depending on the condition of the subject.

[0037] The present invention is not limited to the above embodiments and can be carried out in a variety of modifications in a range without departing the gist of the present invention. In particular, although the number of the fiber units 103 which guide and irradiate laser beams to the scalp portion and of the fiber units 103' which receive and detect the reflected near infrared light are not explained in the present embodiments, the number thereof is of course can be either single or plural.

Claims

1. An optical measurement apparatus for a living body (100), comprising:

    a measurement channel including an optical irradiation fiber (201) which is adapted to be set at an irradiation position on a body surface in an inspection area of a subject and to irradiate an inspection light having a predetermined frequency of from visible to near infrared range and a light receiving optical fiber (202) which is adapted to be set at a light receiving portion adjacent to the optical irradiation fiber (201) on the body surface in the inspection area and adapted to receive the inspection light irradiated from the optical irradiation fiber (201) and penetrated through inside the subject;

    a light detection unit (105) adapted to detect the amount of inspection light received by the light receiving optical fiber (202) in the form of an electrical signal; and

    a signal calculation and processing unit (108) including a hemoglobin signal calculating unit (113) adapted to calculate a hemoglobin signal representing a hemoglobin concentration inside the subject on basis of the electrical signal detected by the light detection unit (105) and an adequacy evaluation unit (115) adapted to evaluate adequacy of setting the optical irradiation fiber (201) and/or the light receiving optical fiber (202) on the body surface in the inspection area,

    characterised in that

    the signal calculation and processing unit (108) further includes a pulse wave calculation unit (114) adapted to calculate the intensity of a pulse wave component contained in the hemoglobin signal, the pulse wave component being due to the subject's heartbeats, and

    the adequacy evaluation unit (115) is adapted to evaluate the adequacy of setting the optical fibers (201, 202) on basis of the intensity of the pulse wave component.

2. The apparatus of claim 1, comprising plural measurement channels constituted by a plurality of said optical irradiation fibers (201) and said light receiving optical fibers (202).

3. The apparatus of claim 1 or 2, wherein the intensity of the pulse wave component calculated by the pulse wave calculation unit (114) is the intensity at the center frequency.

4. The apparatus of any preceding claim, wherein the intensity of the pulse wave component calculated by the pulse wave calculation unit (114) is fourth order statistics around the center frequency.

5. The apparatus of any preceding claim, wherein the pulse wave calculation unit (114) is provided with

means for applying a band pass filter to the hemoglobin signal and means for performing frequency analysis on the filtered signal, and the intensity of the pulse wave component is calculated on the basis of the data gained by the frequency analysis.

6. The apparatus of claim 5, wherein the band pass filter is a high frequency band pass filter, a low frequency band pass filter or a combination thereof.

7. The apparatus of claim 5 or 6, further comprising means for inputting a band threshold value for the band pass filter by an operator.

8. The apparatus of claim 7, wherein the adequacy evaluation unit (115) is adapted to evaluate the setting adequacy of the optical fibers (201, 202) on the body surface of the subject based on whether the intensity of the calculated pulse wave component is larger or smaller than the predetermined threshold value.

9. The apparatus of claim 8, further comprising means for inputting the predetermined threshold value for the intensity of the pulse wave component by an operator.

10. The optical measurement apparatus of any preceding claim, wherein
the signal calculation and processing unit (108) is adapted to calculate the intensity of the pulse wave component and the evaluation of the setting adequacy of the optical fibers during a preparatory measurement prior to an actual optical measurement for the living body and
a resetting is performed for an optical irradiation fiber (201) and/or a light receiving optical fiber (202) of a measurement channel the setting of which is evaluated inadequate by the adequacy evaluation unit (115).

11. The apparatus of any preceding claim, further comprising means adapted to reject, after the actual measurement, a hemoglobin signal of a measurement channel for which resetting of the optical irradiation fiber (201) and/or light receiving optical fiber (202) has been performed, and the setting is evaluated inadequate regardless of the performance of the resetting of the optical irradiation fiber (201) and/or light receiving optical fiber (202).

12. The optical measurement apparatus of any preceding claim, further comprising means for rejecting a hemoglobin signal of a measurement channel the setting of which is evaluated inadequate by the adequacy evaluation unit (115), wherein the evaluation of the setting adequacy is performed after completing the actual optical measurement.

13. A method of optical measurement for a living body, comprising the steps of:

(1) irradiating inspection light having a predetermined wavelength of from visible to near infrared range with an optical irradiation fiber (201) set at an irradiation position on a body surface in an inspection area of a subject,
(2) receiving the inspection light which is irradiated from the optical irradiation fiber (201) and penetrated through inside the subject with a light receiving optical fiber (202) at a light receiving position adjacent to the optical irradiation fiber (201) on the body surface in the inspection area,
(3) detecting the amount of the inspection light received by the light receiving optical fiber (202) in the form of an electrical signal,
(4) calculating a hemoglobin signal representing the hemoglobin concentration inside the subject through which the inspection light has penetrated based on the detected electrical signal,
(5) evaluating setting adequacy of the optical irradiation fiber (201) and/or the light receiving optical fiber (202) on the body surface in the inspection area, **characterised in that** step (5) includes
(6) calculating an intensity of a pulse wave component contained in the hemoglobin signal, the pulse wave component being due to the subject's heartbeats, and
(7) evaluating a setting adequacy of the optical irradiation fiber (201) and/or the light receiving optical fiber (202) on the body surface of the subject on basis of the intensity of the pulse wave component calculated in step (6).

14. The method of claim 13, wherein the setting adequacy evaluation of the optical fibers (201, 202) on the body surface is performed during a preparatory measurement prior to an actual optical measurement and a resetting is performed for an optical irradiation fiber (201) and/or a light receiving optical fiber (202) of a measurement channel the setting of which is evaluated inadequate by the adequacy evaluation step.

15. The method of claim 14, further comprising a step of rejecting, after the actual measurement, a hemoglobin signal of a measurement channel for which the resetting of the optical irradiation fiber (201) and/or light receiving optical fiber (202) on the body surface has been performed, and the setting is evaluated inadequate regardless of the performance of the resetting of the optical irradiation fiber (201) and/or light receiving optical fiber (202).

16. The method of claim 13, further comprising a step of rejecting a hemoglobin signal of a measurement channel the setting of which is evaluated inadequate by the adequacy evaluation step, and wherein the evaluation of the setting adequacy of the optical irradiation fibers (201) on the body surface is performed after completing the actual optical measurement.

