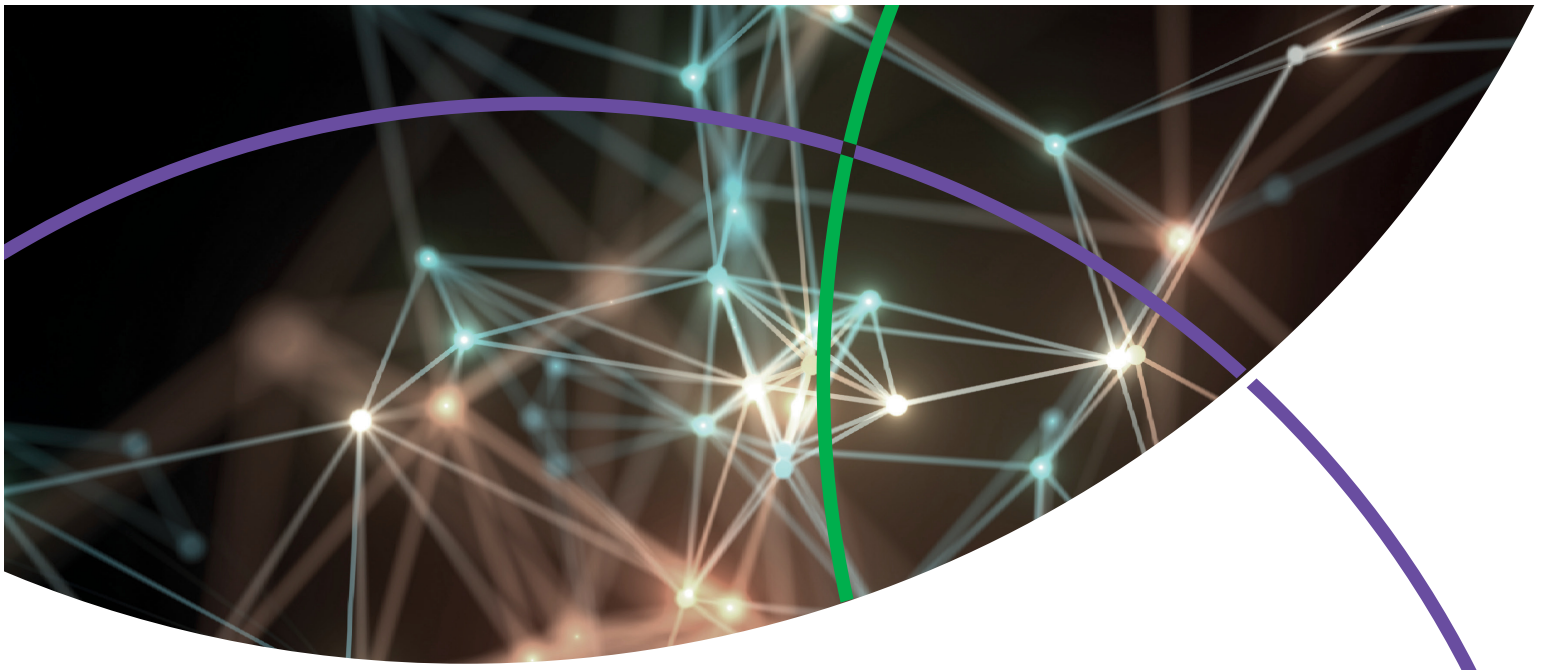

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IP 1702 300
07.2017

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FILE HISTORY

US 6,771,994

PATENT:	6,771,994
INVENTORS:	KIANI MASSI E DIAB MOHAMED K
TITLE:	Pulse oximeter probe-off detection system
APPLICATION NO:	US2003374303A
FILED:	24 FEB 2003
ISSUED:	03 AUG 2004
COMPILED:	19 MAR 2020

31033 U.S. PTO
10/374303
02/24/03

AUG 03 2004

PATENT NUMBER and ISSUE DATE
6771994

U.S. UTILITY Patent Application

APPL NUM	FILING DATE	CLASS	SUBCLASS	GAU	EXAMINER
10374303	02/24/2003	600	322	3736	

**APPLICANTS: Kiani Massi; Diab Mohamed;

**CONTINUING DATA VERIFIED:
This application is a DIV of 09/595,081 06/16/2000 PAT 6,526,300
which claims benefit of 60/160,000 06/18/1999

** FOREIGN APPLICATIONS VERIFIED:

PG-PUB DO NOT PUBLISH ☐ | RESCIND ☐

Foreign priority claimed ☐ yes ☒ no
35 U.S.C. 119 conditions met ☐ yes ☒ no
Verified and Acknowledged Examiner's initials MT

ATTORNEY DOCKET NO
MASIMO.172DV1

TITLE : Pulse oximeter probe-off detection system

U.S.DEPT. OF COMM /PAT & TM-PTO-436L(Rev. 12-94)

6/30/04 Formal Drawings 16 2/24/03

NOTICE OF ALLOWANCE MAILED		Assistant Examiner	CLAIMS ALLOWED	
4/13/04		Matthew Kim	Total Claims 18	Print Claim for O.G 16
ISSUE FEE 1117			DRAWING	
Amount Due $1330.00	Date Paid 6/22/04	Primary Examiner AU 3737	Sheets Drwg. 15	Figs.Drwg. 16	Print Fig. 5B
☐ TERMINAL DISCLAMER		PREPARED FOR ISSUE	Application Examiner S. Piles 4-16-04	

ISSUE FEE IN FILE

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(Attached in pocket on right inside flap)

6,771,994

PULSE OXIMETER PROBE-OFF DETECTION SYSTEM

Transaction History

Date	Transaction Description
02-24-2003	Workflow - Drawings Finished
02-24-2003	Workflow - Drawings Matched with File at Contractor
02-24-2003	Initial Exam Team nn
03-14-2003	IFW Scan & PACR Auto Security Review
04-17-2003	Application Is Now Complete
04-18-2003	Application Dispatched from OIPE
03-09-2004	Case Docketed to Examiner in GAU
04-05-2004	Notice of Allowance Data Verification Completed
04-13-2004	Mail Notice of Allowance
04-19-2004	Dispatch to Publications
04-21-2004	Receipt into Pubs
04-22-2004	Receipt into Pubs
04-22-2004	Workflow - File Sent to Contractor
05-25-2004	Receipt into Pubs
06-22-2004	Issue Fee Payment Verified
06-22-2004	Issue Fee Payment Received
06-22-2004	Receipt into Pubs
07-01-2004	Dispatch to FDC
07-01-2004	Application Is Considered Ready for Issue
07-06-2004	Receipt into Pubs
07-15-2004	Issue Notification Mailed
08-03-2004	Recordation of Patent Grant Mailed
08-03-2004	Patent Issue Date Used in PTA Calculation
12-08-2005	Correspondence Address Change
06-18-2007	Post Issue Communication - Certificate of Correction
08-02-2011	Correspondence Address Change

MAR 26 0334

INITIALS

CONTENTS

		Date Received (Incl. C. of M.) or Date Mailed			Date Received (Incl. C. of M.) or Date Mailed
1.	Application Patent papers.		31.		
2.	IDS	2/24/03	32.		
3.	N/A	4/13/04	33.		
4.	Req Cor	6/1/07	34.		
5.			35.		
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ISSUE SLIP STAPLE AREA (for additional cross-references)

ISSUING CLASSIFICATION

ORIGINAL		CROSS REFERENCE(S)	
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)
600	323	600	344

INTERNATIONAL CLASSIFICATION	
A61B	5/00
	1
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^ Continued on Issue Slip Inside File Jacket

INDEX OF CLAIMS

✓ ..... Rejected – (Through numeral) ... Canceled N ..... Non-elected A ..... Appeal
= ..... Allowed + ... Restricted I ..... Interference O ..... Objected

Claim Final	Claim Original	Date
1	(1)	11/4/2004
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If more than 150 claims or 9 actions staple additional sheet here

SEARCH

Class	Sub.	Date	Exmr.
600	309-310 322-324 316, 344 473, 476	4/2/2004	[illegible]

SEARCH NOTES

(List databases searched. Attach search strategy inside.)

	Date	Exmr.
East: [illegible]		
Palm Inventor Search	4/2/2004	[illegible]
Medline - [illegible]	4/2/2004	

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.
600	322-23 344	4/2/2004	[illegible]

US006771994B2

(12) **United States Patent**
Kiani et al.

(10) **Patent No.: US 6,771,994 B2**
(45) **Date of Patent: Aug. 3, 2004**

(54) **PULSE OXIMETER PROBE-OFF DETECTION SYSTEM**

(75) Inventors: **Massi E. Kiani**, Laguna Niguel, CA (US); **Mohamed K. Diab**, Mission Viejo, CA (US)

(73) Assignee: **Masimo Corporation**, Irvine, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/374,303**

(22) Filed: **Feb. 24, 2003**

(65) **Prior Publication Data**

US 2003/0139656 A1 Jul. 24, 2003

Related U.S. Application Data

(62) Division of application No. 09/595,081, filed on Jun. 16, 2000, now Pat. No. 6,526,300.
(60) Provisional application No. 60/140,000, filed on Jun. 18, 1999.

(51) **Int. Cl.**[7] **A61B 5/00**
(52) **U.S. Cl.** **600/323**; 600/344
(58) **Field of Search** 600/309–310, 600/322–324, 316, 344, 473, 476

(56) **References Cited**

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EP	0315 040 A1	10/1989
GB	2061 496 A	5/1981

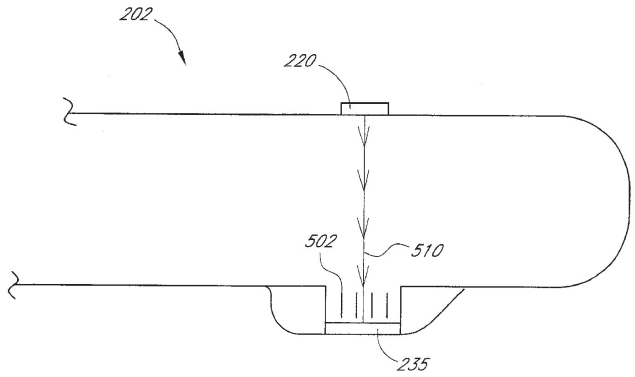
* cited by examiner

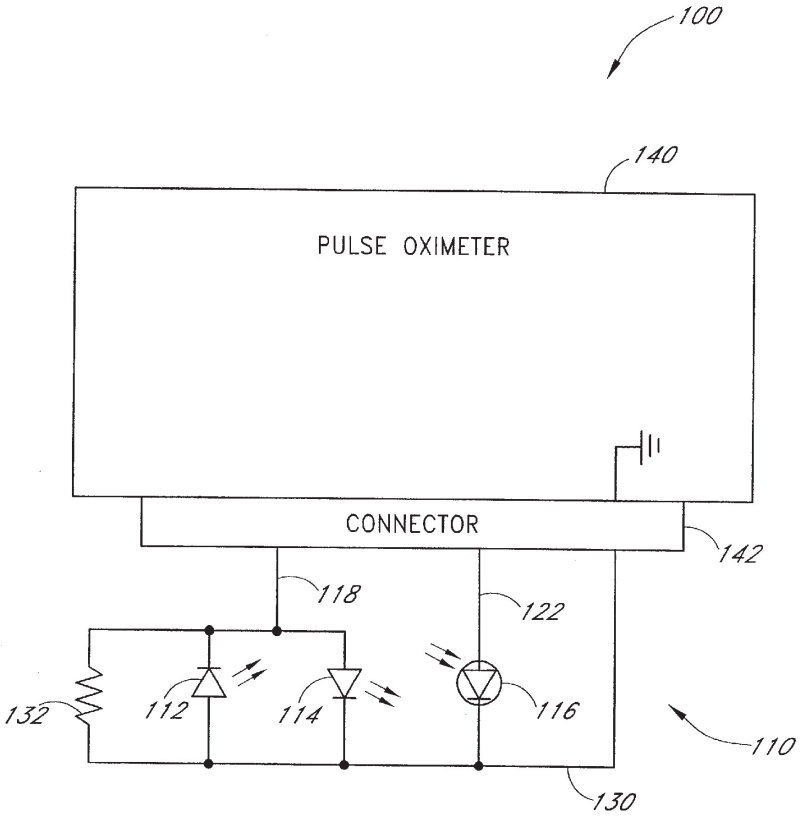
Primary Examiner—Mary Beth Jones
Assistant Examiner—Matthew Kremer
(74) *Attorney, Agent, or Firm*—Knobbe, Martens, Olson, & Bear, LLP

(57) **ABSTRACT**

The present invention provides a number of improvements that can be incorporated into a pulse oximeter probe to detect when a probe has become dislodged from a patient and/or to prevent a probe-off condition. A probe-off condition occurs when the optical probe becomes partially or completely dislodged from the patient, but continues to detect an AC signal within the operating region of the pulse oximeter. In one aspect, the present invention provides electrical contacts that contact the skin of a patient when the probe is properly attached. In another aspect, the present invention provides a number of louvers placed in front of the sensor's photodetector to filter out oblique light rays that do not originate from a point in front of the detector. Accordingly, if the emitter and photodetector are not properly aligned, the photodetector will not produce a signal within the valid operating range of the pulse oximeter. In accordance with a method of the present invention the pulse oximeter can sound an alarm or display a warning if it determines that the probe is not properly attached to the patient.

18 Claims, 15 Drawing Sheets

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CONNECTOR
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132
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110
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FIG. 1

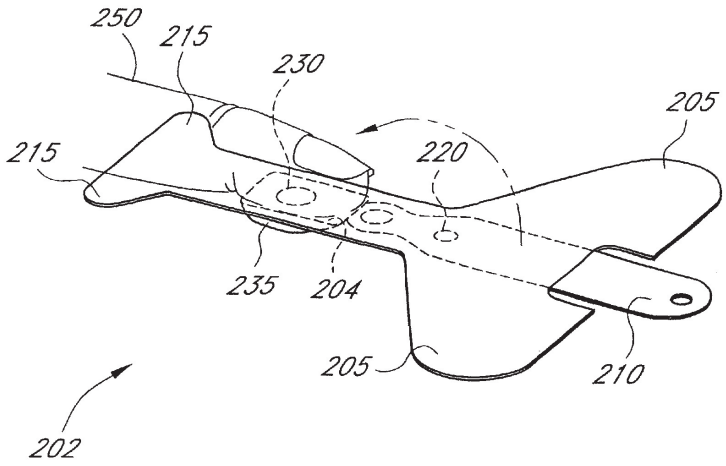
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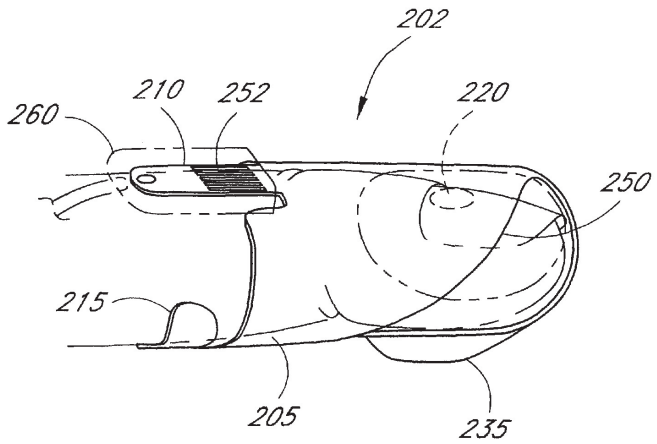
FIG. 2A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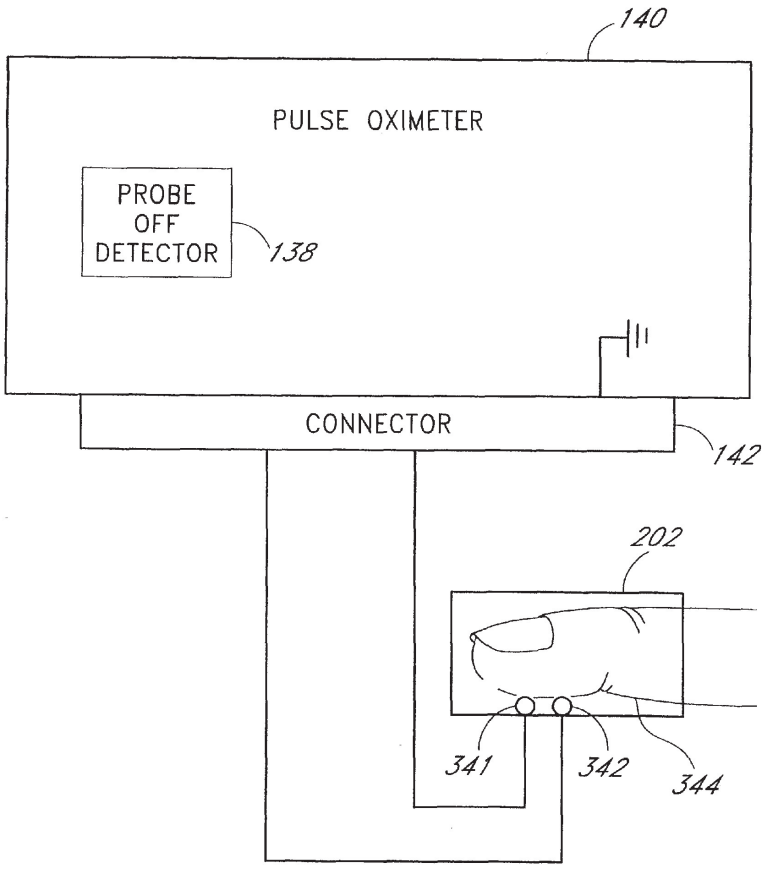
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PULSE OXIMETER
PROBE OFF DETECTOR
138
CONNECTOR
142
202
341
342
344

