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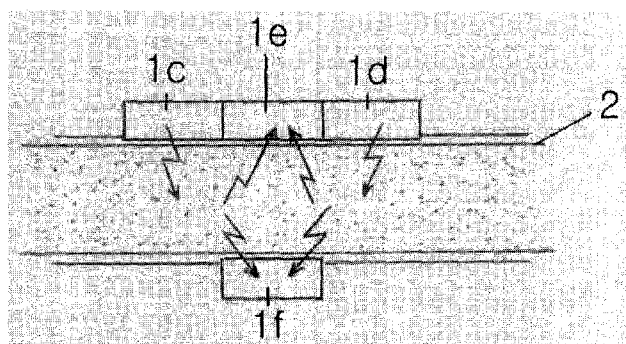
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(54) Title: DEVICE OF MEASURING AND MONITORING A HEMOGLOBIN VALUE THROUGH BLOOD TUBE

FIG. 5



(57) Abstract: Disclosed is a device for measuring and monitoring hemoglobin (hematocrit) value through blood tube, more particularly, a device comprising: (I) a probe 1 mounted on a blood tube of a hemodialysis device to purify blood of a patient while carrying out cardiopulmonary bypass of the blood, which irradiates light from two light sources with different wavelengths to the blood passing through the blood tube in non-invasive mode, digitizes detected signals for transmitted light and reflected light for each of the wavelengths resulting from the irradiation, and transfers the digitized results, that is, digital signals to a main device 3; and (II) the main device 3 which receives the digital signals from the probe 1, estimates hemoglobin value through a linear assembly of data for transmitted light and reflected light for each of wavelengths in relative ratios thereof by using the received digital signals, processes the estimated value, and on-line displays the results. The present invention can more precisely measure hemoglobin value in blood during hemodialysis and on-line display the measured hemoglobin value, prevent deformation of the flexible blood tube, and reduce size of the probe.

DEVICE OF MEASURING AND MONITORING A HEMOGLOBIN VALUE THROUGH BLOOD TUBE

TECHNICAL FIELD

5 The present invention relates to devices for measuring and monitoring hemoglobin value through blood tube, and more particularly, to a device for measuring and monitoring hemoglobin value called 'hematocrit' indicating blood concentration, which is mounted on a blood tube of a hemodialysis device that induces cardiopulmonary
10 bypass of blood of a patient and dialyzes the blood.

 For typical dialysis treatment, a flexible blood tube is generally used to carry out the cardiopulmonary bypass. Such blood tube principally comprises: an arterial blood tube equipped with an artery puncturing needle at front end of the tube, which draws out blood from
15 a patient; a venous blood tube equipped with a vein puncturing needle at front end of the tube, which returns the blood to the patient; and, additionally, a dialyzer interposed between the arterial blood tube and the venous blood tube. To the arterial blood tube, a scrubbing tube type blood pump is fixed and driven to draw out the blood from the artery
20 puncturing needle and induce the cardiopulmonary bypass of the blood from arterial blood line to venous blood line through the dialyzer. The dialyzer is provided with a plurality of hollow fibers, through which the blood passes.

A housing body of the dialyzer has a dialysis solution input port and a dialysis solution output port in a protrusion form to be connected with the hemodialysis device. A dialysis solution with constant concentration is introduced from the hemodialysis device through the dialysis solution input port into the dialyzer while the dialysis solution passes through outer part of the hollow fibers (that is, between outer sides of the hollow fibers and inner circumference of the housing body), then, is exhausted from the dialyzer through the dialysis solution output port.

Since the hollow fibers have microfine pores formed on walls of the fibers to create a blood purification membrane, waste substances of the blood pass through inner parts of the hollow fibers and through the membrane, followed by flowing into the dialysis solution while the purified blood free of the waste substances returns into body of the patient. In this case, the dialysis device is equipped with a water removal pump to remove water moiety from the blood during dialysis treatment.