Patentansprüche

1. Optisches Messgerät für einen lebenden Körper (100), umfassend:

   einen Messkanal, mit einer optischen Abstrahlfaser (201), die dazu ausgelegt ist, auf eine Abstrahlposition auf einer Körperoberfläche in einem Untersuchungsbereich eines Objekts gesetzt zu werden und Untersuchungslicht mit vorgegebener Frequenz im sichtbaren bis zum nahen infraroten Bereich abzustrahlen, und einer optischen Lichtaufnahmefaser (202), die dazu ausgelegt ist, auf einen Lichtaufnahmeabschnitt neben der optischen Abstrahlfaser (201) auf der Körperoberfläche in dem Untersuchungsbereich gesetzt zu werden und das von der optischen Abstrahlfaser (201) abgestrahlte und das Innere des Objekts durchdringende Untersuchungslicht zu empfangen;
   eine Lichterfassungseinheit (105), die dazu ausgelegt ist, die durch die optische Lichtaufnahmefaser (202) empfangene Menge an Untersuchungslicht in Form eines elektrischen Signals zu erfassen; und
   eine Signalberechnungs- und -verarbeitungseinheit (108), mit einer Hämoglobinsignal-Berechnungseinheit (113), die dazu ausgelegt ist, anhand des durch die Lichterfassungseinheit (105) erfassten elektrischen Signals ein eine Hämoglobinkonzentration im Inneren des Objekts darstellendes Hämoglobinsignal zu berechnen, und einer Eignungs-Bewertungseinheit (115), die dazu ausgelegt ist, eine Eignung eines Setzens der optischen Abstrahlfaser (201) und/oder der optischen Lichtaufnahmefaser (202) auf der Körperoberfläche in dem Untersuchungsbereich zu bewerten,
   dadurch gekennzeichnet, dass
   die Signalberechnungs- und Verarbeitungseinheit (108) ferner eine Pulswellenberechnungseinheit (114) enthält, die dazu ausgelegt ist, die Intensität einer in dem Hämoglobinsignal enthaltenen Pulswellenkomponente zu berechnen, wobei die Pulswellenkomponente auf die Herzschläge des Objekts zurückgeht, und
   die Eignungs-Bewertungseinheit (115) dazu ausgelegt ist, die Eignung des Setzens der optischen Fasern (201, 202) anhand der Intensität der Pulswellenkomponente zu bewerten.

2. Gerät nach Anspruch 1, umfassend mehrere Messkanäle, die aus mehreren der optischen Abstrahlfasern (201) und der optischen Lichtaufnahmefasern (202) bestehen.

3. Gerät nach Anspruch 1 oder 2, wobei die Intensität der durch die Pulswellenberechnungseinheit (114) berechneten Pulswellenkomponente die Intensität bei der Mittenfrequenz ist.

4. Gerät nach einem der vorhergehenden Ansprüche, wobei die Intensität der durch die Pulswellenberechnungseinheit (114) berechneten Pulswellenkomponente eine Statistik vierter Ordnung um die Mittenfrequenz ist.

5. Gerät nach einem der vorhergehenden Ansprüche, wobei die Pulswellenberechnungseinheit (114) mit einem Mittel zum Anwenden eines Bandpassfilters auf das Hämoglobinsignal und einem Mittel zum Durchführen einer Frequenzanalyse an dem gefilterten Signal versehen ist, und die Intensität der Pulswellenkomponente anhand der durch die Frequenzanalyse gewonnenen Daten berechnet wird.

6. Gerät nach Anspruch 5, wobei der Bandpassfilter ein Hochfrequenz-Bandpassfilter, ein Niederfrequenz-Bandpassfilter oder eine Kombination daraus ist.

7. Gerät nach Anspruch 5 oder 6, ferner umfassend ein Mittel zum Eingeben eines Bandschwellenwerts für den Bandpassfilter durch eine Bedienperson.

8. Gerät nach Anspruch 7, wobei die Eignungs-Bewertungseinheit (115) dazu ausgelegt ist, die Eignung des Setzens der optischen Fasern (201, 202) auf der Körperoberfläche des Objekts daran zu bewerten, ob die Intensität der berechneten Pulswellenkomponente größer oder kleiner als der vorgegebene Schwellenwert ist.

9. Gerät nach Anspruch 8, ferner umfassend ein Mittel zum Eingeben des vorgegebenen Schwellenwerts für die Intensität der Pulswellenkomponente durch eine Bedienperson.

10. Optisches Messgerät nach einem der vorhergehenden Ansprüche, wobei
    die Signalberechnungs- und -verarbeitungseinheit (108) dazu ausgelegt ist, die Intensität der Pulswellenkomponente und die Bewertung der Eignung des Setzens der optischen Fasern während einer Vorbereitungsmessung vor einer eigentlichen optischen Messung für den lebenden Körpers zu berechnen, und
    ein Neusetzen für eine optische Abstrahlfaser (201) und/oder eine optische Lichtaufnahmefaser (202) ei-

nes Messkanals durchgeführt wird, deren Setzen durch die Eignungs-Bewertungseinheit (115) als ungeeignet bewertet wird.

11. Gerät nach einem der vorhergehenden Ansprüche, ferner umfassend ein Mittel, das dazu ausgelegt ist, nach der eigentlichen Messung ein Hämoglobinsignal eines Messkanals zurückzuweisen, für den ein Neusetzen der optischen Abstrahlfaser (201) und/oder der optischen Lichtaufnahmefaser (202) durchgeführt worden ist und das Setzen ungeachtet der Durchführung des Neusetzens der optischen Abstrahlfaser (201) und/oder der optischen Lichtaufnahmefaser (202) als ungeeignet bewertet wird.

12. Optisches Messgerät nach einem der vorhergehenden Ansprüche, ferner umfassend ein Mittel zum Zurückweisen eines Hämoglobinsignals eines Messkanals, dessen Setzen durch die Eignungs-Bewertungseinheit (115) als ungeeignet bewertet wird, wobei die Bewertung der Eignung des Setzens nach Fertigstellung der eigentlichen optischen Messung durchgeführt wird.