FIG. 3A

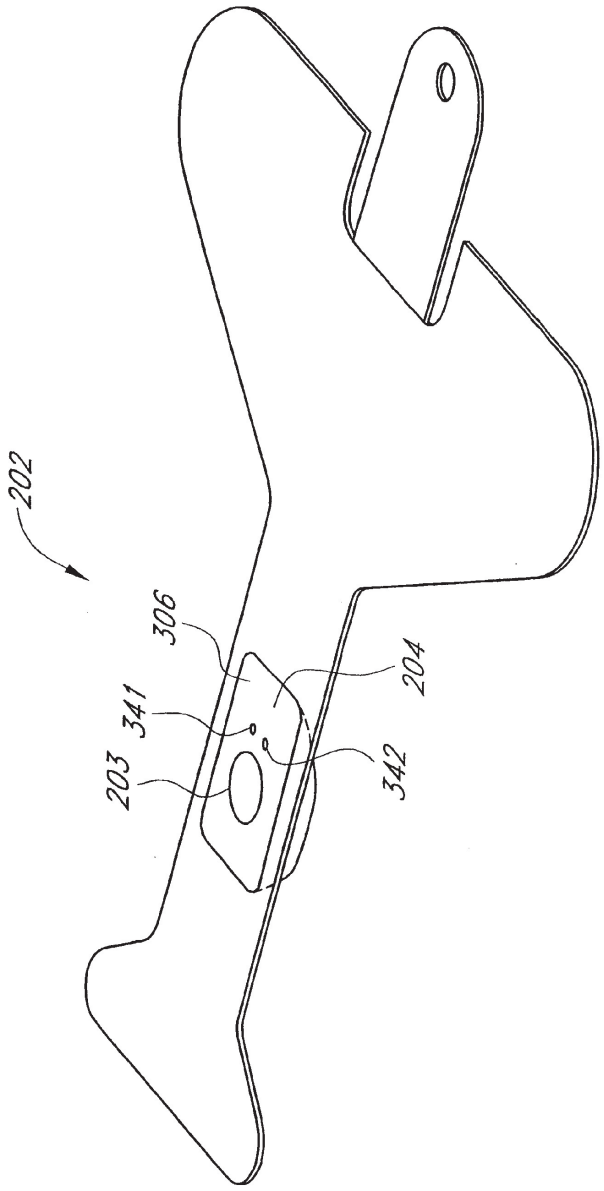
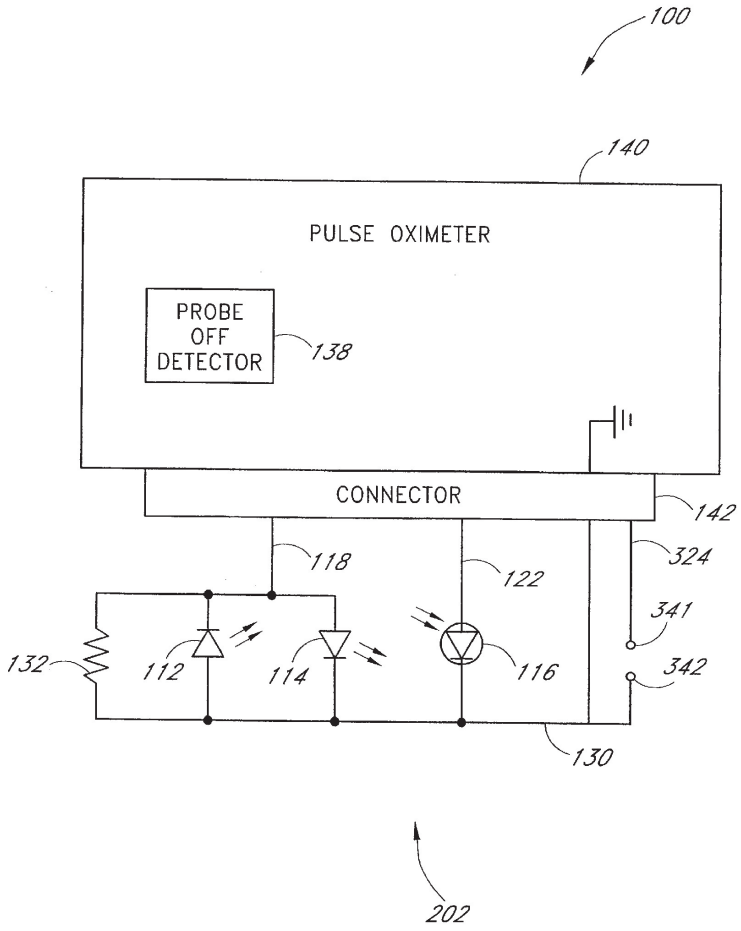


FIG. 3B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140
PULSE OXIMETER
PROBE OFF DETECTOR
138
CONNECTOR
142
118
122
324
341
342
132
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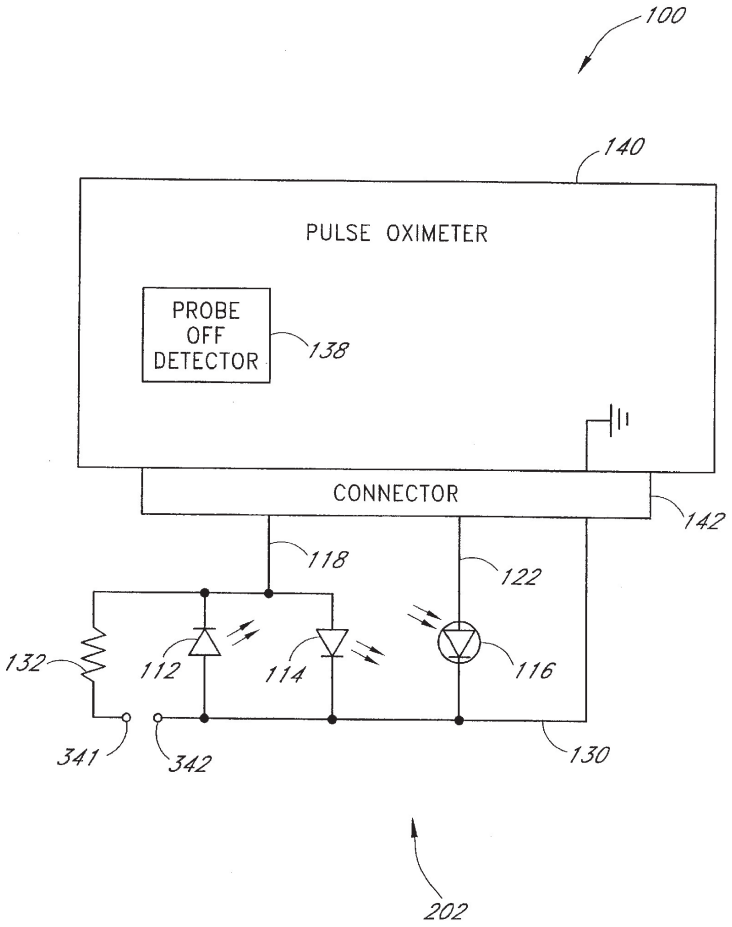
114
116
130
202

FIG. 3C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PULSE OXIMETER
PROBE OFF DETECTOR
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CONNECTOR
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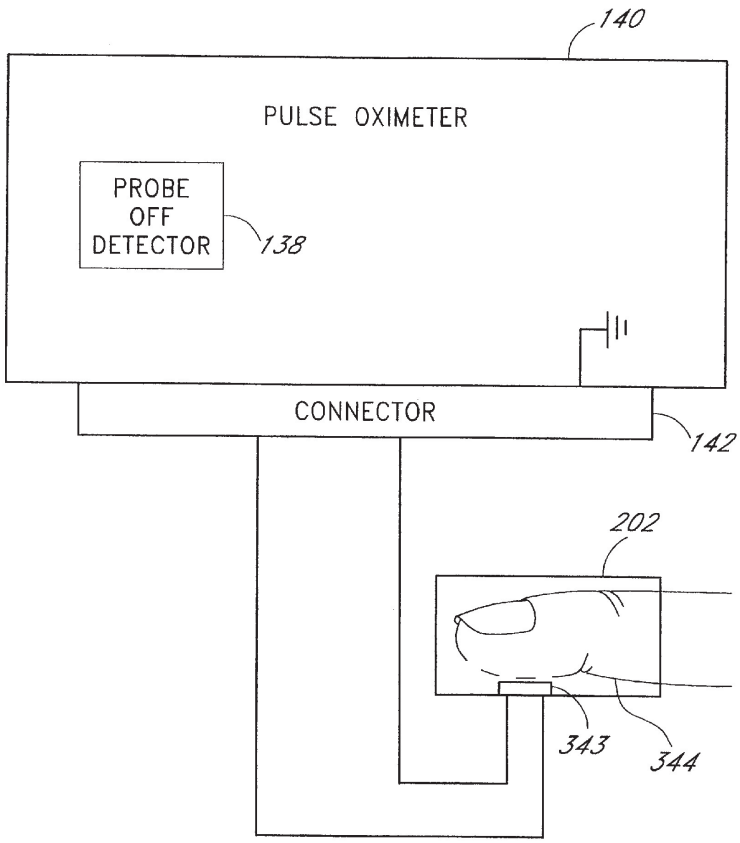
202

FIG. 3D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PROBE OFF DETECTOR
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CONNECTOR
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202
343
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FIG. 3E

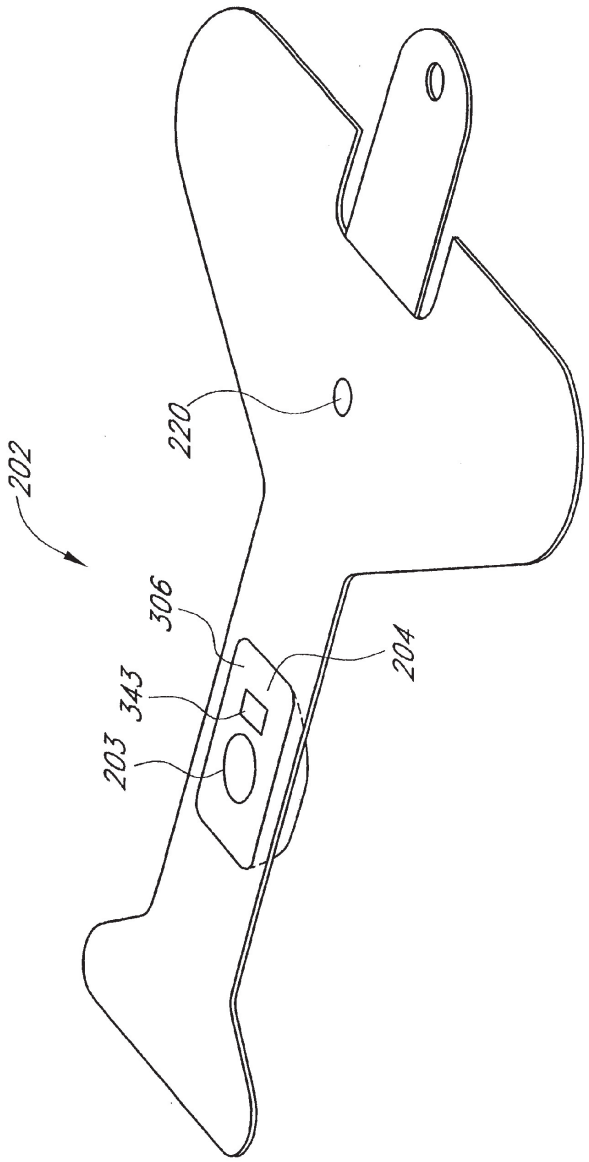
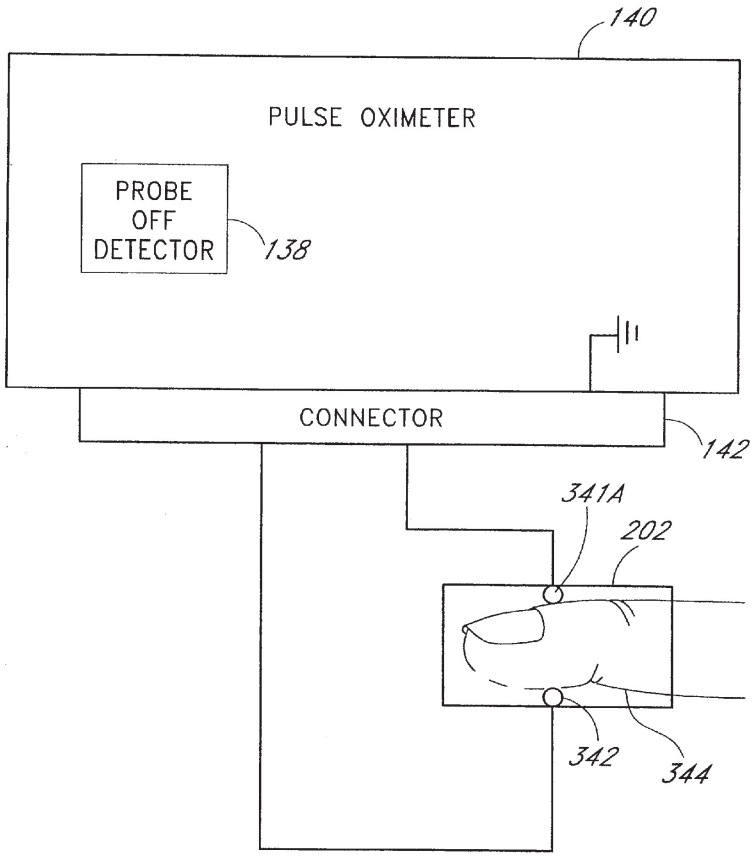


FIG. 3F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PULSE OXIMETER
PROBE OFF DETECTOR
138
CONNECTOR
142
341A
202
342
344