When the water moiety is removed from the blood, amount of water moiety to be removed (that is, water removal rate) is varied by controlling the water removal pump. Rapid or excessive water removal reduces amount of blood circulation too much, thus, may result in blood reduction or cause shock to the patient. On the other hand, if the water removal rate is too low, whole time for dialysis treatment is

increased and may be too demanding for the patient.

BACKGROUND ART

Under the circumstance, some techniques for controlling water
5 removal rate while monitoring blood condition of patients have been
proposed in, for example, Japanese Patent Laid-Open No. H11-221275
and Japanese Patent Laid-Open No.2001-000540. According to such
prior arts, one of parameters indicating the blood condition of a patient
is hematocrit value. Hematocrit value is an indicator of concentration of
10 blood and means a ratio by volume of red blood cells with respect to
whole volume of the blood.

Hematocrit value during water removal usually ranges from 10 to
60%. However, in case that the patient undergoes reduction of blood
pressure or experiences symptoms of shock, the hematocrit value tends
15 to be higher than desirable level. Accordingly, when the patient is
subjected to the dialysis treatment, the treatment can be conducted
with an appropriate water removal rate which causes minimal burden
to the patient by monitoring this parameter (that is, hematocrit value) in
real time during the water removal and controlling the water removal
20 pump. Such hematocrit value is determined by specific instruments
called hematocrit sensors or probes. The hematocrit sensor or probe
generally has construction of a light emitting device and a light
receiving device opposite each other across a flexible blood tube, which

detects light received by the light receiving device after irradiating the light from the light emitting device and measures light transmissivity of the blood, thereby estimating the hematocrit value based on the measured amount.

5 However, since most of conventional hematocrit sensors have adopted the light transmission mode with construction of the light emitting device and the light receiving device opposite each other across the blood tube, the blood tube must be interposed or fitted between the light emitting device and the light receiving device in order to determine
10 the hematocrit value, thereby causing deformation of the blood tube. In other words, in case of the light transmission type sensor, the blood tube should be strongly or forcedly fitted and supported between both of the devices in order to improve measurement accuracy or precision. Herein, such strong fitting force may cause deformation of the flexible
15 blood tube, leading to reduction of flow rate of the blood and great stress or load applied to the blood tube.

 Furthermore, a housing body enclosing the light emitting device and alternative housing body enclosing the light receiving device are separately manufactured then integrated together to form a sensor
20 assembly of some size. Therefore, the known hematocrit sensors certainly have a difficulty in management of such large sensor assembly.

 In order to solve the above problem, Korean Patent Laid-Open No. 2005-25299 disclosed a light reflection type hematocrit sensor that has

a light emitting device and a light receiving device positioned at the same side of a blood tube, instead of arranging both of the devices to be opposed to each other, so that the light receiving device receives only the reflected light. But, known instruments for measuring hemoglobin
5 (that is, hematocrit) value described above have a limit in more precisely determining or correctly identifying the hemoglobin value because the instruments receive only one selected from transmitted light or reflected light after irradiating light from just one among various kinds of light sources.

10

DISCLOSURE OF THE INVENTION

(TECHNICAL PROBLEM)

Accordingly, the present invention is directed to solve the problems of conventional instruments as described above and, an object
15 of the present invention is to provide a device for measuring and monitoring hemoglobin value, characterized in that the device irradiates light from two light sources with different wavelengths to blood passing through a blood tube of a hemodialysis device, digitizes detected signals for transmitted light and reflected light resulting from the irradiation,
20 and determines hemoglobin value by linear assembly of the digital results. Briefly, the device for measuring and monitoring hemoglobin value according to the present invention is an ideal combination of typical transmission form and reflection form to more precisely

determine the hemoglobin value by way of non-invasive technique.

Another object of the present invention is to provide an apparatus for displaying the measured hemoglobin value by indicating the hemoglobin value on monitoring desks through wireless
5 communication.

(TECHNICAL MEANS TO SOLVE THE PROBLEM)

Hereinafter, the present invention will be described in detail below with reference to the accompanying drawings.