13. Verfahren zur optischen Messung für einen lebenden Körper, umfassend die Schritte:

(1) Abstrahlen von Untersuchungslicht mit einer vorgegebenen Wellenlänge im sichtbaren bis zum nahen infraroten Bereich mit einer optischen Abstrahlfaser (201), die auf eine Abstrahlposition auf einer Körperoberfläche in einem Untersuchungsbereich eines Objekts gesetzt wird.
(2) Empfangen des Untersuchungslichts, das von der optischen Abstrahlfaser (201) abgestrahlt wird und das Innere des Objekts durchdringt, mit einer optischen Lichtaufnahmefaser (202) an einer Lichtaufnahmestelle neben der optischen Abstrahlfaser (201) auf der Körperoberfläche in dem Untersuchungsbereich,
(3) Erfassen der Menge des Untersuchungslichts, das durch die optische Lichtaufnahmefaser (202) empfangen wird, in Form eines elektrischen Signals,
(4) Berechnen eines Hämoglobinsignals, das die Hämoglobinkonzentration im Innern des Objekts, durch das das Untersuchungslicht gedrungen ist, darstellt, anhand des erfassten elektrischen Signals,
(5) Bewerten einer Eignung eines Setzens der optischen Abstrahlfaser (201) und/oder der optischen Lichtaufnahmefaser (202) auf der Körperoberfläche in dem Untersuchungsbereich,
dadurch gekennzeichnet, dass Schritt (5) enthält:
(6) Berechnen einer Intensität einer Pulswellenkomponente, die in dem Hämoglobinsignal enthalten ist, wobei die Pulswellenkomponente auf Herzschläge des Objekts zurückgeht, und
(7) Bewerten einer Eignung eines Setzens der optischen Abstrahlfaser (201) und/oder der optischen Lichtaufnahmefaser (202) auf der Körperoberfläche des Objekts anhand der Intensität der in Schritt (6) berechneten Pulswellenkomponente.

14. Verfahren nach Anspruch 13, wobei das Bewerten der Eignung des Setzens der optischen Fasern (201, 202) auf der Körperoberfläche während einer Vorbereitungsmessung vor einer eigentlichen optischen Messung durchgeführt wird und ein Neusetzen für eine optische Abstrahlfaser (201) und/oder eine optische Lichtaufnahmefaser (202) eines Messkanals durchgeführt wird, deren/dessen Setzen durch den Eignungs-Bewertungsschritt als ungeeignet bewertet wird.

15. Verfahren nach Anspruch 14, ferner umfassend einen Schritt zum Zurückweisen eines Hämoglobinsignals eines Messkanals, für den das Neusetzen der optischen Abstrahlfaser (201) und/oder der optischen Lichtaufnahmefaser (202) auf der Körperoberfläche durchgeführt worden ist und das Setzen ungeachtet der Druchführung des Neusetzens der optischen Abstrahlfaser (201) und/oder der optischen Lichtaufnahmefaser (202) als ungeeignet bewertet wird, nach der eigentlichen Messung.

16. Verfahren nach Anspruch 13, ferner umfassend einen Schritt zum Zurückweisen eines Hämoglobinsignals eines Messkanals, dessen Setzen durch den Eignungs-Bewertungsschritt als ungeeignet bewertet wird, und wobei die Bewertung der Eignung des Setzens der optischen Abstrahlfasern (201) auf der Körperoberfläche nach Fertigstellung der eigentlichen optischen Messung durchgeführt wird.

Revendications

1. Appareil de mesure optique pour un corps vivant (100), comprenant :

un canal de mesure comprenant une fibre de rayonnement optique (201) qui est adaptée pour être réglée en une position de rayonnement sur une surface de corps dans une région d'inspection d'un sujet et pour émettre une lumière d'inspection ayant une fréquence prédéterminée allant du domaine visible au proche infrarouge et une fibre optique de réception de lumière (202) qui est adaptée pour être réglée dans une position de réception de lumière adjacente à la fibre de rayonnement optique (201) sur la surface de corps dans la région d'inspection et adaptée

pour recevoir la lumière d'inspection émise par la fibre de rayonnement optique (201) et ayant pénétré à l'intérieur du sujet ;
une unité de détection de lumière (105) adaptée pour détecter la quantité de lumière d'inspection reçue par la fibre optique de réception de lumière (202) sous la forme d'un signal électrique ; et une unité de calcul et de traitement de signal (108) comprenant une unité de calcul de signal d'hémoglobine (113) adaptée pour calculer un signal d'hémoglobine représentant une concentration en hémoglobine à l'intérieur du sujet d'après le signal électrique détecté par l'unité de détection de lumière (105) et une unité d'évaluation d'adéquation (115) adaptée pour évaluer l'adéquation du réglage de la fibre de rayonnement optique (201) et/ou de la fibre optique de réception de lumière (202) sur la surface de corps dans la région d'inspection,
caractérisé en ce que
l'unité de calcul et de traitement de signal (108) comprend en outre une unité de calcul d'onde pulsée (114) adaptée pour calculer l'intensité d'une composante d'onde pulsée contenue dans le signal d'hémoglobine, la composante d'onde pulsée étant due aux battements du coeur du sujet, et
l'unité d'évaluation d'adéquation (115) est adaptée pour évaluer l'adéquation du réglage des fibres optiques (201, 202) d'après l'intensité de la composante d'onde pulsée.

2. Appareil selon la revendication 1, comprenant plusieurs canaux de mesure constitués par une pluralité desdites fibres de rayonnement optique (201) et desdites fibres optiques de réception de lumière (202).

3. Appareil selon la revendication 1 ou 2, dans lequel l'intensité de la composante d'onde pulsée calculée par l'unité de calcul d'onde pulsée (114) est l'intensité à la fréquence centrale.

4. Appareil selon l'une quelconque des revendications précédentes, dans lequel l'intensité de la composante d'onde pulsée calculée par l'unité de calcul d'onde pulsée (114) est une statistique de quatrième ordre autour de la fréquence centrale.

5. Appareil selon l'une quelconque des revendications précédentes, dans lequel l'unité de calcul d'onde pulsée (114) est pourvue d'un moyen permettant d'appliquer un filtre passe-bande au signal d'hémoglobine et d'un moyen permettant d'exécuter une analyse de fréquence sur le signal filtré, et l'intensité de la composante d'onde pulsée est calculée d'après les données obtenues par l'analyse de fréquence.

6. Appareil selon la revendication 5, dans lequel le filtre passe-bande est un filtre passe-bande à haute fréquence, un filtre passe-bande à basse fréquence ou une combinaison de ceux-ci.

7. Appareil selon la revendication 5 ou 6, comprenant en outre un moyen permettant la saisie par un opérateur d'une valeur de seuil pour le filtre passe-bande.

8. Appareil selon la revendication 7, dans lequel l'unité d'évaluation d'adéquation (115) est adaptée pour évaluer l'adéquation de réglage des fibres optiques (201, 202) sur la surface de corps du sujet selon que l'intensité de la composante d'onde pulsée calculée est supérieure ou inférieure à la valeur de seuil prédéterminée.

9. Appareil selon la revendication 8, comprenant en outre un moyen permettant à un opérateur de saisir la valeur de seuil prédéterminée pour l'intensité de la composante d'onde pulsée.