FIG. 3G

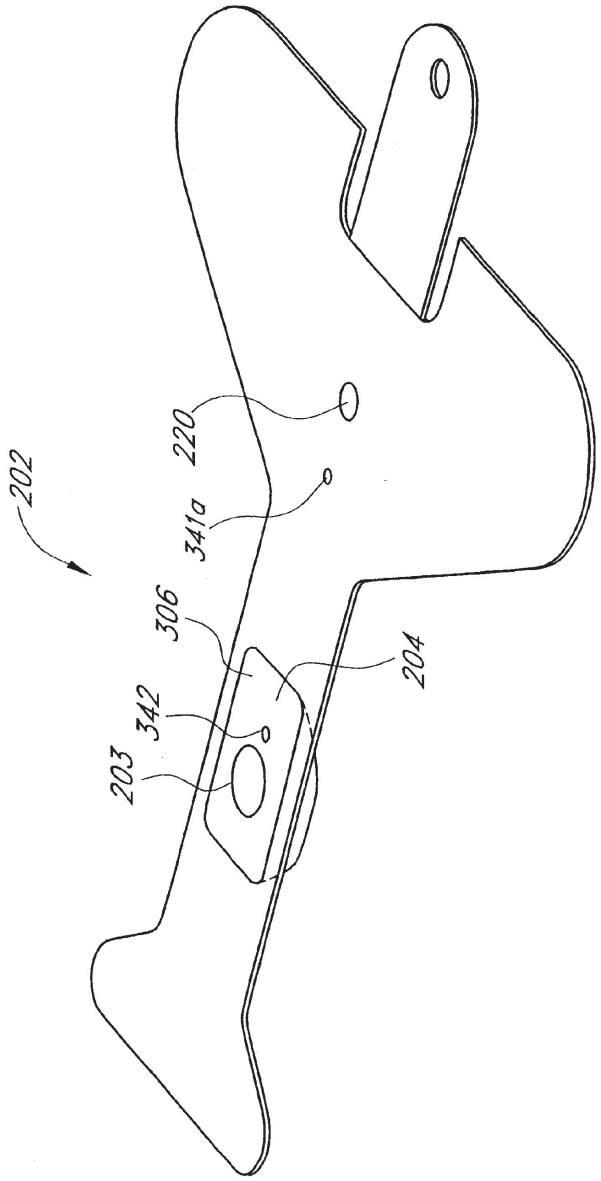

FIG. 3H

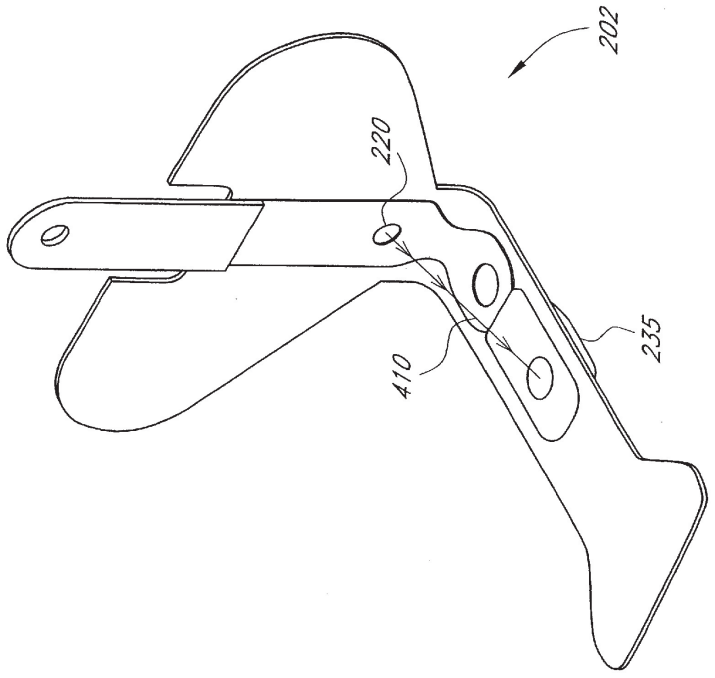

FIG. 4

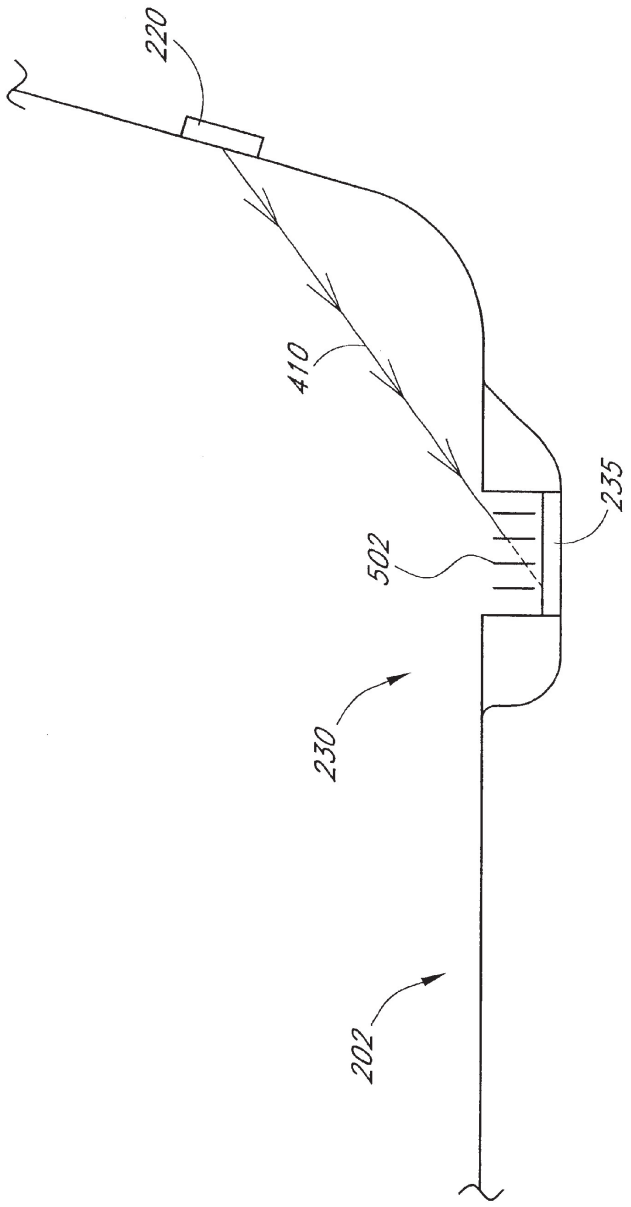

FIG. 5A

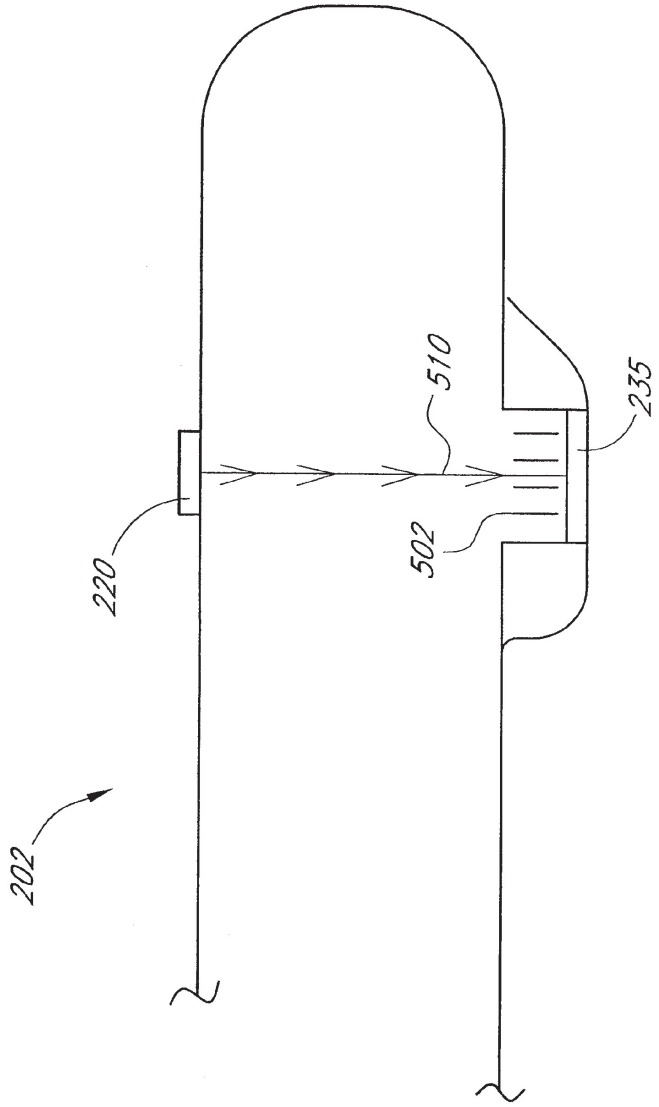

FIG. 5B

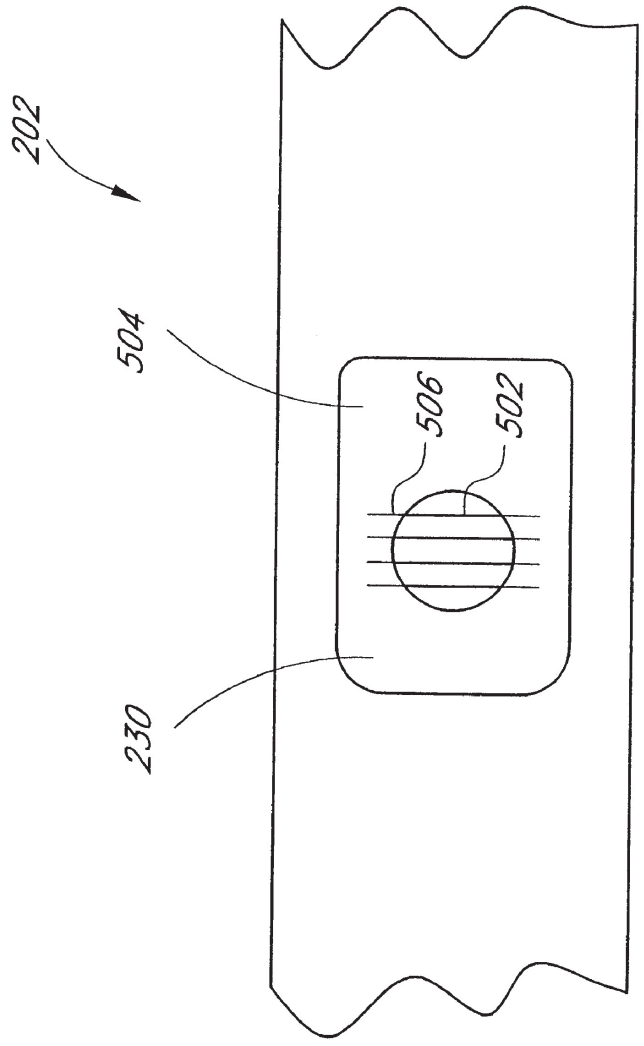

FIG. 5C

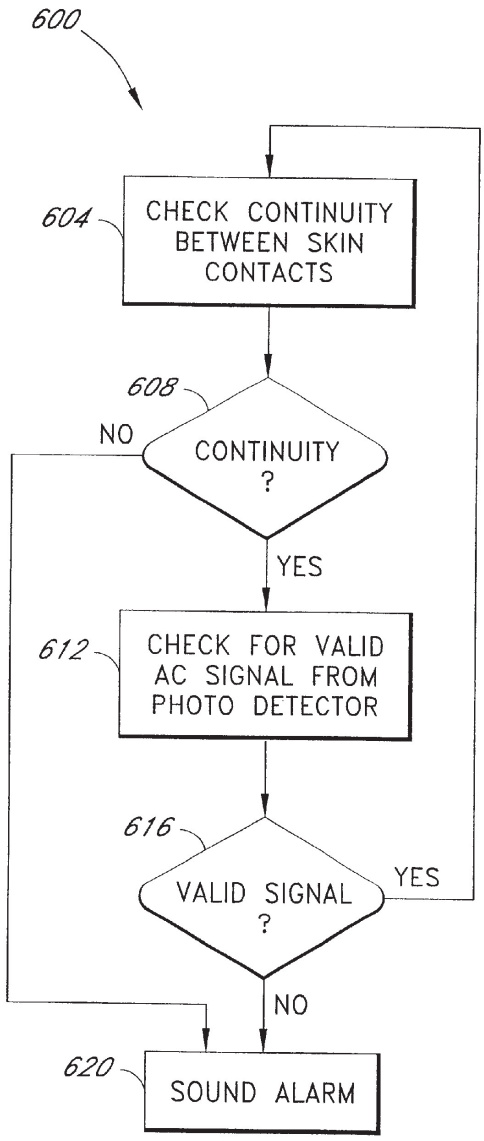
600
604
CHECK CONTINUITY BETWEEN SKIN CONTACTS
608
NO
CONTINUITY ?
YES
612
CHECK FOR VALID AC SIGNAL FROM PHOTO DETECTOR
616
VALID SIGNAL ?
YES
NO
620
SOUND ALARM

FIG. 6

PULSE OXIMETER PROBE-OFF DETECTION SYSTEM

REFERENCE TO RELATED APPLICATIONS

The present application claims priority benefit under 35 U.S.C. § 120 to, and is a divisional of, U.S. patent application Ser. No. 09/595,081, filed Jun. 16, 2000, now U.S. Pat. No. 6,526,300, entitled "Pulse Oximeter Probe-Off Detection System," which claims priority benefit under 35 U.S.C. § 119(e) from U.S. Provisional Application No. 60/140,000, filed Jun. 18, 1999, entitled "Pulse Oximeter Probe-Off Detection System." The present application also incorporates the foregoing utility disclosure herein by reference.

BACKGROUND OF THE INVENTION

The present invention relates to optical probes that can be attached to the finger, toe, or appendage of a patient. More particularly, the present invention relates to devices and methods for identifying when a probe has become dislodged from a patient.

DESCRIPTION OF THE RELATED ART

Oximetry is the measurement of the oxygen status of blood. Early detection of low blood oxygen is critical in the medical field, for example in critical care and surgical applications, because an insufficient oxygen supply can result in brain damage and death in a matter of minutes. Pulse oximetry is a widely accepted noninvasive procedure for measuring the oxygen saturation level of arterial blood, an indicator of oxygen supply. A pulse oximetry system generally consists of a probe attached to a patient, a monitor, and a cable connecting the probe and monitor. Conventionally, a pulse oximetry probe has both red and infrared (IR) light-emitting diode (LED) emitters and a photodiode detector. The probe is typically attached to a patient's finger or toe, or a very young patient's foot. For a finger, the probe is configured so that the emitters project light through the fingernail, the arteries, vessels, capillaries, tissue and bone. The photodiode is positioned opposite the LED so as to detect the LED transmitted light as it emerges from the finger tissues.

The pulse oximetry monitor (pulse oximeter) determines oxygen saturation by analyzing the differential absorption by arterial blood of the two wavelengths emitted by the probe. The pulse oximeter alternately activates the probe LED emitters and reads the resulting current generated by the photodiode detector. This current is proportional to the intensity of the detected light. The pulse oximeter calculates a ratio of detected red and infrared intensities, and an arterial oxygen saturation value is empirically determined based on the ratio obtained. The pulse oximeter contains circuitry for controlling the probe, processing the probe signals and displaying the patient's oxygen saturation and pulse rate. A pulse oximeter is described in U.S. Pat. No. 5,632,272 assigned to the assignee of the present invention.

SUMMARY OF THE INVENTION

The present invention provides a number of improvements that can be incorporated into a pulse oximeter probe to detect when a probe has become dislodged from a patient and/or to prevent a probe-off condition. A probe-off condition occurs when the optical probe becomes partially or completely dislodged from the patient, but may continue to detect an AC signal within the operating region of the pulse oximeter.

In one aspect, the present invention provides a number of electrical contacts that contact the skin of a patient when the probe is properly attached. The pulse oximeter can check the continuity through the contacts to determine whether the probe is properly attached. If the probe is not properly attached, the pulse oximeter can identify a probe-off condition even though the oximeter measures an AC signal that appears like the probe is still attached.

In another aspect, the present invention provides a number of louvers placed in front of the probe's photodetector to filter out oblique light rays that do not originate from a point in front of the detector. If the probe becomes dislodged, the emitter will not likely remain in front of the photodetector. If the emitter and photodetector are not properly aligned, the photodetector will not produce a signal within the valid operating range of the pulse oximeter. The louvers prevent light from an oblique angle from reaching the photodetector and creating a false signal that might be interpreted by the pulse oximeter as a physiological signal. Accordingly, the pulse oximeter can determine that a probe has become dislodged when the photodetector does not produce a valid signal. Furthermore, probe-off conditions can avoided since oblique light rays are not able to reach the photodetector to produce an apparently valid signal.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings in which like reference numbers represent corresponding components throughout:

FIG. **1** illustrates a schematic of one embodiment of a pulse oximeter system;

FIGS. **2**A–B depict an optical probe and the attachment of the optical probe on the fingertip of an adult patient;

FIG. **3**A illustrates a schematic of a pulse oximeter system that incorporates electrical contacts to the skin of a patient, in accordance with one embodimet of the present invention;

FIG. **3**B illustrates a perspective view of an optical probe incorporating electrical contacts to the skin of a patient;

FIG. **3**C illustrates a schematic of one embodiment of a pulse oximeter system that incorporates electrical contacts to the skin of a patient;

FIG. **3**D illustrates a schematic of a preferred embodiment of a pulse oximeter system that incorporates a number of electrical contacts to the skin of a patient;

FIG. **3**E depicts a generalized schematic of a pulse oximeter that incorporates another embodiment of a contact on a pulse oximeter probe;

FIG. **3**F depicts a perspective view an optical probe incorporating the embodiment of FIG. **3**E;

FIG. **3**G depicts a generalized schematic of a pulse oximeter system that incorporates another embodiment of a contact sensor in accordance with the present invention;

FIG. **3**H depicts a perspective view of an optical probe incorporating the contact sensor of FIG. **3**G;

FIG. **4** illustrates a probe that has become unfastened;

FIG. **5**A illustrates a probe wherein a number of louvers are placed in front of the detector assembly;

FIG. **5**B illustrates a properly attached probe wherein a number of louvers are placed in front of the detector assembly;

FIG. **5**C illustrates a top plan view of a preferred embodiment of a probe wherein a number of louvers are placed in front of the detector assembly

FIG. **6** illustrates a flow chart of the method of detecting a dislodged probe.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

To compute peripheral arterial oxygen saturation, denoted Sp_aO_2, pulse oximetry relies on the differential light absorption of oxygenated hemoglobin, HbO_2, and deoxygenated hemoglobin, Hb. This differential absorption is measured at the red and infrared wavelengths of the probe. In addition, pulse oximetry relies on the pulsatile nature of arterial blood to differentiate hemoglobin absorption from absorption of other constituents in the surrounding tissues. Light absorption between systole and diastole varies due to the blood volume change from the inflow and outflow of arterial blood at a peripheral tissue site. The tissue site might also comprise skin, muscle, bone, venous blood, fat, pigment, etc., each of which absorbs light. Blood oxygen saturation measurements are based upon a ratio of the time-varying or AC portion of the detected red and infrared signals with respect to the time-invariant or DC portion. This AC/DC ratio normalizes the signals and accounts for variations in light pathlengths through the measured tissue.

As reproduced in FIG. **1**, a schematic of one embodiment of a pulse oximeter system **100** is disclosed in U.S. Pat. No. 5,758,644 (the '644 patent), assigned to the assignee of the present application and incorporated herein by reference. The system **100** comprises a pulse oximeter **140**, which is attached through a connector **142** to a probe **110**. The probe **110** comprises a first LED **112**, a second LED **114** and a photodetector **116**. The first and second LEDs **112** and **114** are connected back-to-back and share a common electrical connection **118**. The photodetector **116** has its own electrical connection **122**. Each of the LEDs **112** and **114** and the photodetector **116** are connected at their outputs to a common ground electrical connection **130**. The two LEDs **112** and **114** are preferably configured to produce different wavelengths of light, which pass through the flesh of a patient to be detected by the photodetector **116**. The oximeter **140** can select the LED to be driven by applying either a positive or negative voltage to the connection **118**. A coding resistor **132** has a resistance that can measured by the pulse oximeter **140** to determine the particular characteristics of the probe **110**. The coding resistor **132** is coupled in parallel with the first LED **112** or the second LED **114**. The resistor **132** can be used to indicate the operating wavelength of the first and second LEDs **112** and **114**, or to indicate the type of probe. In order to read the coding resistor **132**, the pulse oximeter **140** drives the first LED **112**/coding resistor **132** combination at a level that is low enough that the LED draws insignificant current. At this level, significantly all of the current flows through the coding resistor **132** and the pulse oximeter **140** can determine the value of the resistor in accordance with Ohm's law. By configuring the coding resistor **132** in parallel with one of the LEDs **112**, **114**, the added expense of an additional lead connecting the pulse oximeter **140** to the probe **110** can be saved.

One embodiment of a disposable probe for use with pulse oximetry systems is disclosed in U.S. Pat. No. 5,782,757, assigned to the assignee of the present application and incorporated herein by reference. FIGS. **2**A–B depict the optical probe **202** and the attachment of the optical probe **202** on the fingertip **250** of an adult patient. The disposable optical probe **202** is designed to fit comfortably onto a patient's fingertip. As illustrated in FIG. **2**A, the probe **202** includes a central portion **204**, a pair of adhesive flanges **205** extending from the central portion **204**, a connector portion **210** situated between the flanges **205**, and a pair of smaller adhesive flaps **215** extending from the central portion **204** on the end of the optical probe **202** opposite from a connector tab **210**. The probe **202** further includes an emitter aperture **220** with a number of emitters (e.g., a light-emitting diodes) positioned within the central portion **204** close to the connector portion **210**, and a detector aperture **230** which allows light to pass through the detector aperture **230** to a detector assembly **235**. An adult fingertip **250** is shown in phantom in FIG. **2**A to illustrate the position at which the fingertip **250** is placed when the probe **202** is to be fastened onto the fingertip **250** for use. Although not depicted specifically in FIGS. **2**A–2B, the probe **202** is typically fabricated from multiple layers.

FIG. **2**B illustrates the probe **202** fastened onto the fingertip **250**. As shown in FIG. **2**B, the probe **202** folds to conform to the very end of the fingertip. The adhesive flaps **205** fold downward (in the illustration of FIG. **2**B) to wrap around the fingertip **250** while the adhesive flaps **215** fold upward (in the illustration of FIG. **2**B) about a portion of the circumference of the fingertip **250** to provide support. As shown in FIG. **2**B, when the probe **202** is folded about the fingertip **250**, the emitters located within the probe are spaced opposite the detector assembly **235** such that light from the emitters passes through the emitter aperture **220**, through the finger **250** and is incident upon the detector assembly **235** through the detector aperture **230**.

FIG. **2**B depicts a receiving connector portion **260** which engages with contacts **252** on the connector **210** to provide an electrical connection between the optical probe **202** and the pulse oximeter **140**. Once the optical probe **202** is securely fastened to the fingertip **250** and the connector **210** provides an electrical connection between the optical probe **202** and digital signal processing circuitry, signals are detected from the detector **235** and transmitted to the processing circuitry via the connector **260**.

A probe-off condition occurs when the optical probe becomes partially or completely dislodged from the patient, but continues to detect an AC signal within the operating region of the pulse oximeter. Probe-off errors are serious because the pulse oximeter may display a normal saturation when, in fact, the probe is not properly attached to the patient, potentially leading to missed desaturation events. Failure to detect a probe-off condition is the result of the probe detector receiving light directly from the emitters without transmission through the patient's tissue.

As illustrated in the schematic of FIG. **3**A, a first aspect of the present invention involves an optical probe **202** which incorporates a number of electrical contacts **341** and **342** that make contact to the skin of the patient when the probe **202** is properly secured. In order to detect a probe-off condition, a probe-off detector module **138** of the pulse oximeter **140** periodically applies a voltage across the contacts **341** and **342** or drives a current. A non-zero current indicates that the patient's skin **344** has closed the circuit between the contacts **341** and **342** and the probe **202** is properly secured. If the probe becomes dislodged, the patient's skin **344** is no longer be in contact with the contacts **341** and **342**, resulting in an open circuit.