As shown in Fig. 1, the present invention provides a device for
10 measuring and monitoring hemoglobin value through blood tube, comprising: (I) a probe 1 mounted on a blood tube of a hemodialysis device to purify blood of a patient while carrying out cardiopulmonary bypass of the blood, which irradiates light from two light sources with different wavelengths to the blood passing through the blood tube in
15 non-invasive mode, digitizes detected signals for transmitted light and reflected light for each of the wavelengths resulting from the irradiation, and transfers the digitized results (that is, digital signals) to a main device 3; and (II) the main device 3 which receives the digital signals from the probe 1, estimates hemoglobin value through a linear
20 assembly of data for transmitted light and reflected light for each of wavelengths in relative ratios thereof by using the received digital signals, processes the estimated value, and on-line displays the results.

Fig. 1 is a schematic view illustrating the present inventive

device.

As illustrated in Fig. 2 to Fig. 5, the probe 1 comprises: a groove 1b for fitting the blood tube 2; a sliding lid 1a for covering and fixing the fitted blood tube 2; two emitting units 1c and 1d to be directly
5 in contact with the fitted blood tube 2; first light receiving unit 1e for receiving reflected light; second light receiving unit 1f for receiving transmitted light; an amplifier 1g for amplifying signals; and an ADC 1h for converting analog signals into digital signals.

Fig. 2 is a schematic perspective view illustrating the probe 1
10 according to the present invention. Fig. 3 is a schematic perspective view illustrating the probe 1 having the blood tube 2 fitted into the probe. Fig. 4 is a schematically cross-sectional view illustrating the probe 1, which is cut in longitudinal direction of the probe shown in Fig. 3. Fig. 5 is a schematically cross-sectional view illustrating the probe 1,
15 which is cut in horizontal direction of the probe shown in Fig. 3.

As illustrated in Fig. 5, the emitting units 1c and 1d and the first light receiving unit 1e for receiving the reflected light are arranged in series at one side of the blood tube 2, while the second light receiving unit 1f is located at the other side of the blood tube 2.

20 The light sources used for irradiating light from the emitting units 1c and 1d mounted on the probe 1 are preferably LED at 570nm and LED at 805nm, respectively.

Absorbency of oxidized hemoglobin and absorbency of reduced

hemoglobin are matched to LED at 570nm and LED at 805nm, respectively. Also, the first light receiving unit 1e and the second light receiving unit 1f are preferably photodiodes.

As shown in Fig. 6, the main device 3 is provided with CPU 3b
5 for controlling the probe 1 and processing input data, a display 3a for indicating hemoglobin value, and a wireless communication module 3c.

Fig. 6 is a schematic view illustrating the main device 3 according to the present invention.

The wireless communication module 3c on-line transmits the
10 measured hemoglobin value, especially, hematocrit value to a monitoring desk 4 which is usually used by nurses.

First LED at 570nm and second LED at 805nm used for irradiating light from the emitting units 1c and 1d are controlled as shown in Fig. 7, so that LEDs are alternately used to irradiate light at
15 constant intervals by CPU 3b of the main device connected to the LEDs through a connector 5.

Fig. 7 is a schematic view illustrating that the light sources are controlled to irradiate light in turns at the constant intervals, in particular, A shows a region of detecting the reflected light and the
20 transmitted light for LED at 570nm while B shows another region of detecting the reflected light and the transmitted light for LED at 805nm.

The present invention can improve accuracy of measuring the hemoglobin value by linearly assembling detected values in relative

ratios of the reflected light and the transmitted light detected at two wavelengths of 570nm and 805nm and numerically representing the assembled results.