10. Appareil de mesure optique selon l'une quelconque des revendications précédentes, dans lequel :

l'unité de calcul et de traitement de signal (108) est adaptée pour calculer l'intensité de la composante d'onde pulsée et l'évaluation de l'adéquation de réglage des fibres optiques pendant une mesure préparatoire précédant une mesure optique réelle pour le corps vivant, et
un nouveau réglage est exécuté pour une fibre de rayonnement optique (201) et/ou une fibre optique de réception de lumière (202) d'un canal de mesure dont le réglage est évalué comme inadéquat par l'unité d'évaluation d'adéquation (115).

11. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre un moyen adapté pour rejeter, après la mesure réelle, un signal d'hémoglobine d'un canal de mesure pour lequel un nouveau réglage de la fibre de rayonnement optique (201) et/ou de la fibre optique de réception de lumière (202) a été exécuté, et le réglage est évalué comme inadéquat quel que soit le résultat de l'exécution du nouveau réglage de la fibre de rayonnement optique (201) et/ou de la fibre optique de réception de lumière (202).

12. Appareil de mesure optique selon l'une quelconque des revendications précédentes, comprenant en outre un moyen pour rejeter un signal d'hémoglobine d'un canal de mesure dont le réglage est évalué comme inadéquat par l'unité d'évaluation d'adéquation (115), dans lequel l'évaluation de l'adéquation du réglage est réalisée après l'achèvement de la mesure optique réelle.

13. Procédé de mesure optique pour un corps vivant, comprenant les étapes suivantes :

(1) émettre une lumière d'inspection ayant une longueur d'onde prédéterminée allant du domaine visible au proche infrarouge avec une fibre de rayonnement optique (201) réglée en une position de rayonnement sur une surface de corps dans une région d'inspection d'un sujet,
(2) recevoir la lumière d'inspection qui est émise par la fibre de rayonnement optique (201) et ayant pénétré à l'intérieur du sujet avec une fibre optique de réception de lumière (202) dans une position de réception de lumière adjacente à la fibre de rayonnement optique (201) sur la surface de corps dans la région d'inspection,
(3) détecter la quantité de lumière d'inspection reçue par la fibre optique de réception de lumière (202) sous la forme d'un signal électrique,
(4) calculer un signal d'hémoglobine représentant la concentration en hémoglobine à l'intérieur du sujet à travers lequel la lumière d'inspection a pénétré d'après le signal électrique détecté,
(5) évaluer l'adéquation de réglage de la fibre de rayonnement optique (201) et/ou de la fibre optique de réception de lumière (202) sur la surface de corps dans la région d'inspection,
caractérisé en ce que l'étape (5) comprend :
(6) le calcul d'une intensité d'une composante d'onde pulsée contenue dans le signal d'hémoglobine, la composante d'onde pulsée étant due aux battements du coeur du sujet, et
(7) l'évaluation d'une adéquation de réglage de la fibre de rayonnement optique (201) et/ou de la fibre optique de réception de lumière (202) sur la surface de corps du sujet d'après l'intensité de la composante d'onde pulsée calculée à l'étape (6).

14. Procédé selon la revendication 13, dans lequel l'évaluation de l'adéquation de réglage des fibres optiques (201, 202) sur la surface de corps est réalisée pendant une mesure préparatoire précédant une mesure optique réelle et un nouveau réglage est exécuté pour une fibre de rayonnement optique (201) et/ou une fibre optique de réception de lumière (202) d'un canal de mesure dont le réglage est évalué comme inadéquat par l'étape d'évaluation d'adéquation.

15. Procédé selon la revendication 14, comprenant en outre une étape consistant à rejeter, après la mesure réelle, un signal d'hémoglobine d'un canal de mesure pour lequel le nouveau réglage de la fibre de rayonnement optique (201) et/ou de la fibre optique de réception de lumière (202) sur la surface de corps a été exécuté, et le réglage est évalué comme inadéquat quel que soit le résultat de l'exécution du nouveau réglage de la fibre de rayonnement optique (201) et/ou de la fibre optique de réception de lumière (202).

16. Procédé selon la revendication 13, comprenant en outre une étape consistant à rejeter un signal d'hémoglobine d'un canal de mesure dont le réglage est évalué comme inadéquat par l'étape d'évaluation d'inadéquation, et dans lequel l'évaluation de l'adéquation de réglage des fibres de rayonnement optique (201) sur la surface de corps est exécutée après l'achèvement de la mesure optique réelle.