FIG. **3**B illustrates one preferred embodiment of an optical probe **202** incorporating one embodiment of the present invention. The present embodiment incorporates a first electrical contact **341** and a second electrical contact **342** in the surface **306** of the central portion **204** of the probe **202**. The electrical contacts **341** and **342** are positioned in a location such that contact to a finger or flesh portion of the patient is ensured when the probe **202** is properly attached. In the illustrated embodiment, the contacts **341** and **342** are located

proximate the detector aperture **203**. In another embodiment, contacts **341** and **342** are on opposite sides of the detector aperture **203**. The optical probe **202** also has an emitter aperture **220** through which light of at least two wavelengths passes from LEDs.

As illustrated in the schematic diagram of FIG. **3**C, the pulse oximeter system **100** of FIG. **1** can be modified to incorporate the first aspect of the present invention by extending an additional lead **324** through the connector **142** to the probe **202**. The additional lead can be connected to one contact **341** while the second contact **342** can be wired to the common ground lead **130**.

A schematic diagram of another embodiment of the present invention is illustrated in FIG. **3**D. The contacts **341** and **342** can be installed in line within the path of the coding resistor **132**. When the patient's skin **344** is in contact with the contacts **341** and **342**, the circuit through the coding resistor **132** will be closed; when the patient's skin **344** is not in contact with the contacts **341** and **342**, the circuit through the coding resistor **132** will be open. The skin **344** will have some finite resistance between the contacts **341** and **342** that will affect the measured resistance of the coding resistor. As the contacts **341** and **342** are installed in series with the coding resistor **132**, any resistance across the contacts **341** and **342** will be added to the resistance of the coding resistor **132** when the pulse oximeter **140** attempts to measure the resistance of the coding resistor **132**. The resistance of the skin **344** can effectively be ignored in the measurement of the coding resistor **132**, however, by choosing the value of the coding resistor **132** to be substantially larger than the resistance of a patient's skin **344** between the contacts **341** and **342**. Alternatively, the acceptable resistance for the coding resistor can be specified as in a range that includes the likely added resistance of the skin in the circuit. In the present configuration, the probe-off detector module **138** of the pulse oximeter **140** can verify that the optical probe **202** is properly secured simultaneously with checking the resistance of the coding resistor **132**. An open circuit indicates that the probe has become dislodged, whereas a valid resistance of a coding resistor **132** indicates a proper attachment of the probe **202**. If the probe has become dislodged, the pulse oximeter **140** can sound an alarm, display a warning message, or both.

The pulse oximeter **140** is particularly vulnerable to probe-off errors when operating at its highest sensitivity, where even small induced variations in light directly detected from the emitters have sufficient signal strength to be processed as a physiological signal. In a probe-off condition, a detector AC signal can be induced by slight changes in the direct light path between the emitters and the detector. For example, small amounts of patient motion, such as chest movement from breathing, can induce a probe-off AC signal. As another example, "creep" in the probe configuration, such as a folded probe gradually returning to its original unfolded shape after becoming dislodged can also induce a probe-off AC signal.

FIGS. **3**E and **3**F depict a generalized embodiment of the present invention with the same features as described in **3**A and **3**B, except that the electrical contacts **341**, **342** are replaced with a contact sensor **343**. The electrical contacts **341** and **342** comprise a specialized case of a contact sensor **343** where skin is involved. The contact sensor **343** may also comprise a piezoelectric sensor, a conductive contact sensor, or any other contact sensors which detect the contact of the tissue material.

FIGS. **3**G and **3**H depict yet another embodiment of the electrical contact based contact sensor of FIGS. **3**A and **3**B. FIG. **3**G depicts a schematic form with a pulse oximeter **140** and a probe off detector module. FIG. **3**H depicts a perspective view of the optical pulse oximeter probe haveing optical emitters and at least one detector. However, in this embodiment, electrical contact **341**A and electrical contact **342** are positioned opposite each other. The electrical contact **341**A is positioned near the emitter aperture **220**, so as to contact the portion of the tissue material near the emitter **220**. The electrical contact **342** is positioned near the detector aperture **203**. Similarly, other contact sensors could be positioned, one near the emitter aperture **220** and one near the detector aperture **203**.

In one embodiment the electrical contacts **341**, **342**, **341**A are metallic. In another embodiment, these contacts comprise conductive adhesive, or gel based contacts.

FIG. **4** illustrates a probe **202** that has become unfastened. The illustrated probe **202** is shown in a partially unfolded shape that provides an oblique path **410** from the emitter aperture **220** to the detector assembly **235**. As a patient moves, or as the probe **202** unfolds, rays of light travelling along the oblique light path **410** may generate an AC signal that could be interpreted by the pulse oximeter **140** as a physiological signal.

As illustrated in the cross section of FIG. **5**A, a number of louvers **502** are placed in front of the detector assembly **235** within the detector aperture **203** in accordance with a second aspect of the present invention. The louvers **502** block light rays travelling along an oblique path **410** (i.e., light that does not originate from in front of the detector assembly **235**). As illustrated in FIG. **5**B, if the probe **202** is properly attached, the emitter aperture **220** will be directly in front of the detector assembly **235** and light rays will pass directly through the louvers **502** along a direct path **510**.

FIG. **5**C illustrates a top plan view of a preferred embodiment of this aspect of the present invention. The detector aperture **2**o**3** is formed in a plastic body **504** having slots **506** to hold the louvers **502** in place across the detector aperture **203**. In a preferred embodiment of the present aspect, the louvers **502** can be created from commercially available "3M Light Control Film."

The louvers **502** of the present aspect advantageously provide a separate or improved method for the pulse oximeter **140** to determine when a probe has become dislodged through monitoring the signal produced by the photodetector **116**. If the probe **202** becomes improperly secured, the emitter aperture will likely move from its proper location directly above the detector assembly **235**, which will cause any oblique light rays to be blocked by the louvers **502**. With no light rays reaching the detector assembly **235**, the detector will produce no signal. The probe-off detector **138** of the pulse oximeter **140** can detect the lack of signal and sound an alarm. The louvers **502** also advantageously block oblique light rays that might create a false signal that could be interpreted by the pulse oximeter **140** to be a physiological signal. Accordingly, the louvers **502** reduce or eliminate the possibility of a probe-off condition. The louvers **502** may be used alone or in combination with the contacts described herein.

FIG. **6** illustrates one embodiment of a method **600** by which a pulse oximeter **140** detects a dislodged probe and/or a probe-off condition. At a step **604**, the probe off detector module **138** checks for continuity between the skin contacts **341** and **342**. If, at a step **608**, there is continuity between the contacts **341** and **342**, the oximeter **140** passes control to a step **612**. If, on the other hand, there is no continuity at the step **608**, the oximeter **140** passes control to a step **620**. At

step **620** the oximeter **140** sounds an alarm to alert a condition necessitating attention. At the step **612**, the oximeter **140** checks for a valid AC signal from the photodetector. If, at a step **616**, there is a valid signal, the oximeter **140** passes control back to the step **604** to start the cycle over again. If, on the other hand, there is no valid AC signal at the step **616** the oximeter sounds an alarm at the step **620**. Accordingly, the pulse oximeter checks for and detects dislodgment of a probe and/or a probe-off condition.

While certain exemplary preferred embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention. Further, it is to be understood that this invention shall not be limited to the specific construction and arrangements shown and described since various modifications or changes may occur without departing from the spirit and scope of the invention as claimed. It is intended that the scope of the invention be limited not by this detailed description but by the claims appended hereto.

What is claimed is:

1. A pulse oximetry probe comprising:

a flexible probe body configured to contact the skin of a patient on opposing surfaces of a body member of the patient when the probe body is properly affixed to the patient;

light emitting diodes incorporated into the probe body;

a light sensitive detector which detects light from a first direction originally emitted by the light emitting diodes, wherein the light comprises at least first and second wavelengths and has been transmitted through body tissue carrying pulsing blood; and

at least one structure positioned approximately parallel to the first direction and is configured to filter out light from reaching the light sensitive detector from a direction substantially different from the first direction.

2. The pulse oximetry probe of claim **1**, wherein the structure comprises one or more louvers.

3. The pulse oximetry probe of claim **1**, wherein the structure comprises a plurality of louvers.

4. The pulse oximetry probe of claim **1**, further comprising a coding resistor.

5. The pulse oximetry probe of claim **1**, further comprising an circuit configured to contact at least a portion of the body tissue.

6. The pulse oximetry probe of claim **1**, wherein the flexible probe body comprises a reusable optical probe.

7. The pulse oximetry probe of claim **1**, wherein the flexible probe body comprises a disposable optical probe.

8. The pulse oximetry probe of claim **1**, wherein the flexible probe body comprises reusable and disposable portions of an optical probe.

9. A pulse oximeter for processing signals received from an optical probe, the pulse oximeter comprising:

an input for receiving at least first and second intensity signals from a light-sensitive detector which detects light of at least first and second wavelengths transmitted through body tissue carrying pulsing blood; and

a signal processor which determines a probe-off condition when at least one of the first and second intensity signals is substantially attenuated.

10. The pulse oximeter of claim **9**, wherein the attenuation is caused by improper application an optical probe to the body tissue.

11. The pulse oximeter of claim **9**, further comprising an audio alarm indicating when the probe-off condition is determined.

12. The pulse oximeter of claim **9**, further comprising an visual alarm indicating when the probe-off condition is determined.

13. The pulse oximeter of claim **9**, further comprising a coding resistor.

14. The pulse oximeter of claim **9**, further comprising an circuit configured to contact at least a portion of the body tissue.

15. A sensor which generates at least first and second intensity signals from a light-sensitive detector which detects light of at least first and second wavelengths transmitted through body tissue carrying pulsing blood; the sensor comprising:

at least one light emission device;

a light sensitive detector; and

a plurality of louvers positioned over the light sensitive detector to accept light from the at least one light emission device originating from a general direction of the at least one light emission device and then transmitting through body tissue carrying pulsing blood, wherein the louvers accept the light when the sensor is properly applied to tissue of a patient.

16. A method of processing one or more signals to detect a condition of improper positioning of an optical probe, the method comprising:

expecting to receive at least first and second intensity signals from a light-sensitive detector which detects light of at least first and second wavelengths transmitted through body tissue carrying pulsing blood;

blocking light originating from an angle oblique to a proximate relationship between the detector and a light source; and

receiving one of an un-interpretable signal or signal other than the expected first and second intensity signals because the light is blocked; and

indicating a probe off condition.

17. The method of claim **16**, wherein the indicating comprises at least one of an audible or visual alarm.

18. The method of claim **16**, wherein blocking light comprises positioning a plurality of louvers between the light source and the light-sensitive detector.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,771,994 B2
APPLICATION NO. : 10/374303
DATED : August 3, 2004
INVENTOR(S) : Massi E. Kiani

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

At column 2, line 36, delete "embodimet" and insert -- embodiment --, therefore.

At column 6, line 3, delete "haveing" and insert -- having --, therefore.

Signed and Sealed this

Seventeenth Day of July, 2007

JON W. DUDAS
Director of the United States Patent and Trademark Office

PATENT APPLICATION SERIAL NO. 10/374,303

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

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PATENT

Attorney Docket No. MASIMO.172DV1
Date: February 24, 2003

United States Patent and Trademark Office
P.O. Box 2327
Arlington, VA 22202

ATTENTION: BOX PATENT APPLICATION

Sir:

Transmitted herewith for filing is the patent application of

Inventors: **Massi E. Kiani**
Laguna Niguel, CA

Mohamed K. Diab
Mission Viejo, CA

For:

PULSE OXIMETER PROBE-OFF DETECTION SYSTEM

This application is a divisional of U.S. Application Serial No. 09/595,081, filed on June 16, 2000, entitled *"Pulse Oximeter Probe-Off Detection System."*

Enclosed are:

(X) 15 sheets of drawing;

(X) a copy of the Declaration (2 pages), Recorded Assignment (3 pages), and Power of Attorney with copy of Assignment (4 pages) from parent patent application;

(X) 14 pages of specification;

(X) an Information Disclosure Statement (2 pages), and PTO Form 1449 (1 pages) with 16 references, one of which is being submitted;

(X) a check in the amount of $834 to cover the filing fee; and

(X) a return prepaid postcard.

CLAIMS AS FILED

FOR	NUMBER FILED	NUMBER EXTRA	RATE	FEE
Basic Fee			$750	$750
Total Claims	18 - 20 =	0 x	$18	$0
Independent Claims	4 - 3 =	1 x	$84	$84
If application contains any multiple dependent claims(s), then add			$280	$0
		TOTAL FILING FEE		$834

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

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CERTIFICATE OF MAILING BY "EXPRESS MAIL"

Attorney Docket No.:		MASIMO.172DV1
Applicants	:	Massi E. Kiani, Mohamed K. Diab
For	:	PULSE OXIMETER PROBE-OFF DETECTION SYSTEM
Attorney	:	John M. Grover
"Express Mail" Mailing Label No.	:	EV 211919815 US
Date of Deposit	:	February 24, 2003

I hereby certify that the accompanying

Transmittal Letter; Specification in 14 pages; 15 sheets of drawings; Copy of Declaration (2 pages), Copy of Recorded Assignment (3 pages), Copy of Power of Attorney Form with copy of Assignment (4 pages) from the parent patent Application; Information Disclosure Statement (2 pages); PTO Form 1449 with 16 references, one of which is being submitted; Check for Filing Fee; and Return Prepaid Postcard

are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and are addressed to the United States Patent and Trademark Office, P.O. Box 2327, Arlington, VA 22202.

John M. Grover

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012103

MASIMO.172DV1 PATENT

PULSE OXIMETER PROBE-OFF DETECTION SYSTEM

REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority benefit under 35 U.S.C. § 120 to, and is a divisional of, U.S. Patent Application No. 09/595,081, filed June 16, 2000, entitled "*Pulse Oximeter Probe-Off Detection System,*" which claims priority benefit under 35 U.S.C. § 119(e) from U.S. Provisional Application No. 60/140,000, filed June 18, 1999, entitled "*Pulse Oximeter Probe-Off Detection System.*" The present application also incorporates the foregoing utility disclosure herein by reference.

Pat. No. 6526,300,

mjk 4/2/2004

BACKGROUND OF THE INVENTION

[0002] The present invention relates to optical probes that can be attached to the finger, toe, or appendage of a patient. More particularly, the present invention relates to devices and methods for identifying when a probe has become dislodged from a patient.

DESCRIPTION OF THE RELATED ART

[0003] Oximetry is the measurement of the oxygen status of blood. Early detection of low blood oxygen is critical in the medical field, for example in critical care and surgical applications, because an insufficient oxygen supply can result in brain damage and death in a matter of minutes. Pulse oximetry is a widely accepted noninvasive procedure for measuring the oxygen saturation level of arterial blood, an indicator of oxygen supply. A pulse oximetry system generally consists of a probe attached to a patient, a monitor, and a cable connecting the probe and monitor. Conventionally, a pulse oximetry probe has both red and infrared (IR) light-emitting diode (LED) emitters and a photodiode detector. The probe is typically attached to a patient's finger or toe, or a very young patient's foot. For a finger, the probe is configured so that the emitters project light through the fingernail, the arteries, vessels, capillaries, tissue and bone. The photodiode is positioned opposite the LED so as to detect the LED transmitted light as it emerges from the finger tissues.

[0004] The pulse oximetry monitor (pulse oximeter) determines oxygen saturation by analyzing the differential absorption by arterial blood of the two wavelengths emitted by the probe. The pulse oximeter alternately activates the probe LED emitters and reads the resulting current generated by the photodiode detector. This current is proportional to the

intensity of the detected light. The pulse oximeter calculates a ratio of detected red and infrared intensities, and an arterial oxygen saturation value is empirically determined based on the ratio obtained. The pulse oximeter contains circuitry for controlling the probe, processing the probe signals and displaying the patient's oxygen saturation and pulse rate. A pulse oximeter is described in U.S. Patent 5,632,272 assigned to the assignee of the present invention.

SUMMARY OF THE INVENTION

[0005] The present invention provides a number of improvements that can be incorporated into a pulse oximeter probe to detect when a probe has become dislodged from a patient and/or to prevent a probe-off condition. A probe-off condition occurs when the optical probe becomes partially or completely dislodged from the patient, but may continue to detect an AC signal within the operating region of the pulse oximeter.

[0006] In one aspect, the present invention provides a number of electrical contacts that contact the skin of a patient when the probe is properly attached. The pulse oximeter can check the continuity through the contacts to determine whether the probe is properly attached. If the probe is not properly attached, the pulse oximeter can identify a probe-off condition even though the oximeter measures an AC signal that appears like the probe is still attached.

[0007] In another aspect, the present invention provides a number of louvers placed in front of the probe's photodetector to filter out oblique light rays that do not originate from a point in front of the detector. If the probe becomes dislodged, the emitter will not likely remain in front of the photodetector. If the emitter and photodetector are not properly aligned, the photodetector will not produce a signal within the valid operating range of the pulse oximeter. The louvers prevent light from an oblique angle from reaching the photodetector and creating a false signal that might be interpreted by the pulse oximeter as a physiological signal. Accordingly, the pulse oximeter can determine that a probe has become dislodged when the photodetector does not produce a valid signal. Furthermore, probe-off conditions can avoided since oblique light rays are not able to reach the photodetector to produce an apparently valid signal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Referring now to the drawings in which like reference numbers represent corresponding components throughout:

[0009] Figure 1 illustrates a schematic of one embodiment of a pulse oximeter system;

[0010] Figures 2A-B depict an optical probe and the attachment of the optical probe on the fingertip of an adult patient;

[0011] Figure 3A illustrates a schematic of a pulse oximeter system that incorporates electrical contacts to the skin of a patient, in accordance with one embodimet of the present invention;

[0012] Figure 3B illustrates a perspective view of an optical probe incorporating electrical contacts to the skin of a patient;

[0013] Figure 3C illustrates a schematic of one embodiment of a pulse oximeter system that incorporates electrical contacts to the skin of a patient;

[0014] Figure 3D illustrates a schematic of a preferred embodiment of a pulse oximeter system that incorporates a number of electrical contacts to the skin of a patient;

[0015] Figure 3E depicts a generalized schematic of a pulse oximeter that incorporates another embodiment of a contact on a pulse oximeter probe;

[0016] Figure 3F depicts a perspective view an optical probe incorporating the embodiment of Figure 3E;

[0017] Figure 3G depicts a generalized schematic of a pulse oximeter system that incorporates another embodiment of a contact sensor in accordance with the present invention;

[0018] Figure 3H depicts a perspective view of an optical probe incorporating the contact sensor of Figure 3G;

[0019] Figure 4 illustrates a probe that has become unfastened;

[0020] Figure 5A illustrates a probe wherein a number of louvers are placed in front of the detector assembly;

[0021] Figure 5B illustrates a properly attached probe wherein a number of louvers are placed in front of the detector assembly;

[0022] Figure 5C illustrates a top plan view of a preferred embodiment of a probe wherein a number of louvers are placed in front of the detector assembly

[0023] Figure 6 illustrates a flow chart of the method of detecting a dislodged probe.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0024] To compute peripheral arterial oxygen saturation, denoted Sp_aO_2, pulse oximetry relies on the differential light absorption of oxygenated hemoglobin, HbO_2, and deoxygenated hemoglobin, Hb. This differential absorption is measured at the red and infrared wavelengths of the probe. In addition, pulse oximetry relies on the pulsatile nature of arterial blood to differentiate hemoglobin absorption from absorption of other constituents in the surrounding tissues. Light absorption between systole and diastole varies due to the blood volume change from the inflow and outflow of arterial blood at a peripheral tissue site. The tissue site might also comprise skin, muscle, bone, venous blood, fat, pigment, etc., each of which absorbs light. Blood oxygen saturation measurements are based upon a ratio of the time-varying or AC portion of the detected red and infrared signals with respect to the time-invariant or DC portion. This AC/DC ratio normalizes the signals and accounts for variations in light pathlengths through the measured tissue.