Numerical Algorithm used in the present invention is as follows:

(1) Calculation of ratio of reflected light $R_{570(1)}$ inputted in the first photodiode to irradiated light $I_{570(1)}$ of first LED at 570nm: $R_{570(1)} / I_{570(1)}$;

(2) Calculation of ratio of transmitted light $T_{570(1)}$ inputted in the second photodiode to irradiated light $I_{570(1)}$ of first LED at 570nm: $T_{570(1)} / I_{570(1)}$;

(3) Calculation of ratio of reflected light $R_{805(1)}$ inputted in the first photodiode to irradiated light $I_{805(1)}$ of second LED at 805nm: $R_{805(1)} / I_{805(1)}$;

(4) Calculation of ratio of transmitted light $T_{805(1)}$ inputted in the second photodiode to irradiated light $I_{805(1)}$ of second LED at 805nm: $T_{805(1)} / I_{805(1)}$;

(5) Calculation of ratio of reflected light to irradiated light ($R_{570(2)} / I_{570(2)}$; $R_{805(2)} / I_{805(2)}$) and ratio of transmitted light to irradiated light ($T_{570(2)} / I_{570(2)}$; $T_{805(2)} / I_{805(2)}$), at each of the wavelengths by irradiating light from the first LED at 570nm and the second LED at 805nm;

(6) Calculation of average value for the ratios of reflected light

to irradiated light;

$$\begin{aligned} 570nm : \frac{R_{570}}{I_{570}} &= (R_{570(1)}/I_{570(1)} + R_{570(2)}/I_{570(2)})/2 \\ 805nm : \frac{R_{805}}{I_{805}} &= (R_{805(1)}/I_{805(1)} + R_{805(2)}/I_{805(2)})/2 \end{aligned}$$

(7) Calculation of a ratio ΔR of reflected light at 570nm to reflected light at 805nm;

$$\Delta R = \frac{(R_{570}/I_{570})}{(R_{805}/I_{805})}$$

(8) Calculation of average value for the ratios of transmitted light to irradiated light;

$$\begin{aligned} 570nm : \frac{T_{570}}{I_{570}} &= (T_{570(1)}/I_{570(1)} + T_{570(2)}/I_{570(2)})/2 \\ 805nm : \frac{T_{805}}{I_{805}} &= (T_{805(1)}/I_{805(1)} + T_{805(2)}/I_{805(2)})/2 \end{aligned}$$

(9) Calculation of a ratio ΔT of transmitted light at 570nm to reflected light at 805nm;

$$\Delta T = \frac{(T_{570}/I_{570})}{(T_{805}/I_{805})}$$

(10) Calculation of compensated hematocrit value Hb by using a linear assembly of ratios of the reflected light and the transmitted light.

$$Hb = \Delta R + K \Delta T \text{ (K: proportionality constant)}$$

(ADVANTAGEOUS EFFECTS)

As described in detail above, the present invention can more

precisely measure hemoglobin value in blood during hemodialysis and on-line display the measured hemoglobin value on a main device and a monitoring desk. Consequently, the present invention has beneficial features such as effective preventative treatment for anemia during the hemodialysis and removal of need for biochemical blood test which is typically applied to patients requiring the hemodialysis.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects, features and advantages of the present invention will become more apparent to those skilled in the related art in conjunction with the accompanying drawings.

Fig. 1 is a schematic view illustrating the present inventive device;

Fig. 2 is a schematic perspective view illustrating the probe 1 of the device according to the present invention;

Fig. 3 is a schematic perspective view illustrating the probe 1 having the blood tube 2 fitted into the probe;

Fig. 4 is a schematically cross-sectional view illustrating the probe, which is cut in longitudinal direction of the probe shown in Fig. 3;

Fig. 5 is a schematically cross-sectional view illustrating the probe, which is cut in horizontal direction of the probe shown in Fig. 3;

Fig. 6 is a schematic view illustrating the main device 3 of the device according to the present invention; and

Fig. 7 is a schematic view illustrating that light sources are controlled to irradiate light in turns at the constant intervals by two emitting units 1c and 1d.