Fig. 1

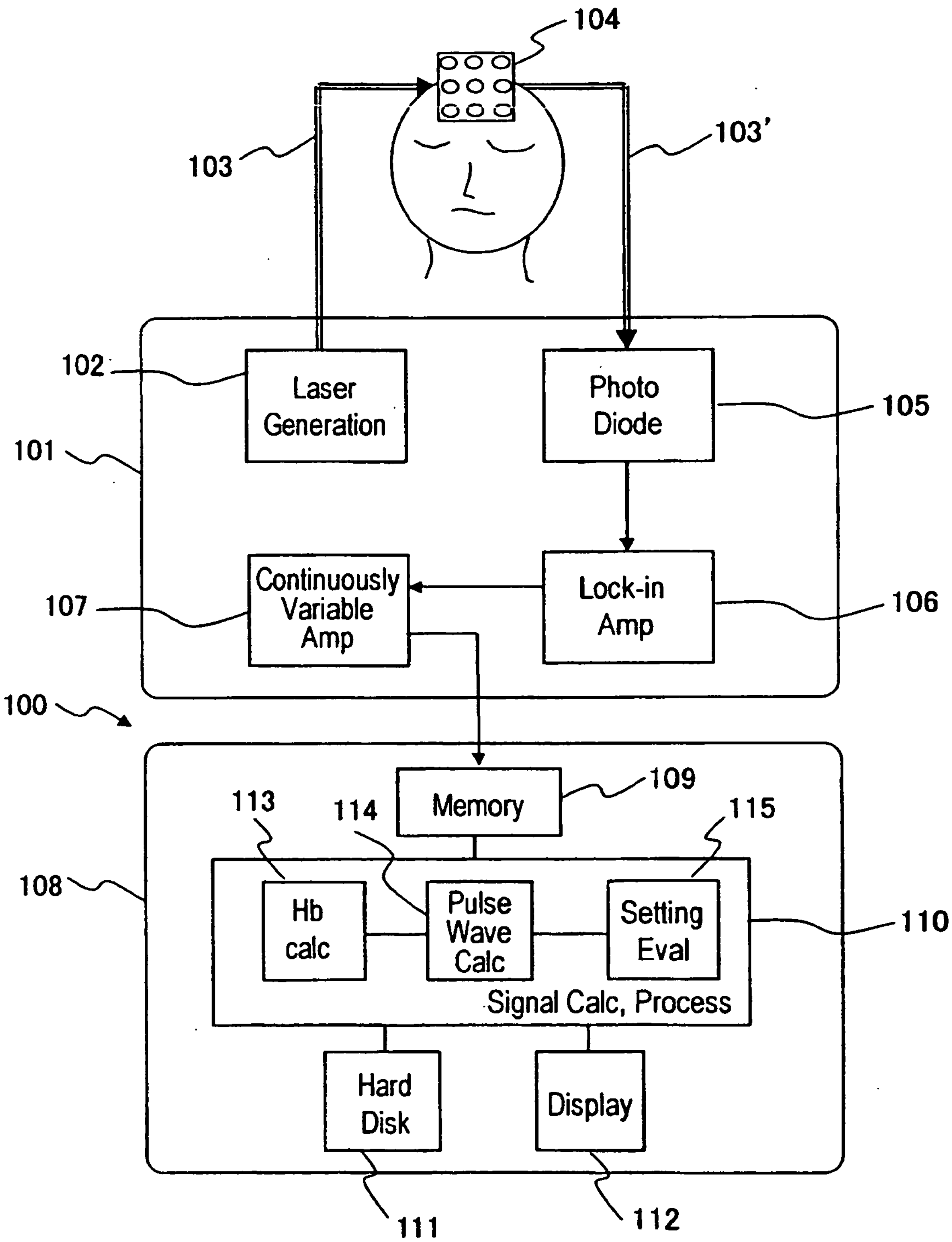

104
103
103'
102
Laser Generation
Photo Diode
105
101
107
Continuously Variable Amp
Lock-in Amp
106
100
Memory
109
113
114
115
108
Hb calc
Pulse Wave Calc
Setting Eval
110
Signal Calc, Process
Hard Disk
Display
111
112