[0025] As reproduced in Figure 1, a schematic of one embodiment of a pulse oximeter system 100 is disclosed in U.S. Patent 5,758,644 (the '644 patent), assigned to the assignee of the present application and incorporated herein by reference. The system 100 comprises a pulse oximeter 140, which is attached through a connector 142 to a probe 110. The probe 110 comprises a first LED 112, a second LED 114 and a photodetector 116. The first and second LEDs 112 and 114 are connected back-to-back and share a common electrical connection 118. The photodetector 116 has its own electrical connection 122. Each of the LEDs 112 and 114 and the photodetector 116 are connected at their outputs to a common ground electrical connection 130. The two LEDs 112 and 114 are preferably configured to produce different wavelengths of light, which pass through the flesh of a patient to be detected by the photodetector 116. The oximeter 140 can select the LED to be driven by applying either a positive or negative voltage to the connection 118. A coding resistor 132 has a resistance that can measured by the pulse oximeter 140 to determine the

particular characteristics of the probe 110. The coding resistor 132 is coupled in parallel with the first LED 112 or the second LED 114. The resistor 132 can be used to indicate the operating wavelength of the first and second LEDs 112 and 114, or to indicate the type of probe. In order to read the coding resistor 132, the pulse oximeter 140 drives the first LED 112/coding resistor 132 combination at a level that is low enough that the LED draws insignificant current. At this level, significantly all of the current flows through the coding resistor 132 and the pulse oximeter 140 can determine the value of the resistor in accordance with Ohm's law. By configuring the coding resistor 132 in parallel with one of the LEDs 112, 114, the added expense of an additional lead connecting the pulse oximeter 140 to the probe 110 can be saved.

[0026] One embodiment of a disposable probe for use with pulse oximetry systems is disclosed in U.S. Patent 5,782,757, assigned to the assignee of the present application and incorporated herein by reference. Figures 2A-B depict the optical probe 202 and the attachment of the optical probe 202 on the fingertip 250 of an adult patient. The disposable optical probe 202 is designed to fit comfortably onto a patient's fingertip. As illustrated in Figure 2A, the probe 202 includes a central portion 204, a pair of adhesive flanges 205 extending from the central portion 204, a connector portion 210 situated between the flanges 205, and a pair of smaller adhesive flaps 215 extending from the central portion 204 on the end of the optical probe 202 opposite from a connector tab 210. The probe 202 further includes an emitter aperture 220 with a number of emitters (e.g., a light-emitting diodes) positioned within the central portion 204 close to the connector portion 210, and a detector aperture 230 which allows light to pass through the detector aperture 230 to a detector assembly 235. An adult fingertip 250 is shown in phantom in Figure 2A to illustrate the position at which the fingertip 250 is placed when the probe 202 is to be fastened onto the fingertip 250 for use. Although not depicted specifically in Figures 2A-2B, the probe 202 is typically fabricated from multiple layers.

[0027] Figure 2B illustrates the probe 202 fastened onto the fingertip 250. As shown in Figure 2B, the probe 202 folds to conform to the very end of the fingertip. The adhesive flaps 205 fold downward (in the illustration of Figure 2B) to wrap around the fingertip 250 while the adhesive flaps 215 fold upward (in the illustration of Figure 2B) about

a portion of the circumference of the fingertip 250 to provide support. As shown in Figure 2B, when the probe 202 is folded about the fingertip 250, the emitters located within the probe are spaced opposite the detector assembly 235 such that light from the emitters passes through the emitter aperture 220, through the finger 250 and is incident upon the detector assembly 235 through the detector aperture 230.

[0028] Figure 2B depicts a receiving connector portion 260 which engages with contacts 252 on the connector 210 to provide an electrical connection between the optical probe 202 and the pulse oximeter 140. Once the optical probe 202 is securely fastened to the fingertip 250 and the connector 210 provides an electrical connection between the optical probe 202 and digital signal processing circuitry, signals are detected from the detector 235 and transmitted to the processing circuitry via the connector 260.

[0029] A probe-off condition occurs when the optical probe becomes partially or completely dislodged from the patient, but continues to detect an AC signal within the operating region of the pulse oximeter. Probe-off errors are serious because the pulse oximeter may display a normal saturation when, in fact, the probe is not properly attached to the patient, potentially leading to missed desaturation events. Failure to detect a probe-off condition is the result of the probe detector receiving light directly from the emitters without transmission through the patient's tissue.

[0030] As illustrated in the schematic of Figure 3A, a first aspect of the present invention involves an optical probe 202 which incorporates a number of electrical contacts 341 and 342 that make contact to the skin of the patient when the probe 202 is properly secured. In order to detect a probe-off condition, a probe-off detector module 138 of the pulse oximeter 140 periodically applies a voltage across the contacts 341 and 342 or drives a current. A non-zero current indicates that the patient's skin 344 has closed the circuit between the contacts 341 and 342 and the probe 202 is properly secured. If the probe becomes dislodged, the patient's skin 344 is no longer be in contact with the contacts 341 and 342, resulting in an open circuit.

[0031] Figure 3B illustrates one preferred embodiment of an optical probe 202 incorporating one embodiment of the present invention. The present embodiment incorporates a first electrical contact 341 and a second electrical contact 342 in the surface

306 of the central portion 204 of the probe 202. The electrical contacts 341 and 342 are positioned in a location such that contact to a finger or flesh portion of the patient is ensured when the probe 202 is properly attached. In the illustrated embodiment, the contacts 341 and 342 are located proximate the detector aperture 203. In another embodiment, contacts 341 and 342 are on opposite sides of the detector aperture 203. The optical probe 202 also has an emitter aperture 220 through which light of at least two wavelengths passes from LEDs.

[0032] As illustrated in the schematic diagram of Figure 3C, the pulse oximeter system 100 of Figure 1 can be modified to incorporate the first aspect of the present invention by extending an additional lead 324 through the connector 142 to the probe 202. The additional lead can be connected to one contact 341 while the second contact 342 can be wired to the common ground lead 130.

[0033] A schematic diagram of another embodiment of the present invention is illustrated in Figure 3D. The contacts 341 and 342 can be installed in line within the path of the coding resistor 132. When the patient's skin 344 is in contact with the contacts 341 and 342, the circuit through the coding resistor 132 will be closed; when the patient's skin 344 is not in contact with the contacts 341 and 342, the circuit through the coding resistor 132 will be open. The skin 344 will have some finite resistance between the contacts 341 and 342 that will affect the measured resistance of the coding resistor. As the contacts 341 and 342 are installed in series with the coding resistor 132, any resistance across the contacts 341 and 342 will be added to the resistance of the coding resistor 132 when the pulse oximeter 140 attempts to measure the resistance of the coding resistor 132. The resistance of the skin 344 can effectively be ignored in the measurement of the coding resistor 132, however, by choosing the value of the coding resistor 132 to be substantially larger than the resistance of a patient's skin 344 between the contacts 341 and 342. Alternatively, the acceptable resistance for the coding resistor can be specified as in a range that includes the likely added resistance of the skin in the circuit. In the present configuration, the probe-off detector module 138 of the pulse oximeter 140 can verify that the optical probe 202 is properly secured simultaneously with checking the resistance of the coding resistor 132. An open circuit indicates that the probe has become dislodged, whereas a valid resistance of a coding resistor

132 indicates a proper attachment of the probe 202. If the probe has become dislodged, the pulse oximeter 140 can sound an alarm, display a warning message, or both.

[0034] The pulse oximeter 140 is particularly vulnerable to probe-off errors when operating at its highest sensitivity, where even small induced variations in light directly detected from the emitters have sufficient signal strength to be processed as a physiological signal. In a probe-off condition, a detector AC signal can be induced by slight changes in the direct light path between the emitters and the detector. For example, small amounts of patient motion, such as chest movement from breathing, can induce a probe-off AC signal. As another example, "creep" in the probe configuration, such as a folded probe gradually returning to its original unfolded shape after becoming dislodged can also induce a probe-off AC signal.

[0035] Figures 3E and 3F depict a generalized embodiment of the present invention with the same features as described in 3A and 3B, except that the electrical contacts 341, 342 are replaced with a contact sensor 343. The electrical contacts 341 and 342 comprise a specialized case of a contact sensor 343 where skin is involved. The contact sensor 343 may also comprise a piezoelectric sensor, a conductive contact sensor, or any other contact sensors which detect the contact of the tissue material.

[0036] Figures 3G and 3H depict yet another embodiment of the electrical contact based contact sensor of Figures 3A and 3B. Figure 3G depicts a schematic form with a pulse oximeter 140 and a probe off detector module. Figure 3H depicts a perspective view of the optical pulse oximeter probe haveing optical emitters and at least one detector. However, in this embodiment, electrical contact 341A and electrical contact 342 are positioned opposite each other. The electrical contact 341A is positioned near the emitter aperture 220, so as to contact the portion of the tissue material near the emitter 220. The electrical contact 342 is positioned near the detector aperture 203. Similarly, other contact sensors could be positioned, one near the emitter aperture 220 and one near the detector aperture 203.

[0037] In one embodiment the electrical contacts 341, 342, 341A are metallic. In another embodiment, these contacts comprise conductive adhesive, or gel based contacts.

[0038] Figure 4 illustrates a probe 202 that has become unfastened. The illustrated probe 202 is shown in a partially unfolded shape that provides an oblique path 410

from the emitter aperture 220 to the detector assembly 235. As a patient moves, or as the probe 202 unfolds, rays of light travelling along the oblique light path 410 may generate an AC signal that could be interpreted by the pulse oximeter 140 as a physiological signal.

[0039] As illustrated in the cross section of Figure 5A, a number of louvers 502 are placed in front of the detector assembly 235 within the detector aperture 203 in accordance with a second aspect of the present invention. The louvers 502 block light rays travelling along an oblique path 410 (i.e., light that does not originate from in front of the detector assembly 235). As illustrated in Figure 5B, if the probe 202 is properly attached, the emitter aperture 220 will be directly in front of the detector assembly 235 and light rays will pass directly through the louvers 502 along a direct path 510.

[0040] Figure 5C illustrates a top plan view of a preferred embodiment of this aspect of the present invention. The detector aperture 2o3 is formed in a plastic body 504 having slots 506 to hold the louvers 502 in place across the detector aperture 203. In a preferred embodiment of the present aspect, the louvers 502 can be created from commercially available "3M Light Control Film."

[0041] The louvers 502 of the present aspect advantageously provide a separate or improved method for the pulse oximeter 140 to determine when a probe has become dislodged through monitoring the signal produced by the photodetector 116. If the probe 202 becomes improperly secured, the emitter aperture will likely move from its proper location directly above the detector assembly 235, which will cause any oblique light rays to be blocked by the louvers 502. With no light rays reaching the detector assembly 235, the detector will produce no signal. The probe-off detector 138 of the pulse oximeter 140 can detect the lack of signal and sound an alarm. The louvers 502 also advantageously block oblique light rays that might create a false signal that could be interpreted by the pulse oximeter 140 to be a physiological signal. Accordingly, the louvers 502 reduce or eliminate the possibility of a probe-off condition. The louvers 502 may be used alone or in combination with the contacts described herein.

[0042] Figure 6 illustrates one embodiment of a method 600 by which a pulse oximeter 140 detects a dislodged probe and/or a probe-off condition. At a step 604, the probe off detector module 138 checks for continuity between the skin contacts 341 and 342. If, at a

step 608, there is continuity between the contacts 341 and 342, the oximeter 140 passes control to a step 612. If, on the other hand, there is no continuity at the step 608, the oximeter 140 passes control to a step 620. At step 620 the oximeter 140 sounds an alarm to alert a condition necessitating attention. At the step 612, the oximeter 140 checks for a valid AC signal from the photodetector. If, at a step 616, there is a valid signal, the oximeter 140 passes control back to the step 604 to start the cycle over again. If, on the other hand, there is no valid AC signal at the step 616 the oximeter sounds an alarm at the step 620. Accordingly, the pulse oximeter checks for and detects dislodgment of a probe and/or a probe-off condition.

[0043] While certain exemplary preferred embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention. Further, it is to be understood that this invention shall not be limited to the specific construction and arrangements shown and described since various modifications or changes may occur without departing from the spirit and scope of the invention as claimed. It is intended that the scope of the invention be limited not by this detailed description but by the claims appended hereto.

WHAT IS CLAIMED IS:

1. A pulse oximetry probe comprising:

a flexible probe body configured to contact the skin of a patient on opposing surfaces of a body member of the patient when the probe body is properly affixed to the patient;

light emitting diodes incorporated into the probe body;

a light sensitive detector which detects light from a first direction originally emitted by the light emitting diodes, wherein the light comprises at least first and second wavelengths and has been transmitted through body tissue carrying pulsing blood; and

at least one structure positioned approximately parallel to the first direction and is configured to filter out light from reaching the light sensitive detector from a direction substantially different from the first direction.

2. The pulse oximetry probe of Claim 1, wherein the structure comprises one or more louvers.

3. The pulse oximetry probe of Claim 1, wherein the structure comprises a plurality of louvers.

4. The pulse oximetry probe of Claim 1, further comprising a coding resistor.

5. The pulse oximetry probe of Claim 1, further comprising an circuit configured to contact at least a portion of the body tissue.

6. The pulse oximetry probe of Claim 1, wherein the flexible probe body comprises a reusable optical probe.

7. The pulse oximetry probe of Claim 1, wherein the flexible probe body comprises a disposable optical probe.

8. The pulse oximetry probe of Claim 1, wherein the flexible probe body comprises reusable and disposable portions of an optical probe.

9. A pulse oximeter for processing signals received from an optical probe, the pulse oximeter comprising:

an input for receiving at least first and second intensity signals from a light-sensitive detector which detects light of at least first and second wavelengths transmitted through body tissue carrying pulsing blood; and

a signal processor which determines a probe-off condition when at least one of the first and second intensity signals is substantially attenuated.

10. The pulse oximeter of Claim 9, wherein the attenuation is caused by improper application an optical probe to the body tissue.

11. The pulse oximeter of Claim 9, further comprising an audio alarm indicating when the probe-off condition is determined.

12. The pulse oximeter of Claim 9, further comprising an visual alarm indicating when the probe-off condition is determined.

13. The pulse oximeter of Claim 9, further comprising a coding resistor.

14. The pulse oximeter of Claim 9, further comprising an circuit configured to contact at least a portion of the body tissue .

15. A sensor which generates at least first and second intensity signals from a light-sensitive detector which detects light of at least first and second wavelengths transmitted through body tissue carrying pulsing blood; the sensor comprising:

at least one light emission device;

a light sensitive detector; and

a plurality of louvers positioned over the light sensitive detector to accept light from the at least one light emission device originating from a general direction of the at least one light emission device and then transmitting through body tissue carrying pulsing blood, wherein the louvers accept the light when the sensor is properly applied to tissue of a patient.

16. A method of processing one or more signals to detect a condition of improper positioning of an optical probe, the method comprising:

expecting to receive at least first and second intensity signals from a light-sensitive detector which detects light of at least first and second wavelengths transmitted through body tissue carrying pulsing blood;

blocking light originating from an angle oblique to a proximate relationship between the detector and a light source; and

receiving one of an un-interpretable signal or signal other than the expected first and second intensity signals because the light is blocked; and

indicating a probe off condition.

17. The method of Claim 16, wherein the indicating comprises at least one of an audible or visual alarm.

18. The method of Claim 16, wherein blocking light comprises positioning a plurality of louvers between the light source and the light-sensitive detector.

PULSE OXIMETER PROBE-OFF DETECTION SYSTEM

ABSTRACT OF THE DISCLOSURE

The present invention provides a number of improvements that can be incorporated into a pulse oximeter probe to detect when a probe has become dislodged from a patient and/or to prevent a probe-off condition. A probe-off condition occurs when the optical probe becomes partially or completely dislodged from the patient, but continues to detect an AC signal within the operating region of the pulse oximeter. In one aspect, the present invention provides electrical contacts that contact the skin of a patient when the probe is properly attached. In another aspect, the present invention provides a number of louvers placed in front of the sensor's photodetector to filter out oblique light rays that do not originate from a point in front of the detector. Accordingly, if the emitter and photodetector are not properly aligned, the photodetector will not produce a signal within the valid operating range of the pulse oximeter. In accordance with a method of the present invention the pulse oximeter can sound an alarm or display a warning if it determines that the probe is not properly attached to the patient.