[Description of symbols for major parts in drawings]

5	1:	probe	2:	blood tube
	3:	main device	4:	monitoring desk
	5:	connector	6:	adaptor
	7:	supporter	1a:	sliding lid
	1b:	groove for fitting blood tube		
10	1c:	first emitting unit		
	1d:	second emitting unit		
	1e:	first light receiving unit		
	1f:	second light receiving unit		
	1h:	ADC	1g:	signal amplifier
15	1j:	PCB	3a:	display
	3b:	CPU		
	3c:	wireless communication module		
	A:	region for detecting reflected light and transmitted light for irradiated light at 570nm		
20	B:	region for detecting reflected light and transmitted light for irradiated light at 805nm		

INDUSTRIAL APPLICABILITY

As described in detail above, the present invention is effective to measure constitutional ingredients of blood during hemodialysis by way of non-invasive mode and monitor the result by applying the device
5 of the present invention to a conventional hemodialysis device.

While the present invention has been described with reference to the accompanying drawings, it will be understood by those skilled in the art that various modifications and variations may be made therein without departing from the scope of the present invention as defined by
10 the appended claims.

WHAT IS CLAIMED IS:

1. A device for measuring and monitoring hemoglobin value through blood tube, comprising: (I) a probe 1 mounted on a blood tube
5 of a hemodialysis device to purify blood of a patient while carrying out cardiopulmonary bypass of the blood, which irradiates light from two light sources with different wavelengths to the blood passing through the blood tube in non-invasive mode, digitizes detected signals for transmitted light and reflected light for each of the wavelengths
10 resulting from the irradiation, and transfers the digitized results, that is, digital signals to a main device 3; and (II) the main device 3 which receives the digital signals from the probe 1, estimates hemoglobin value through a linear assembly of data for transmitted light and reflected light for each of wavelengths in relative ratios thereof by using
15 the received digital signals, processes the estimated value, and on-line displays the results.

2. The device according to Claim 1, wherein the probe 1 includes: a groove 1b for fitting the blood tube 2; a sliding lid 1a for covering and
20 fixing the fitted blood tube 2; two emitting units 1c and 1d to be directly in contact with the fitted blood tube 2; a first light receiving unit 1e for receiving reflected light; a second light receiving unit 1f for receiving transmitted light; an amplifier 1g for amplifying signals; and an ADC 1h

for converting analog signals into digital signals.

3. The device according to Claim 1, wherein the main device 3 is provided with a CPU 3b for controlling the probe 1 and processing input
5 data, a display 3a for indicating hemoglobin value, and a wireless communication module 3c.

4. The device according to Claim 1, wherein the two light sources in the probe 1 are LED at 570nm and LED at 805nm, respectively.

10

5. The device according to Claim 2, wherein the first light receiving unit 1e and the second light receiving unit 1f are photodiodes, respectively.