Fig. 2

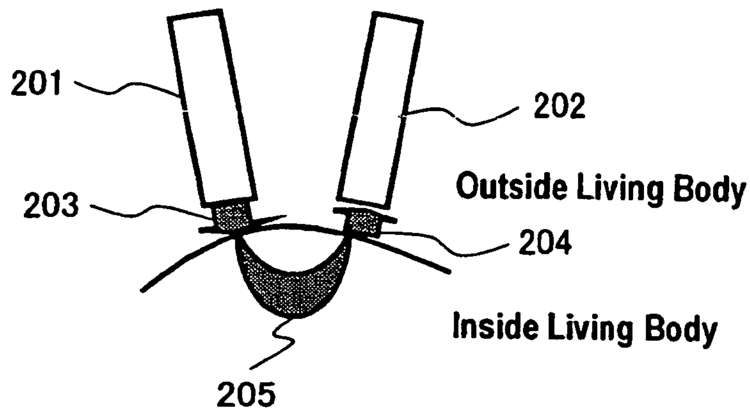

201
202
Outside Living Body
203
204
Inside Living Body
205

Fig. 3

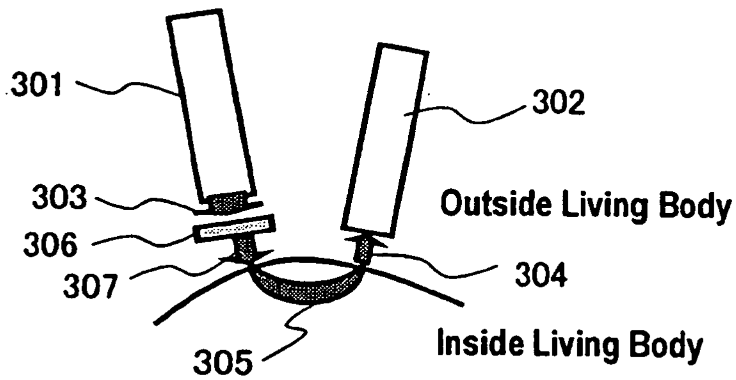

301
302
303
Outside Living Body
306
307
304
305
Inside Living Body

Fig. 4

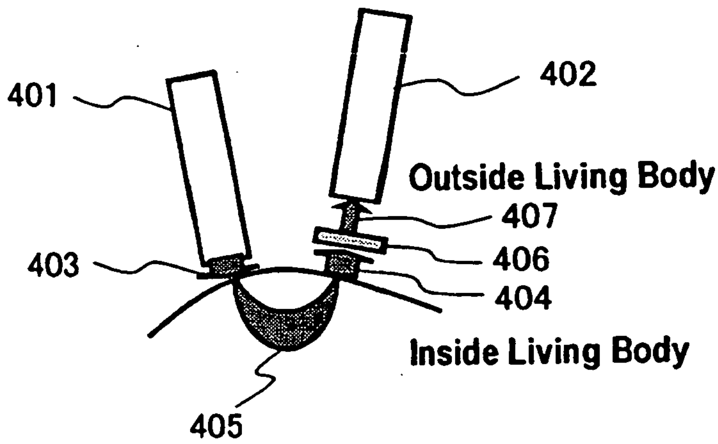

401
402
Outside Living Body
407
406
403
404
Inside Living Body
405

Fig. 5

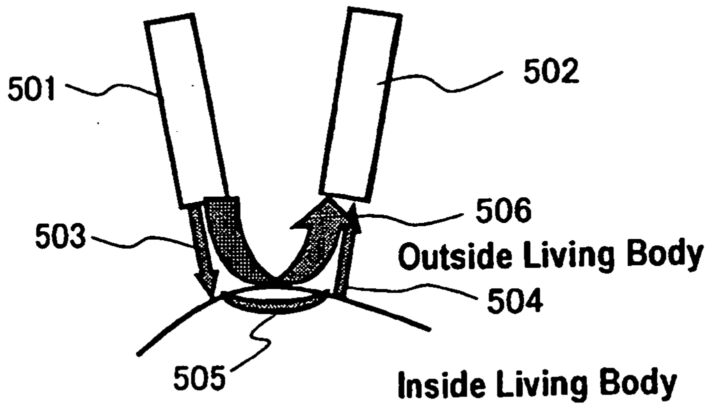
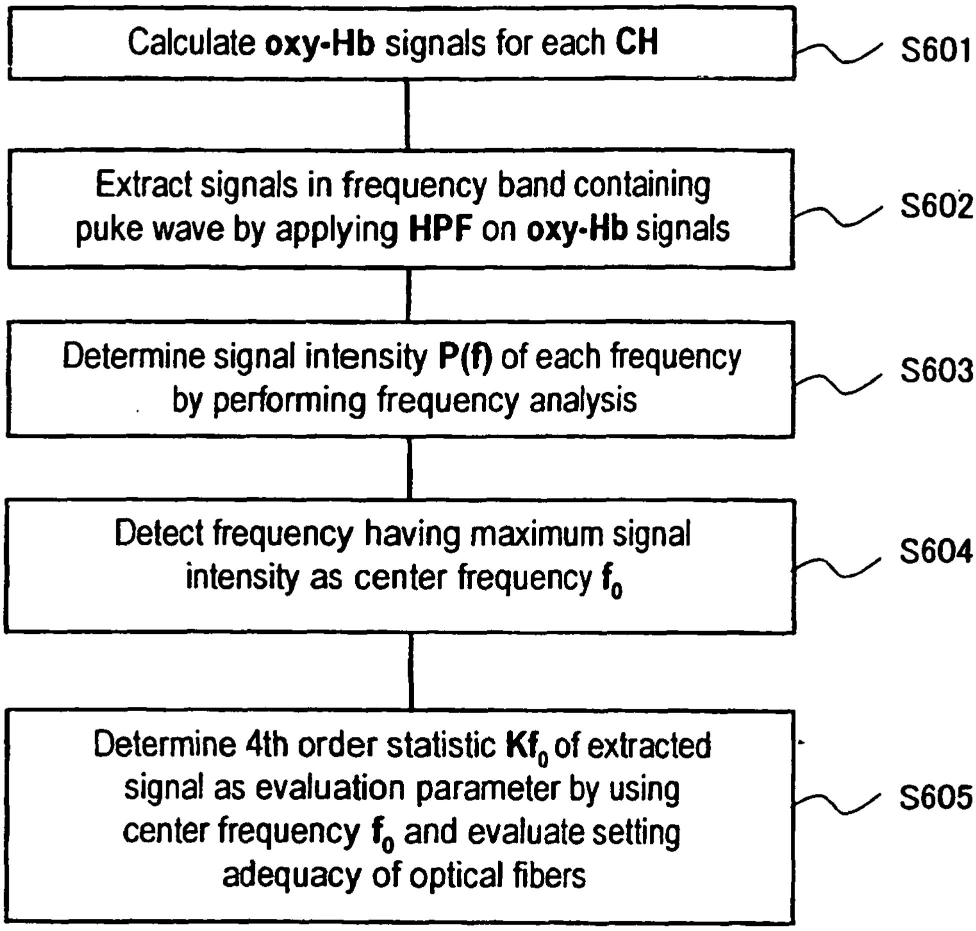

501
502
506
503
Outside Living Body
504
505
Inside Living Body

Fig. 6



$$K_{f_0} = \frac{\sum_f (f - f_0)^4 \times \frac{P(f)}{\sum_f P(f)}}{\sum_f (f - f_0)^2 \times \frac{P(f)}{\sum_f P(f)}}$$