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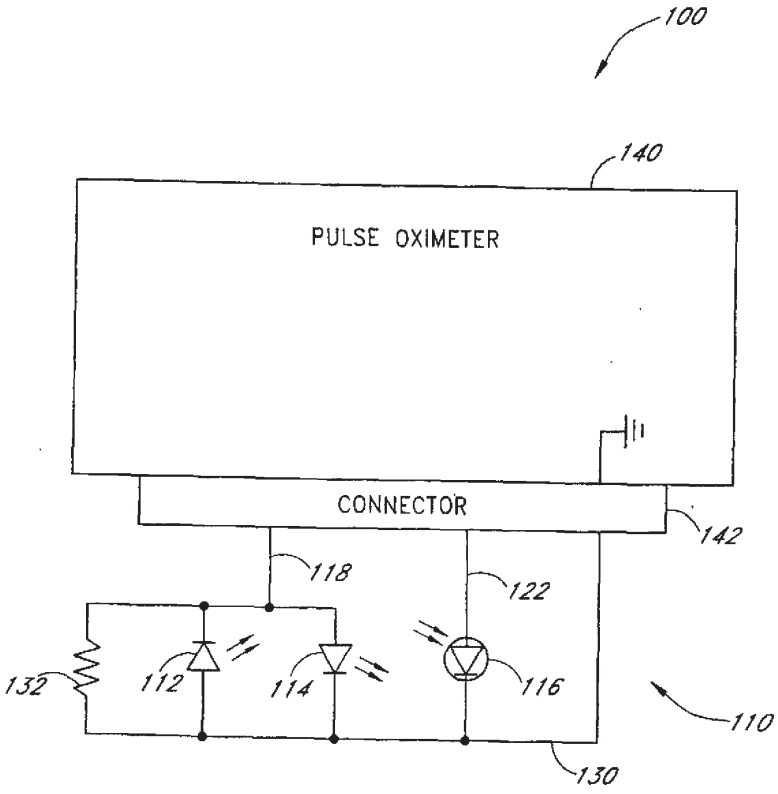
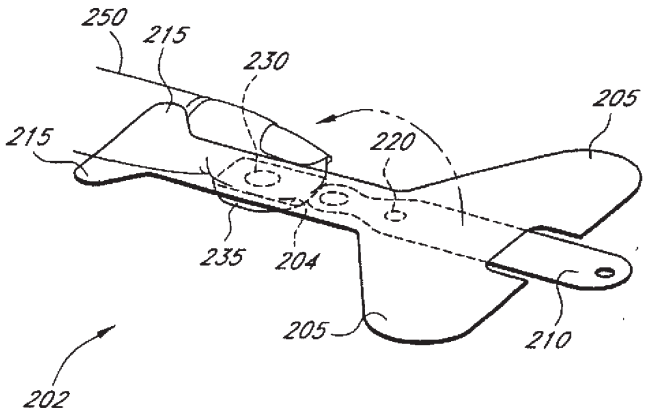


FIG. 1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215
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235
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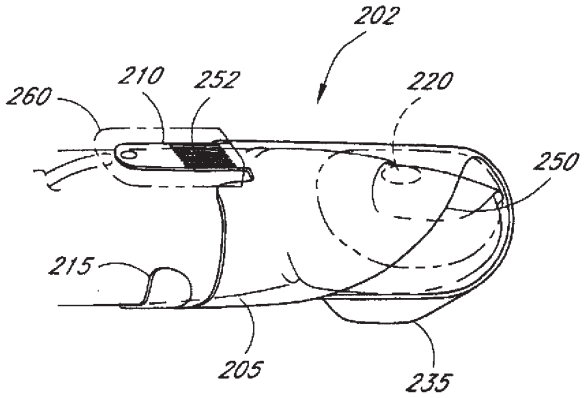
210
202

FIG. 2A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235

FIG. 2B

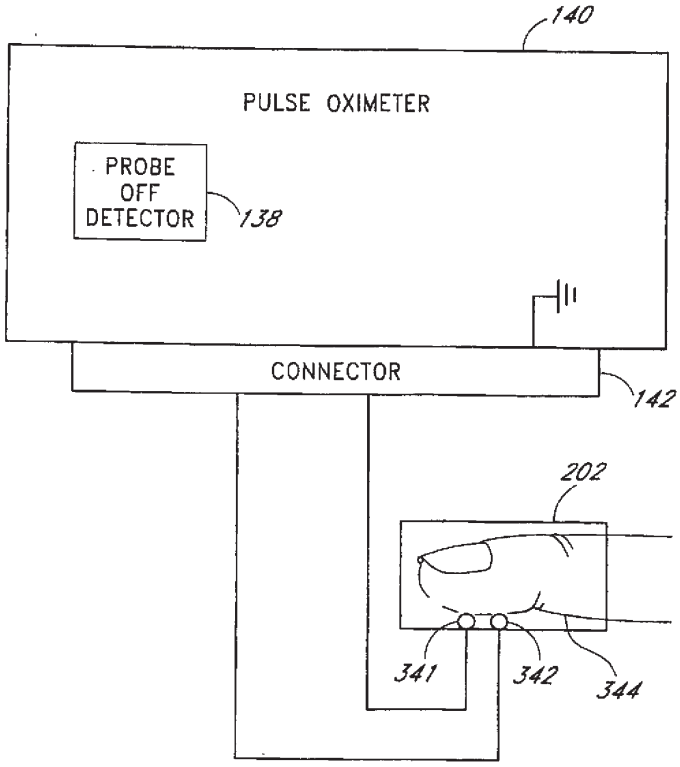

140
PULSE OXIMETER
PROBE OFF DETECTOR
138
CONNECTOR
142
202
341
342
344

FIG. 3A

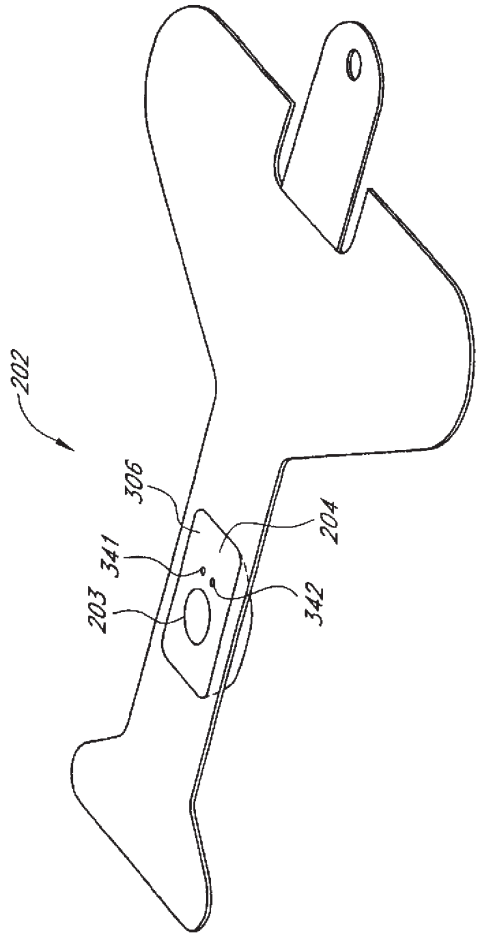
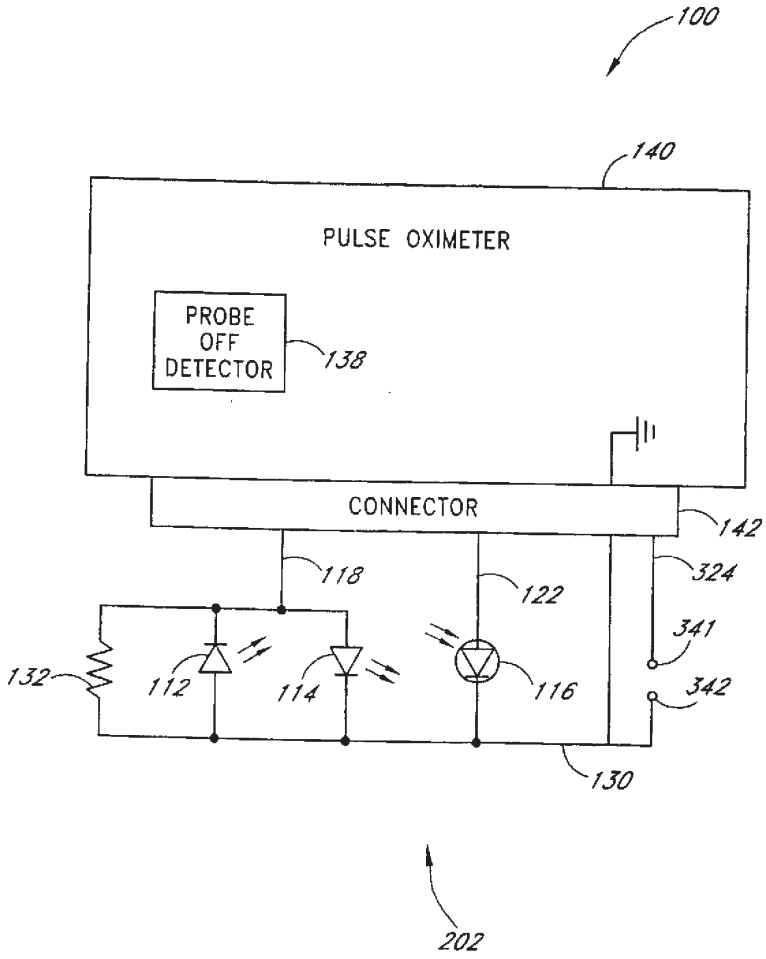


FIG.3B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PROBE OFF DETECTOR
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CONNECTOR
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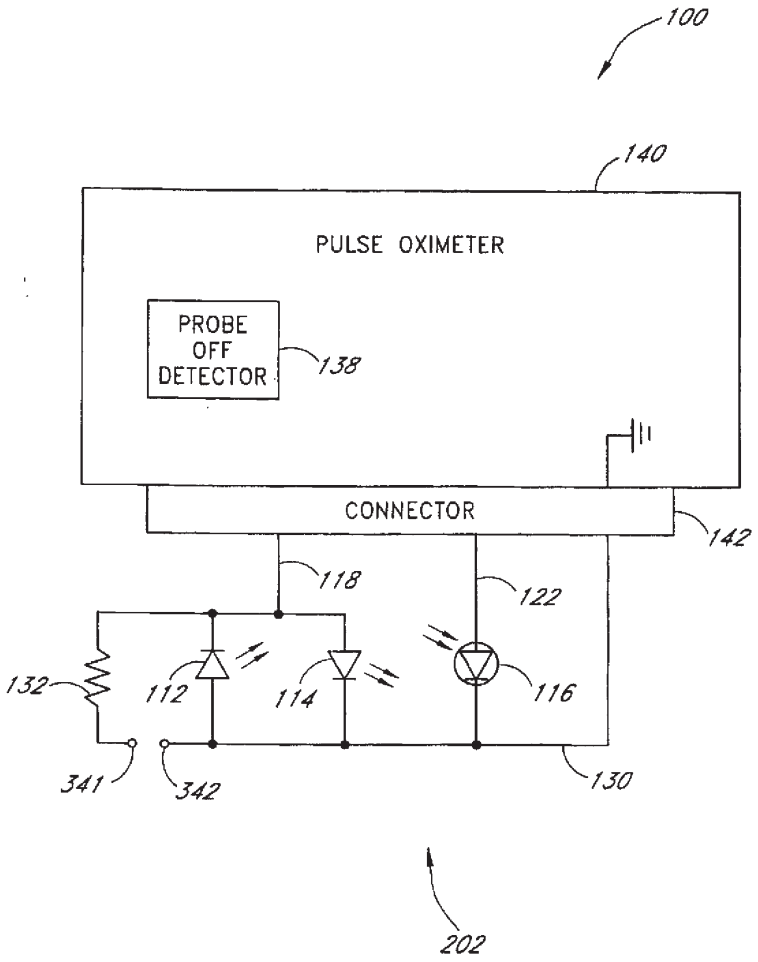
202

FIG.3C


100
140
PULSE OXIMETER
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138
CONNECTOR
142
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122
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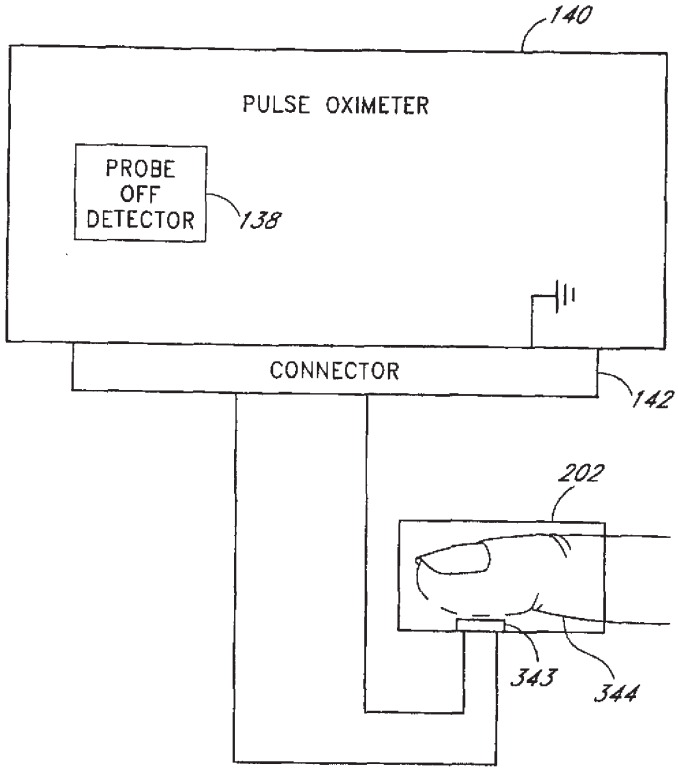
130
202

FIG. 3D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PROBE OFF DETECTOR
138
CONNECTOR
142
202
343
344

FIG.3E

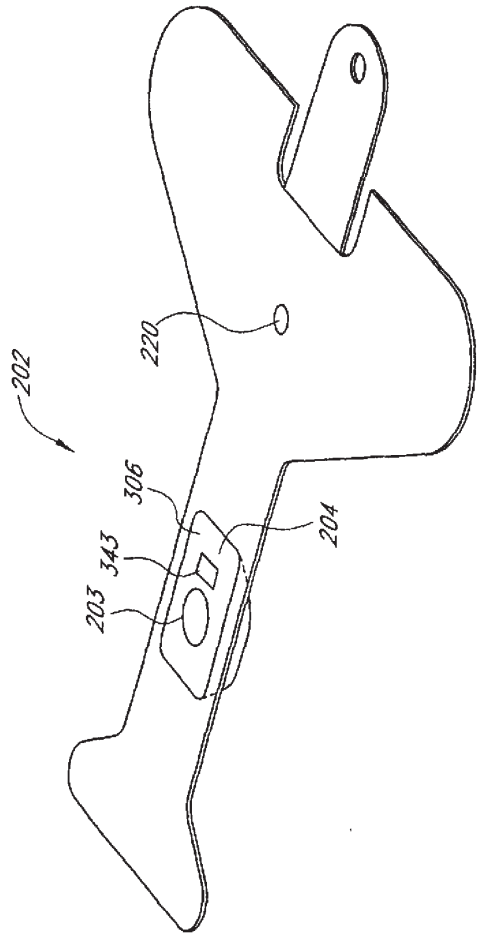
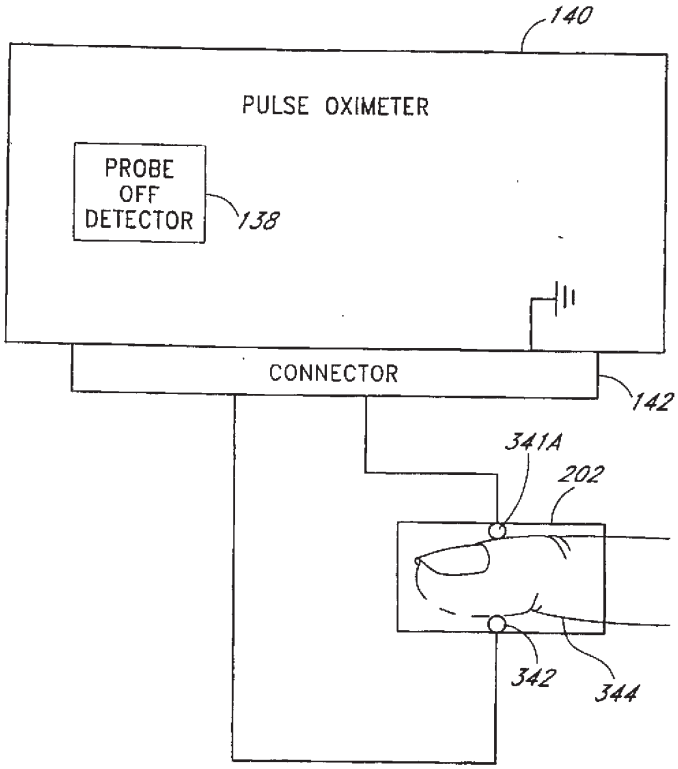


FIG. 3F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PROBE
OFF
DETECTOR
138
CONNECTOR
142
341A
202
342
344