DRAWING

FIG. 1

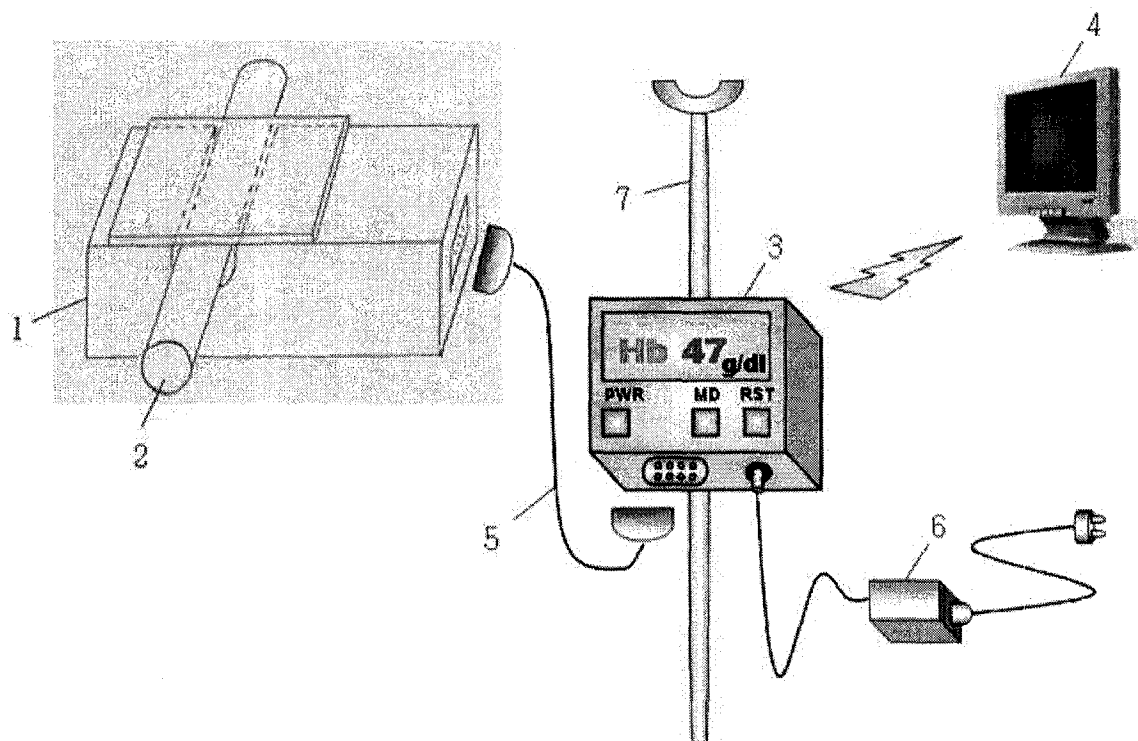


FIG. 2

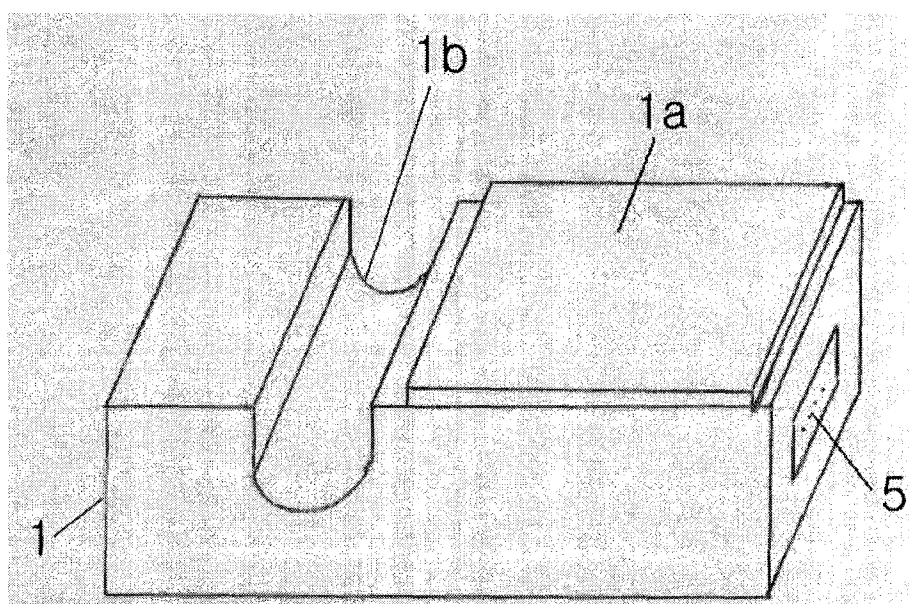


FIG. 3

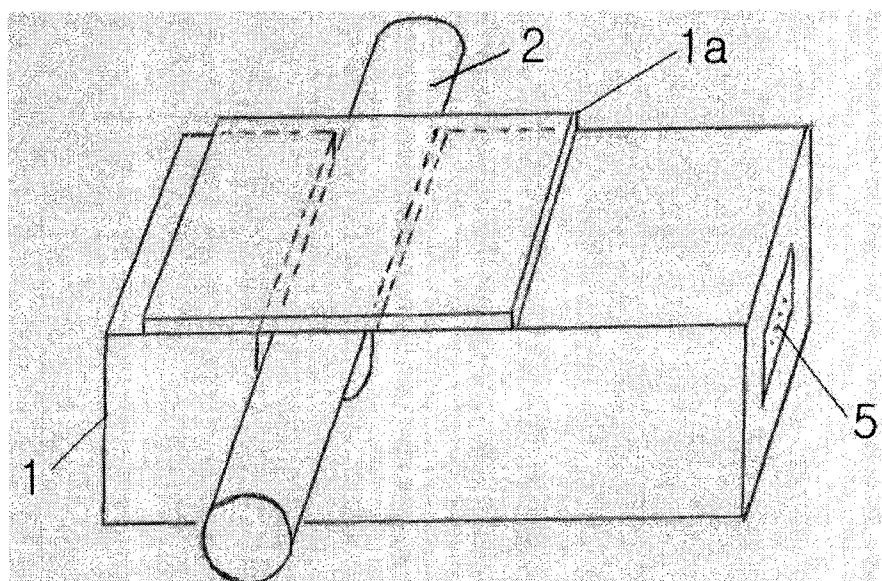


FIG. 4

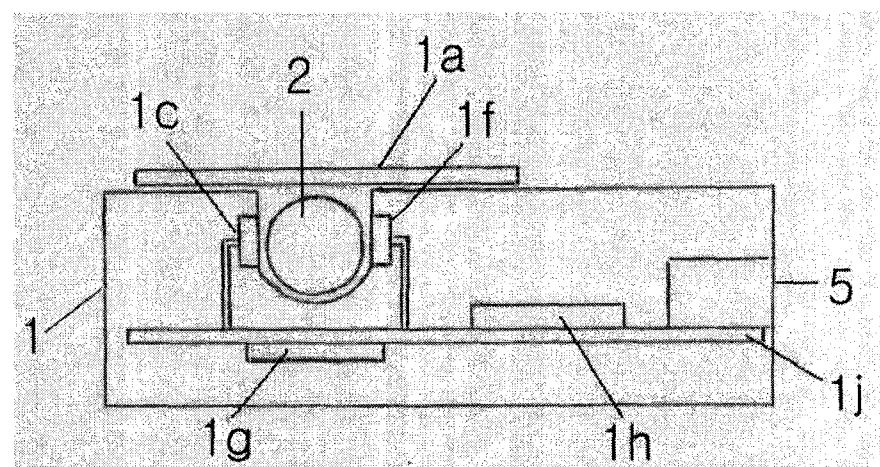


FIG. 5

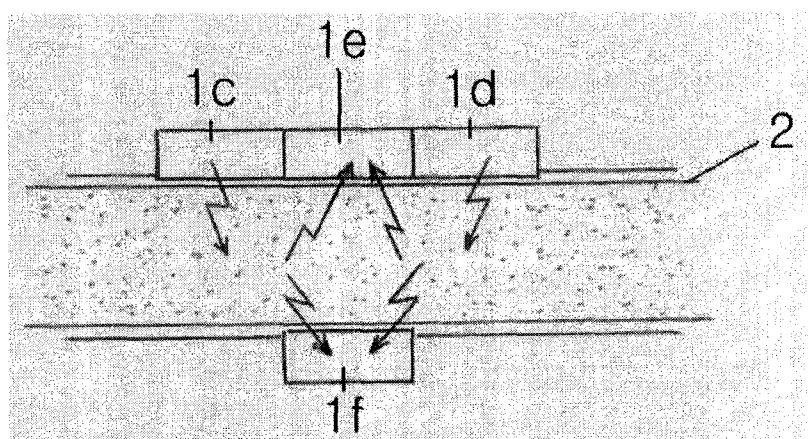


FIG. 6

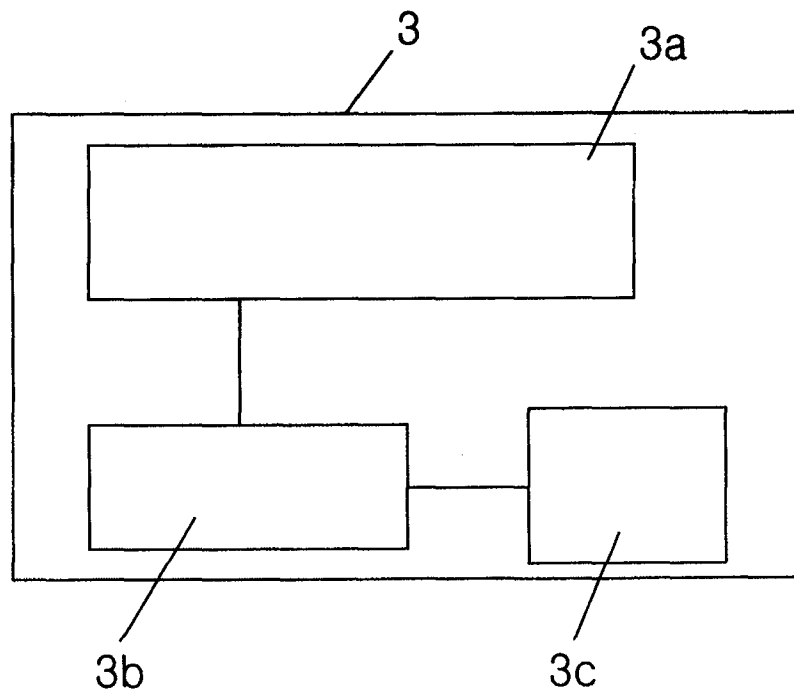
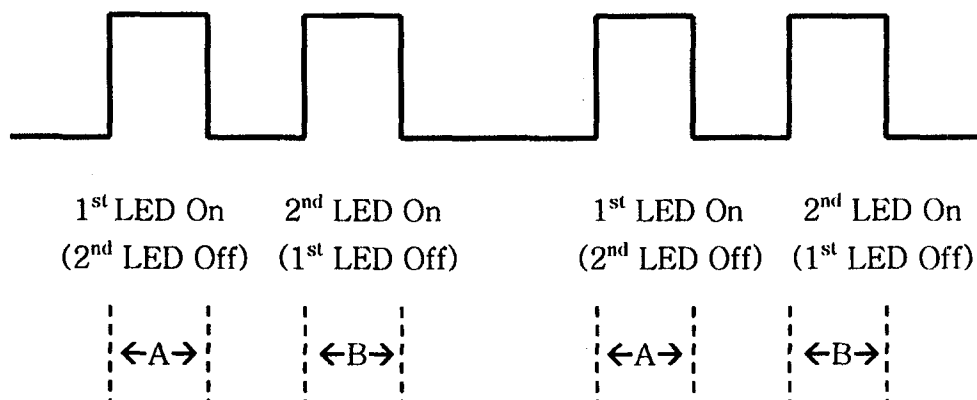


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/002237**A. CLASSIFICATION OF SUBJECT MATTER*****A61M 1/14(2006.01)i, G01N 21/31(2006.01)i, G01N 33/72(2006.01)i, A61B 5/02(2006.01)i***

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 A61B 5/00, A61M 1/14

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

Korean Utility Models and Application for Utility Models since 1975

Japanese Utility Models and Application for Utility Models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal), esp@cenet, Delphion, ScienceDirect, "hemoglobin, hematocrit, dialysis, and wavelength"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 2003/0009090 A1 (KYE-JIN JEON et al.) 9 January 2003 See Paragraphs [0023]-[0096], Figures 1-10.	1-5



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See patent family annex.

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search

29 JANUARY 2008 (29.01.2008)

Date of mailing of the international search report

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Name and mailing address of the ISA/KR

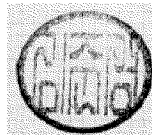
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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