Fig. 7

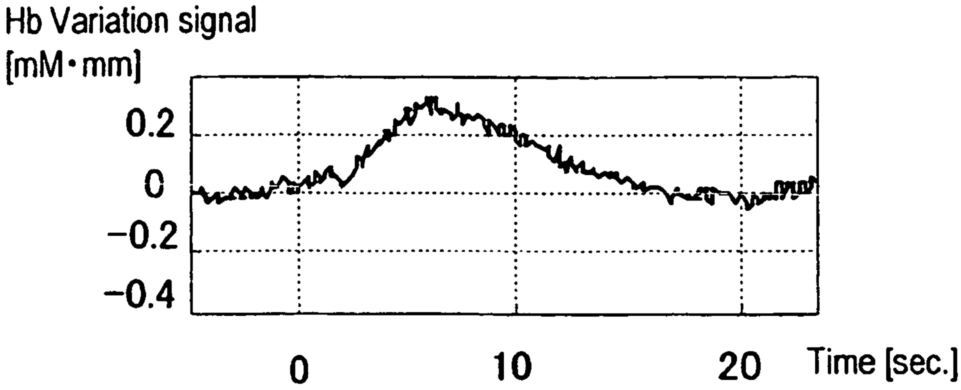


Fig. 8

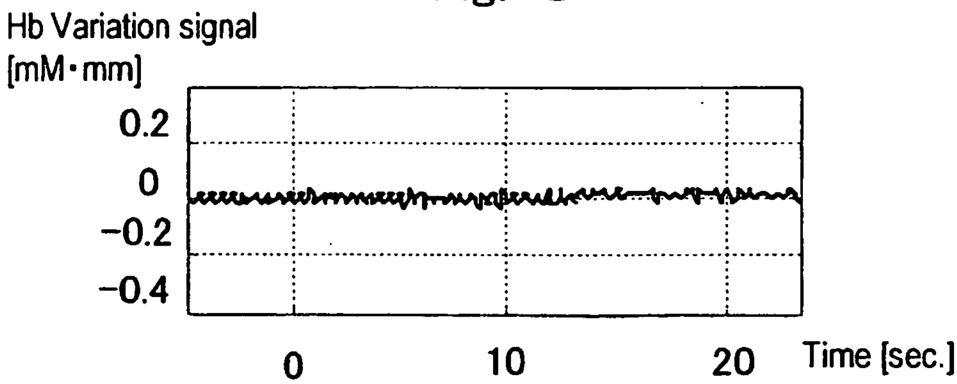


Fig. 9

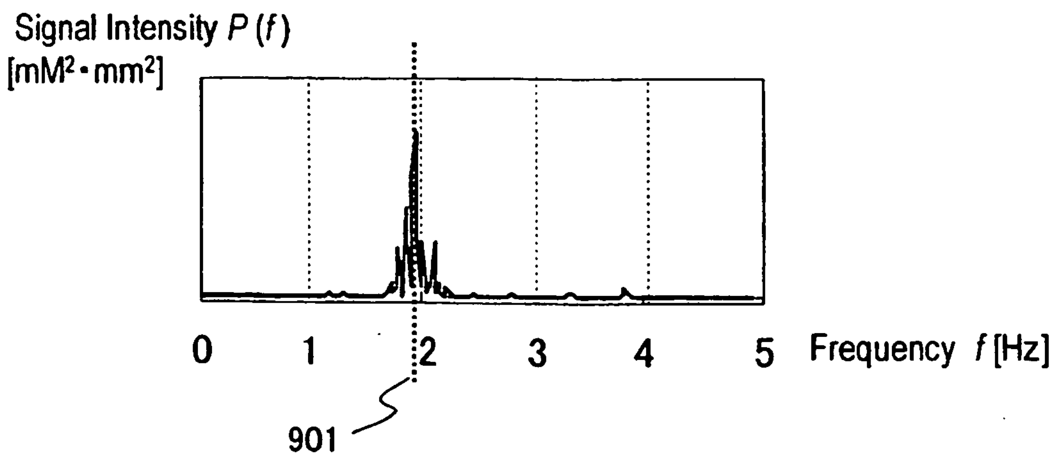


Fig. 10

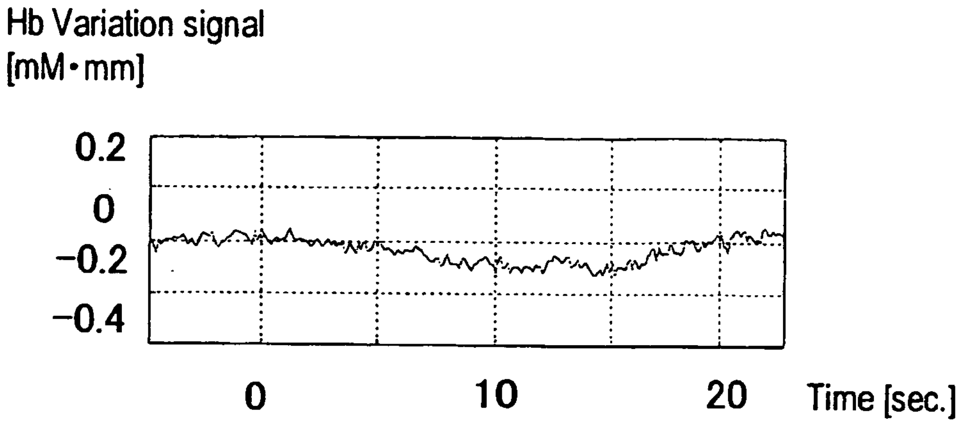


Fig. 11

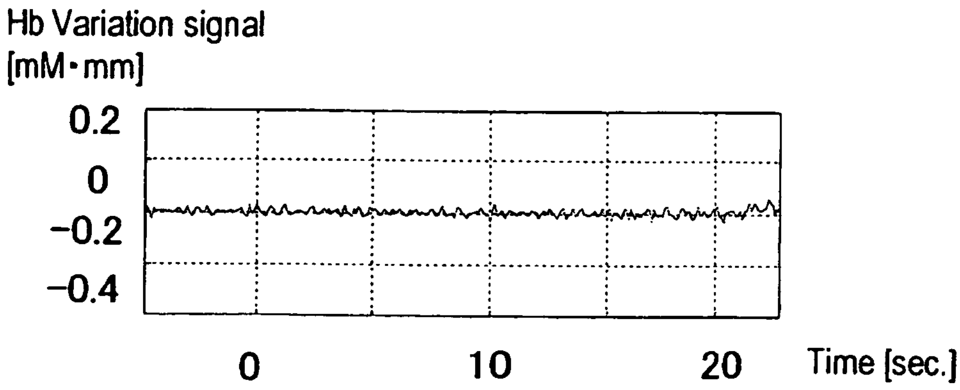


Fig. 12

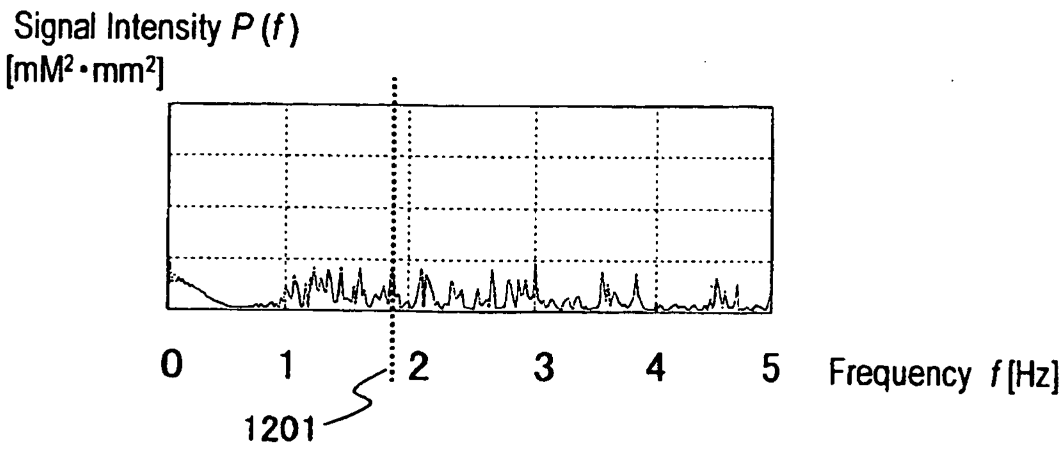


Fig. 13

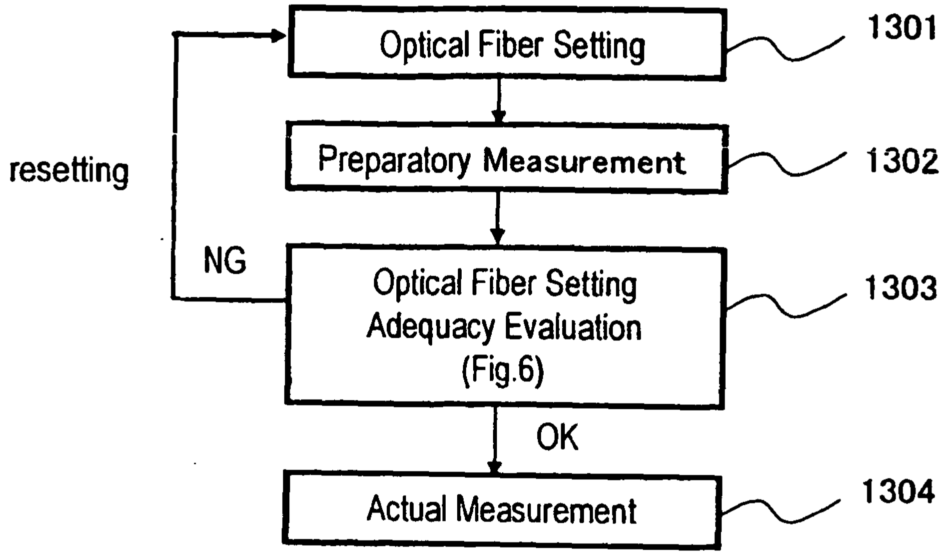

Optical Fiber Setting
1301
Preparatory Measurement
1302
resetting
NG
Optical Fiber Setting
Adequacy Evaluation
(Fig.6)
1303
OK
Actual Measurement
1304