FIG. 3G

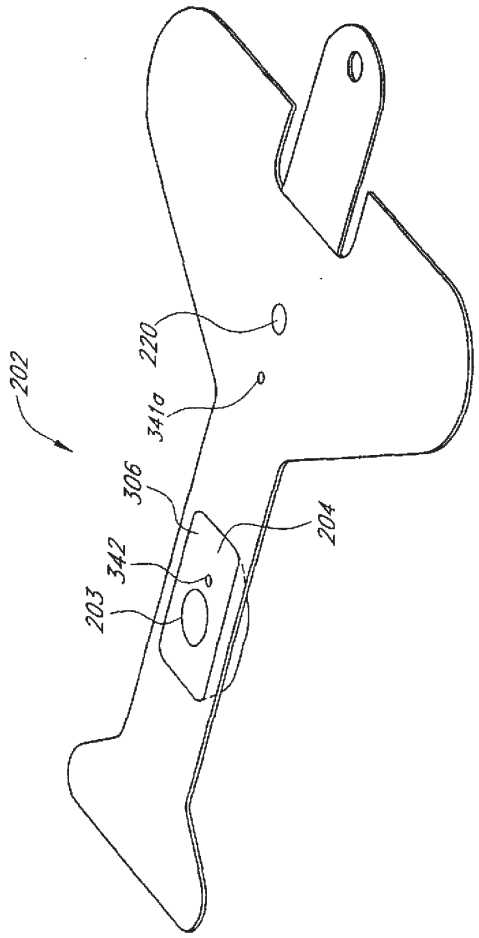


FIG. 3H

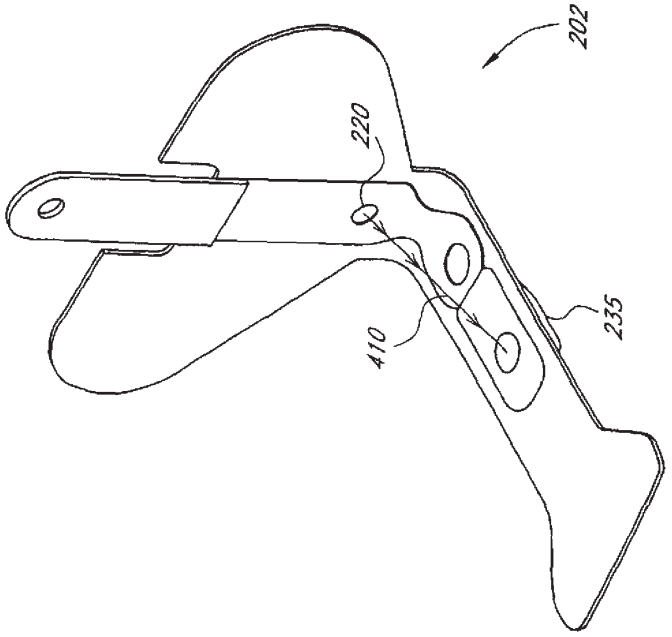


FIG. 4

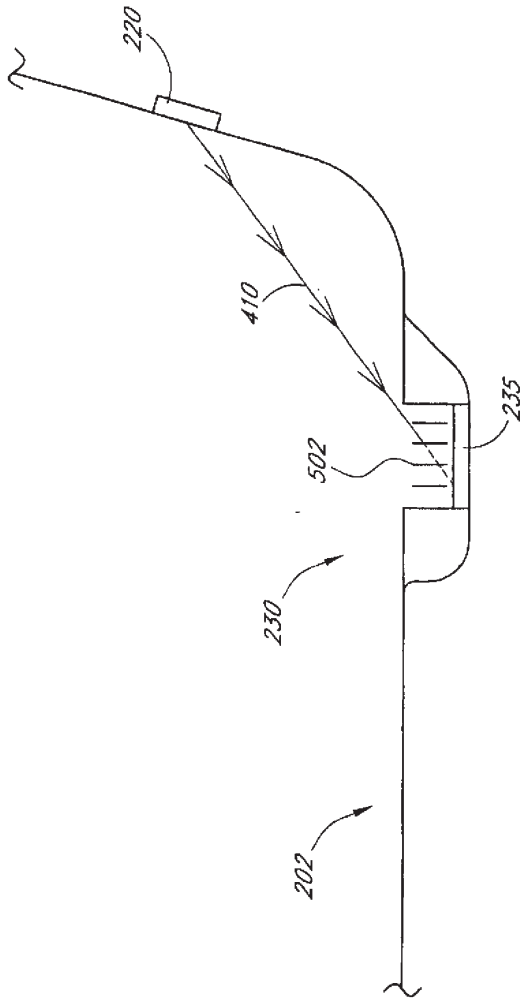


FIG.5A

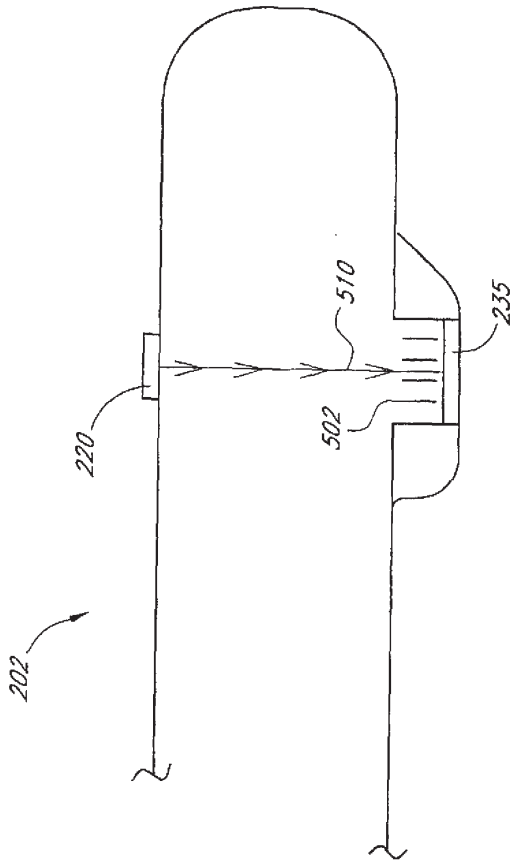


FIG.5B

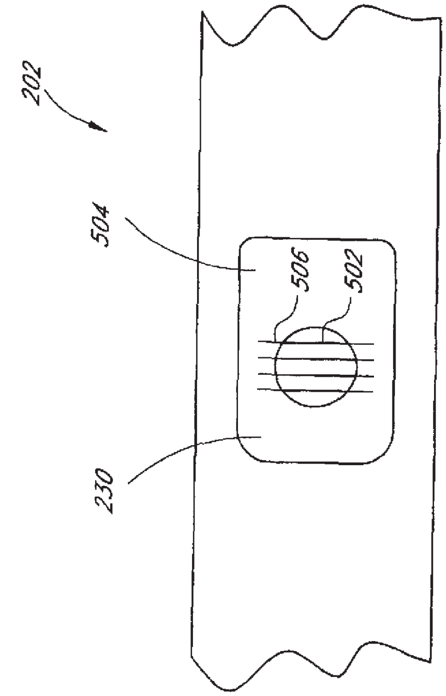


FIG.5C

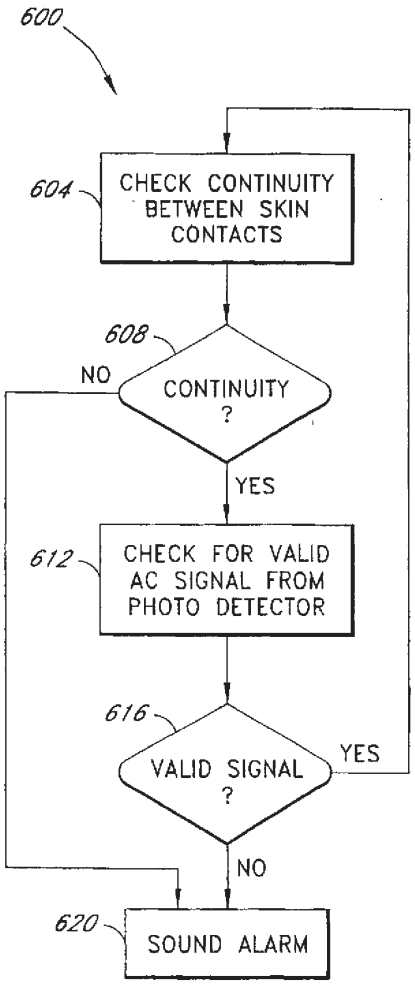
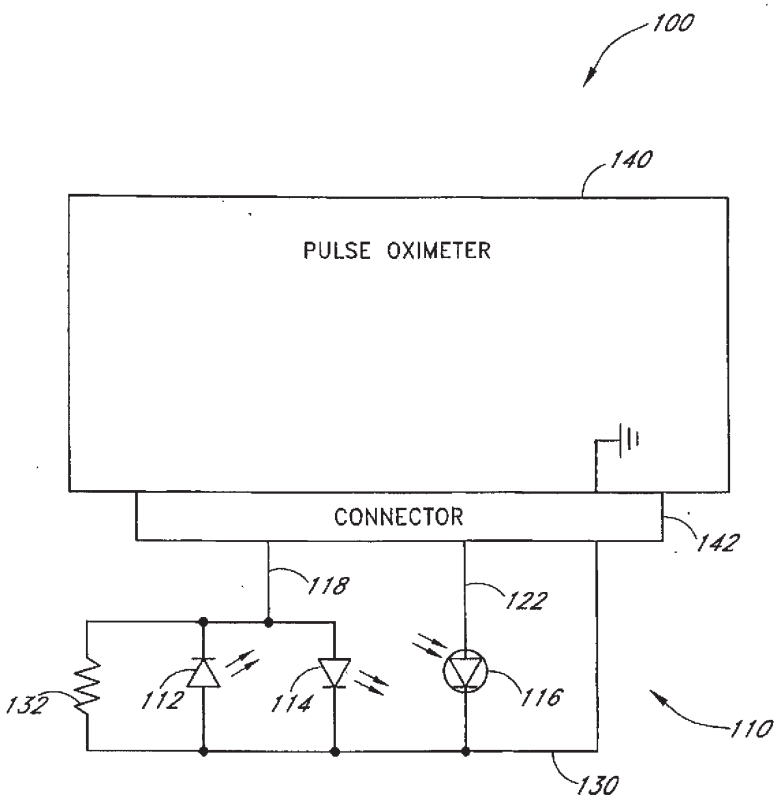

600
604
CHECK CONTINUITY BETWEEN SKIN CONTACTS
608
NO
CONTINUITY ?
YES
612
CHECK FOR VALID AC SIGNAL FROM PHOTO DETECTOR
616
VALID SIGNAL ?
YES
NO
620
SOUND ALARM

FIG. 6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CONNECTOR
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FIG. 1

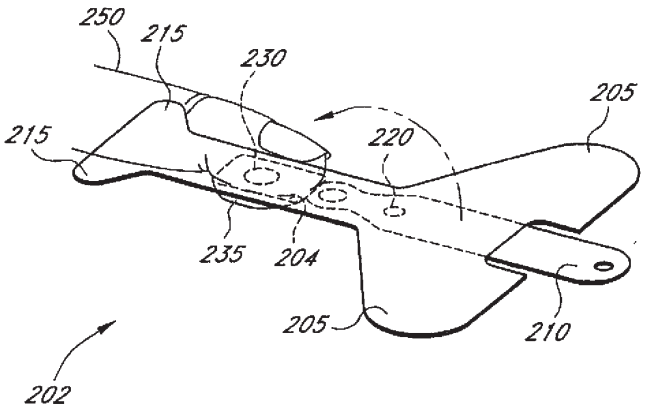
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FIG. 2A

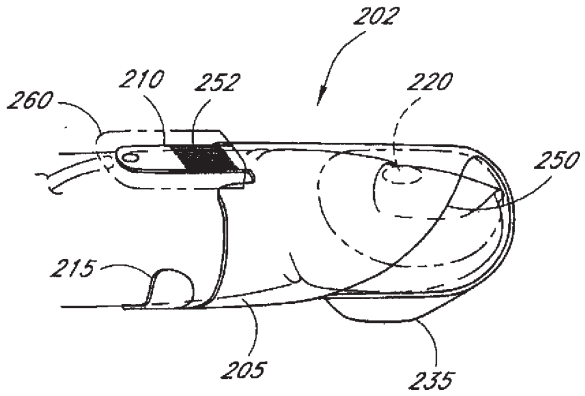
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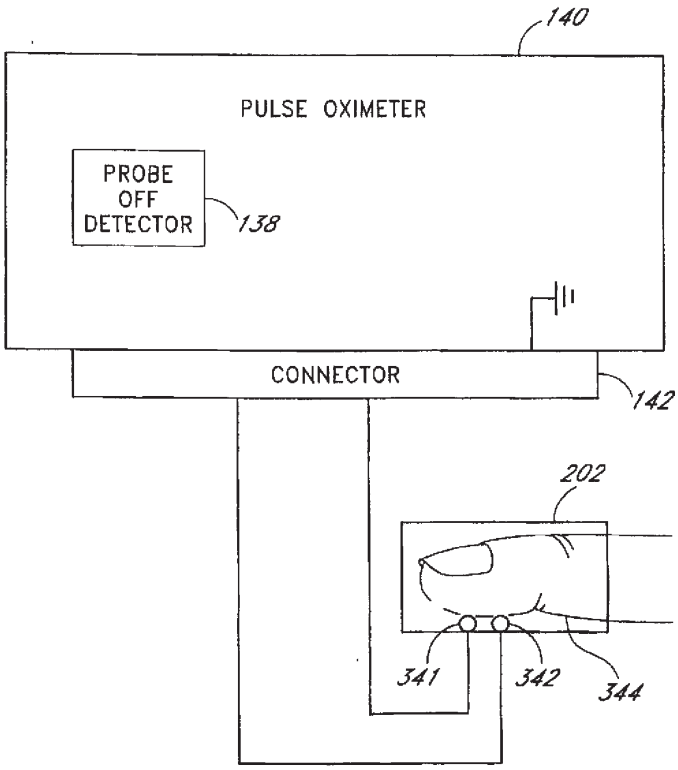
FIG. 2B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PULSE OXIMETER
PROBE OFF DETECTOR
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CONNECTOR
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202
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FIG. 3A

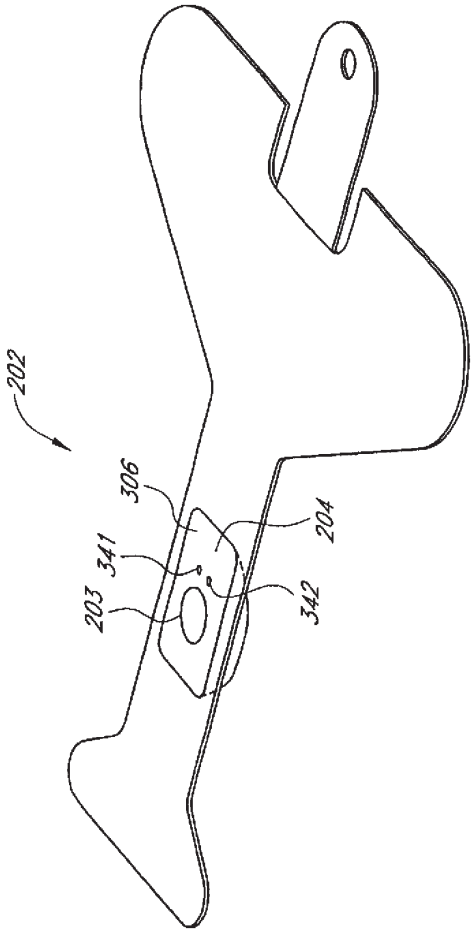
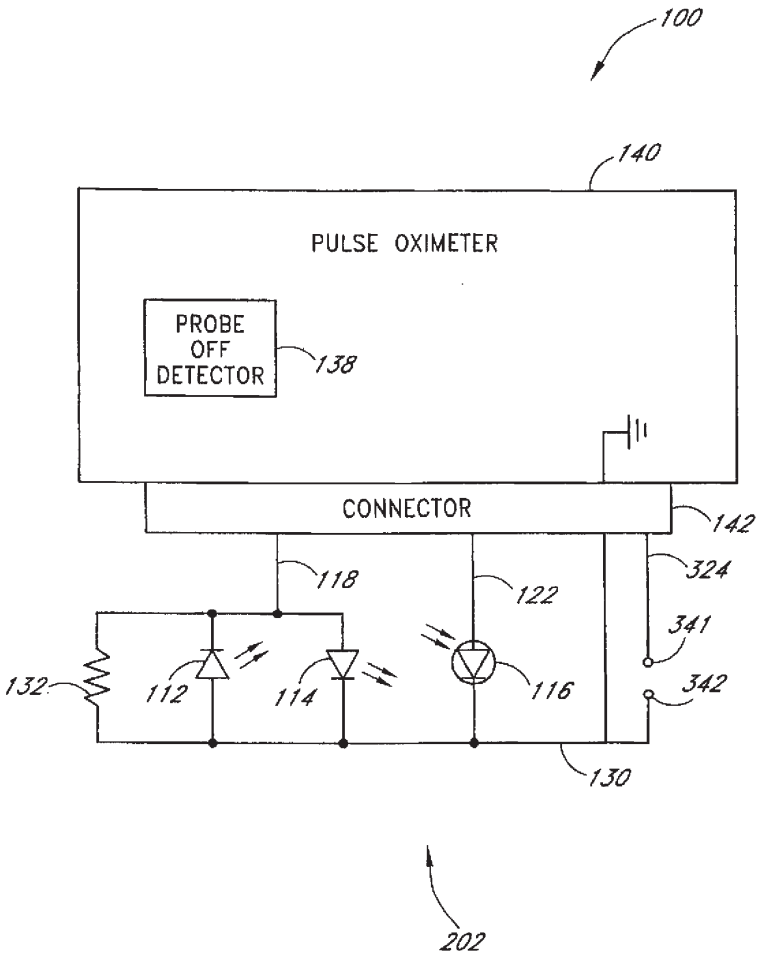


FIG.3B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PROBE OFF DETECTOR
138
CONNECTOR
142
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324
341
342
132
112
114
116
130
202