Fig. 14

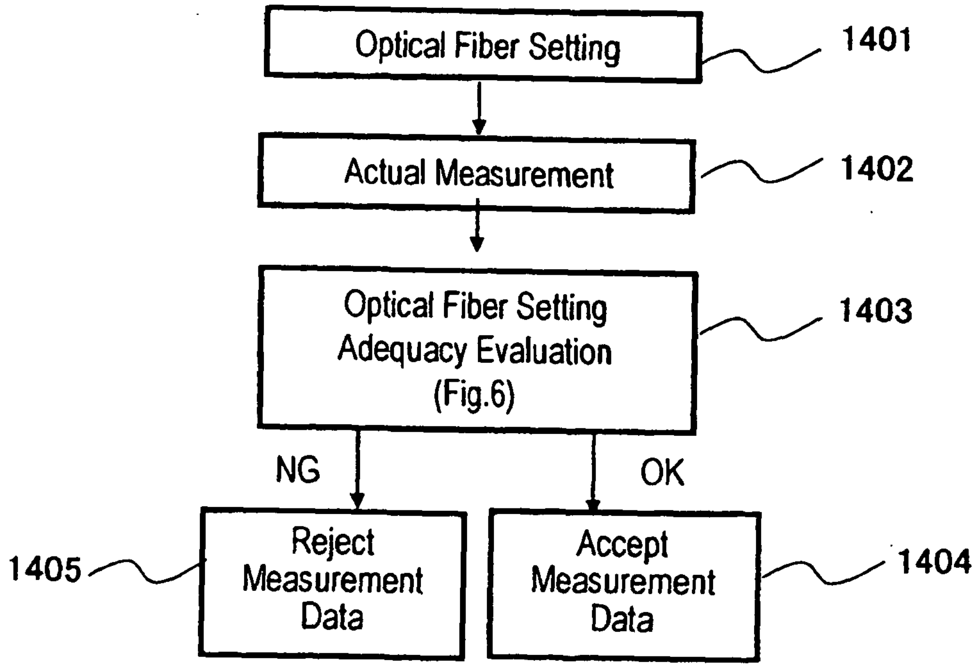
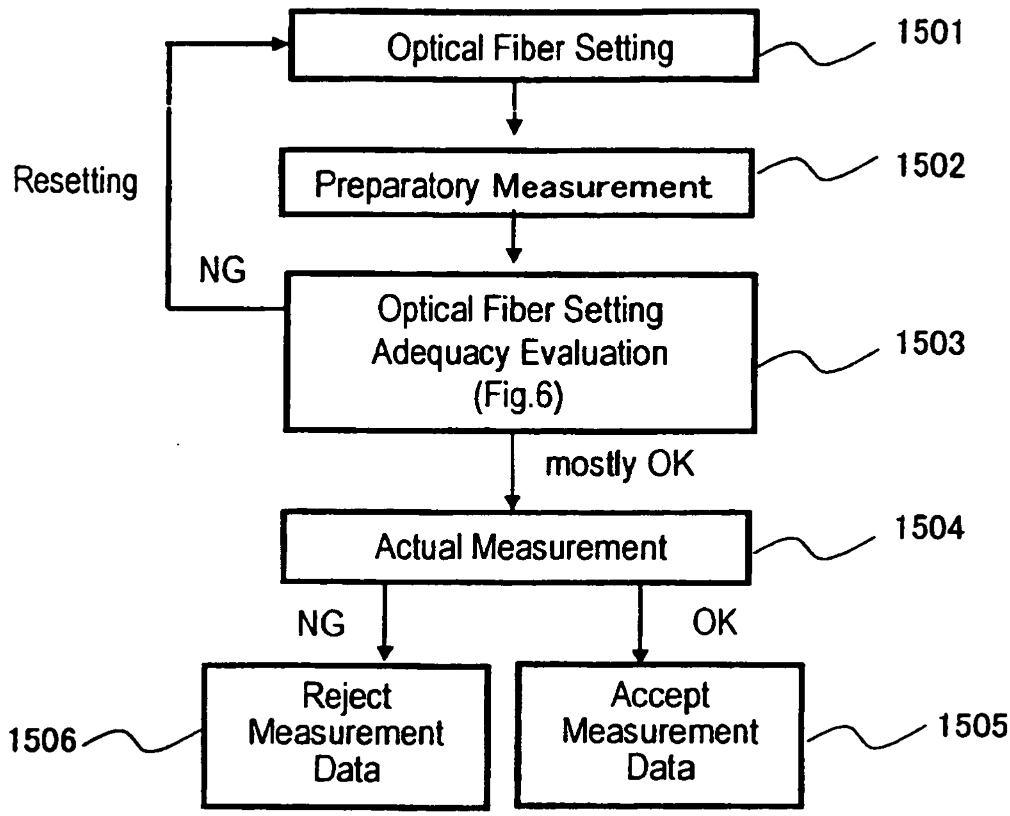

Optical Fiber Setting
1401
Actual Measurement
1402
Optical Fiber Setting
Adequacy Evaluation
(Fig.6)
1403
NG
OK
1405
Reject
Measurement
Data
Accept
Measurement
Data
1404

Fig. 15



Optical Fiber Setting
1501
Preparatory Measurement
1502
Resetting
NG
Optical Fiber Setting
Adequacy Evaluation
(Fig.6)
1503
mostly OK
Actual Measurement
1504
NG
OK
Reject
Measurement
Data
1506
Accept
Measurement
Data
1505

REFERENCES CITED IN THE DESCRIPTION

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- JP 11311599 A **[0009]**

专利名称(译)	生物光测量装置和方法		
公开(公告)号	[EP1688090B1](EP1688090B1)	公开(公告)日	2013-07-03
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申请(专利权)人(译)	日立医疗器械股份有限公司		
当前申请(专利权)人(译)	日立医疗器械股份有限公司		
[标]发明人	ASAKA YUICHI		
发明人	ASAKA, YUICHI		
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代理机构(译)	斯切尔，PETER		
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摘要(译)

一种光纤设定充分性评估单元（115），用于评估在各个测量通道的两端的照射用光纤（103）或光接收用光纤（103'）的检查区域中的体表设置充分性。用于生物体的光学测量装置（100）基于脉冲波评估用于各个测量通道的照射用光纤（103）或光接收用光纤（103'）的对象的体表的设置充分性由脉搏波计算单元（114）计算的各测量通道的强度，该计算单元计算由血红蛋白信号计算单元（113）计算的各测量通道的血红蛋白信号中包含的对象的心跳引起的脉搏波的强度，从而正确地判断设定充分性。

Fig. 1