FIG.3C

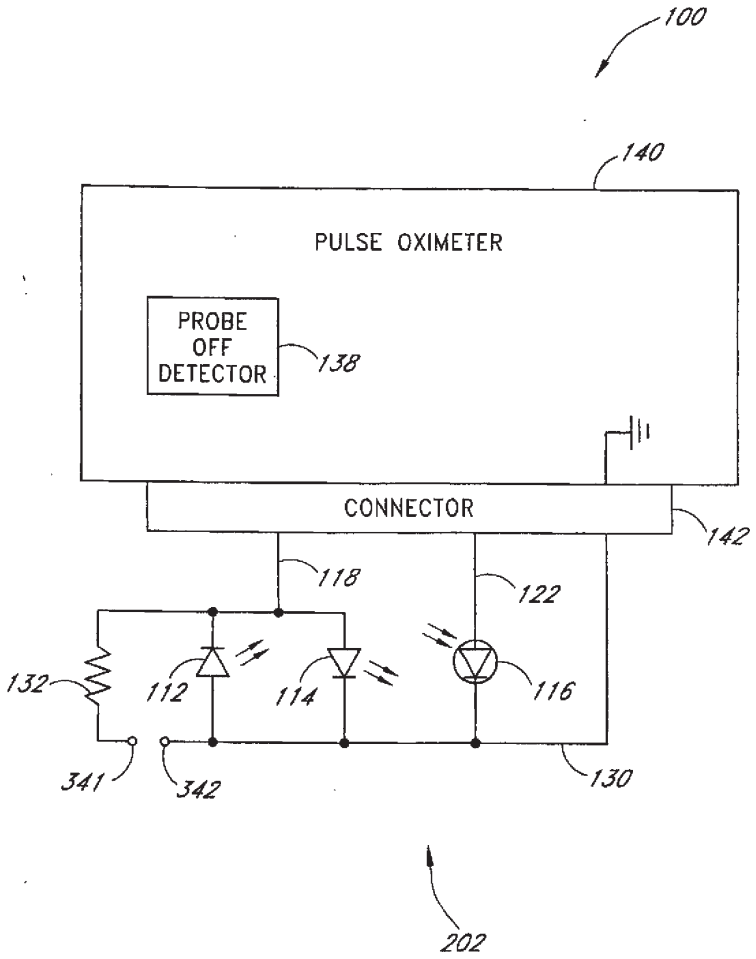

100
140
PULSE OXIMETER
PROBE OFF DETECTOR
138
CONNECTOR
142
118
122
132
112
114
116
341
342
130
202

FIG.3D

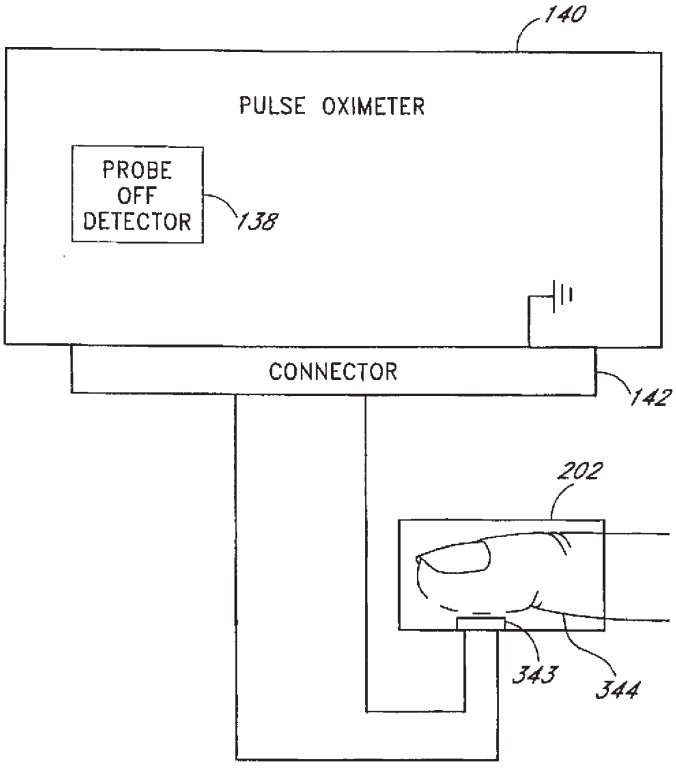

140
PULSE OXIMETER
PROBE OFF DETECTOR
138
CONNECTOR
142
202
343
344

FIG.3E

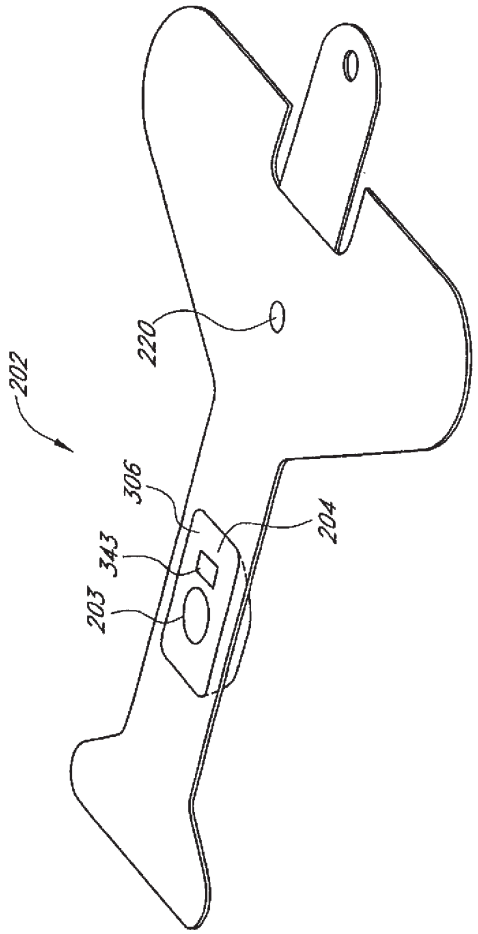


FIG. 3F

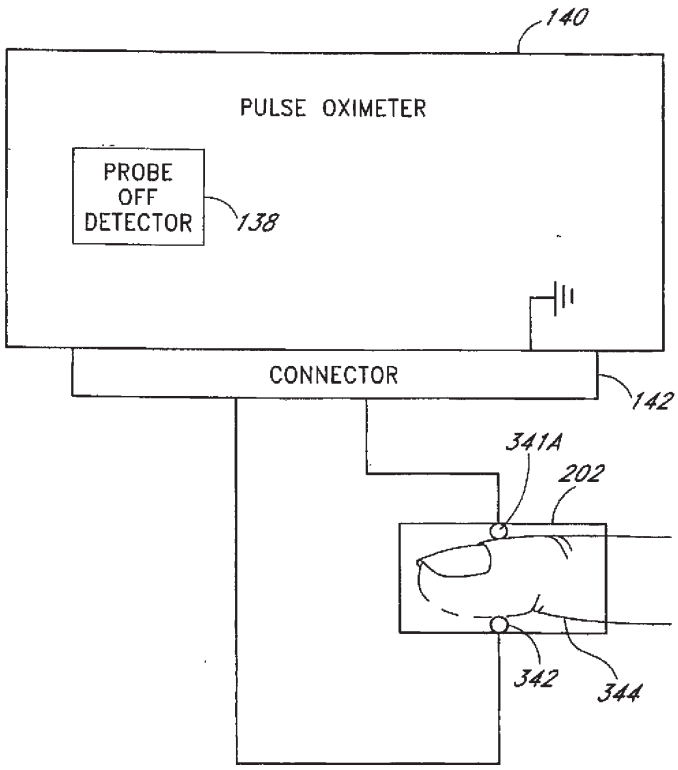

140
PULSE OXIMETER
PROBE OFF DETECTOR
138
CONNECTOR
142
341A
202
342
344

FIG. 3G

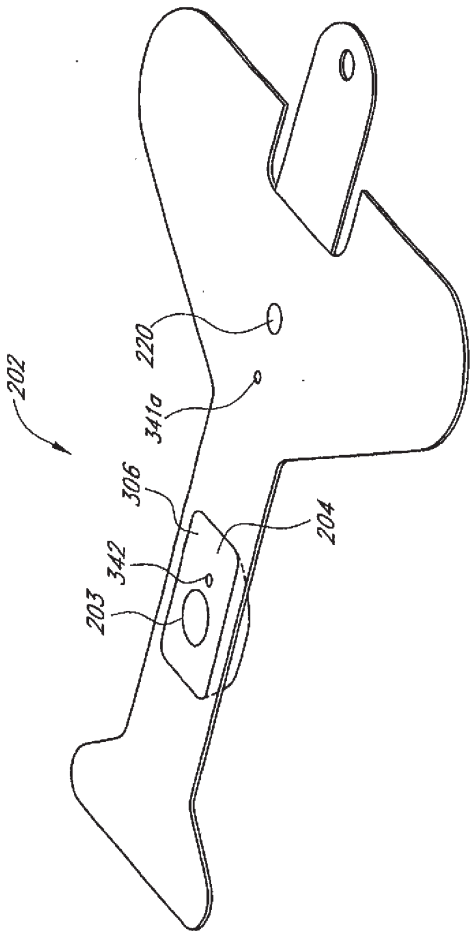


FIG.3H

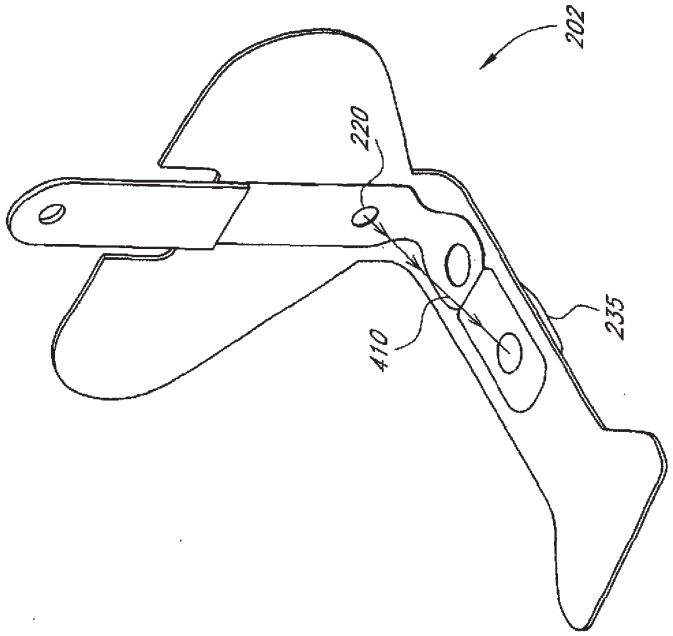


FIG. 4

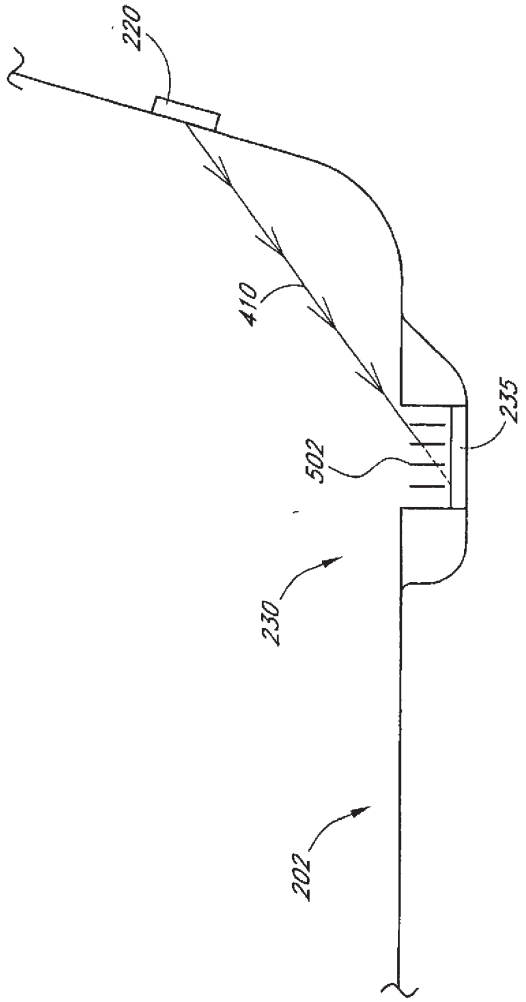


FIG.5A

13/15

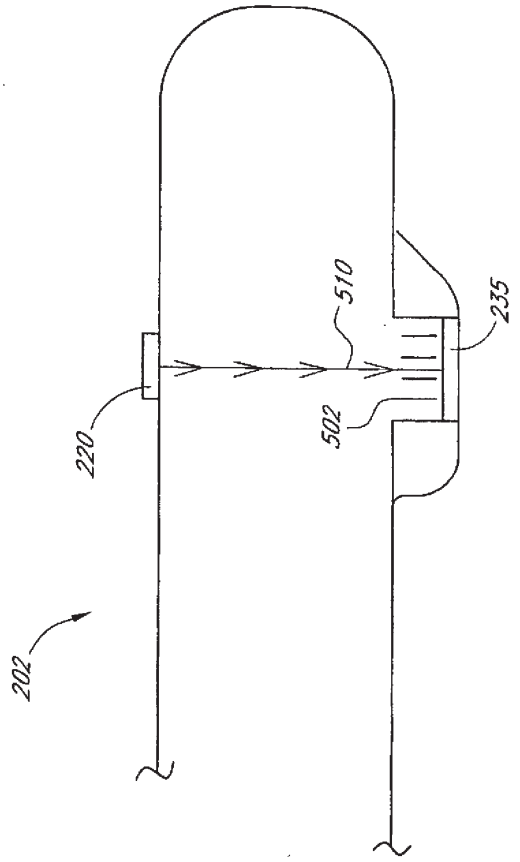


FIG.5B

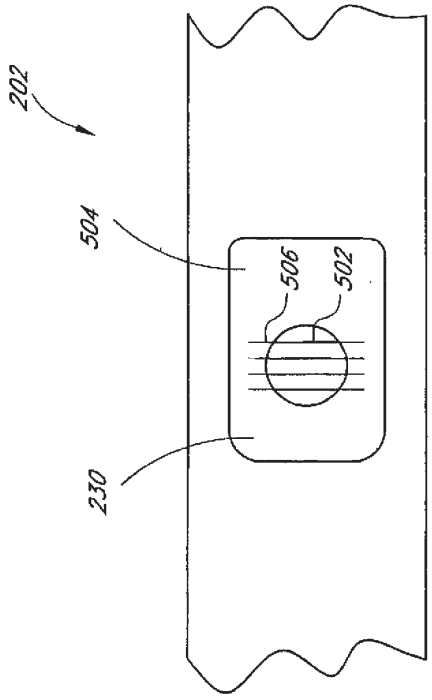


FIG.5C

15/15

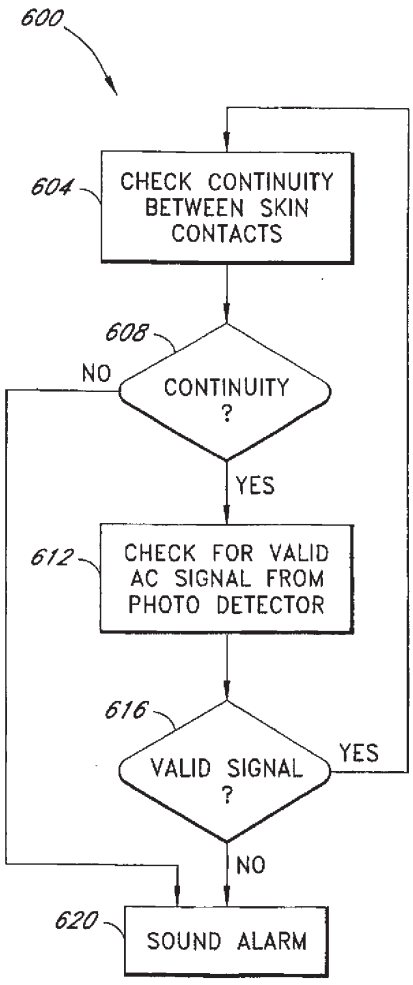

600
604
CHECK CONTINUITY BETWEEN SKIN CONTACTS
608
NO
CONTINUITY ?
YES
612
CHECK FOR VALID AC SIGNAL FROM PHOTO DETECTOR
616
VALID SIGNAL ?
YES
NO
620
SOUND ALARM

FIG. 6

DECLARATION - USA PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled PULSE OXIMETER PROBE OFF DETECTION SYSTEM; the specification of which was filed on **June 16, 2000** as Application No. 09/595,081.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above;

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56;

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below, and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56, which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Prior U.S.A. Application(s)

Application No.: **60/140,000** Filing Date: **June 18, 1999** Status: **Pending**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be 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 application or any patent issued thereon.

Full name of first inventor: **Massi E. Kiani**

Inventor's signature _____

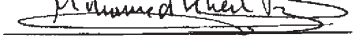
Date 8-31-00

Residence: **35 Brindisi, Laguna Niguel, CA 92677**

Citizenship: **US**

Post Office Address:

Full name of second inventor: **Mohamed K. Diab**

Inventor's signature 

Date 8-31-2000

Residence: **25075 White Spring, Mission Viejo, CA 92692**

Citizenship: **US**

Post Office Address:

Send Correspondence To:
KNOBBE, MARTENS, OLSON & BEAR, LLP
Customer No. 20,995

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082200

Client Code. MASIMO.172A

..CORDATION FORM COVER SHEE
PATENTS ONLY

TO THE ASSISTANT COMMISSIONER FOR PATENTS: Please record the attached original documents or copy thereof.

1. Name of conveying party(ies): (If multiple assignors, list numerically)

   1. Massi E. Kiani
   2. Mohamed K. Diab

   Additional name(s) of conveying party(ies) attached?
   ( ) Yes (X) No

2. Name and address of receiving party(ies):

   Name: Masimo Corporation
   Internal Address:
   Street Address: 2852 Kelvin Avenue
   City: Irvine **State:** CA **ZIP:** 92614

   Additional name(s) of receiving party(ies) attached?
   ( ) Yes (X) No

3. Nature of conveyance:

   (X) Assignment
   ( ) Merger
   ( ) Security Agreement
   ( ) Change of Name
   ( ) Other:

   Execution Date: (If multiple assignors, list execution dates in numerical order corresponding to numbers indicated in 1 above) August 31, 2000

4. Application number(s) or Patent number(s):

   ( ) Application(s) filed herewith Execution Date(s):

   (X) Patent Application No.: 09/595,081
   Filing Date: June 16, 2000

   ( ) Patent No.:
   Issue Date:

   Additional numbers attached? ( ) Yes (X) No

5. Name and address of party to whom correspondence concerning document should be mailed:

   Name: Stephen C. Jensen
   KNOBBE, MARTENS, OLSON & BEAR, LLP
   Customer No. 20,995
   Internal Address: Sixteenth Floor
   Street Address: 620 Newport Center Drive
   City: Newport Beach **State:** CA **ZIP:** 92660
   Attorney's Docket No.: MASIMO.172A

7. Total fee (37 CFR 3.41): $40

   (X) Enclosed
   (X) Authorized to be charged to deposit account if any additional fees are required, or to credit any overpayment

8. Deposit account number: 11-1410

   Please charge this account for any additional fees which may be required, or credit any overpayment to this account.

6. Total number of applications and patents involved: one

9. Statement and signature.

   To the best of my knowledge and belief, the foregoing information is true and correct, and any attached copy is a true copy of the original document.

   Stephen C. Jensen
   Name of Person Signing

   [signature]
   Signature

   9/26/2000
   Date

   35,556
   Registration No.

Total number of pages including cover sheet, attachments and document: 3

Mail documents to be recorded with required cover sheet information to:

Assistant Commissioner for Patents
Box Assignments
Washington, D.C. 20231

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092600

ASSIGNMENT

WHEREAS, We, Massi E. Kiani, a United States citizen, residing at 35 Brindisi, Laguna Niguel, California 92677, and Mohamed K. Diab, a United States citizen, residing at 25075 White Spring, Mission Viejo, California 92692, have invented certain new and useful improvements in a PULSE OXIMETER PROBE OFF DETECTION SYSTEM for which we have filed an application for Letters Patent in the United States, 09/595,081, June 16, 2000;

AND WHEREAS, MASIMO CORPORATION (hereinafter "ASSIGNEE"), a Delaware Corporation, with its principal place of business at 2852 Kelvin Avenue, Irvine, California 92614, desires to acquire the entire right, title, and interest in and to the said improvements and the said Application:

NOW, THEREFORE, in consideration of the sum of One Dollar ($1.00) to us in hand paid, and other good and valuable consideration, the receipt of which is hereby acknowledged, we, the said inventors, do hereby acknowledge that we have sold, assigned, transferred and set over, and by these presents do hereby sell, assign, transfer and set over, unto the said ASSIGNEE, its successors, legal representatives and assigns, the entire right, title, and interest throughout the world in, to and under the said improvements, and the said application and all divisions, renewals and continuations thereof, and all Letters Patent of the United States which may be granted thereon and all reissues and extensions thereof, and all rights of priority under International Conventions and applications for Letters Patent which may hereafter be filed for said improvements in any country or countries foreign to the United States, and all Letters Patent which may be granted for said improvements in any country or countries foreign to the United States and all extensions, renewals and reissues thereof; and we hereby authorize and request the Commissioner of Patents of the United States, and any Official of any country or countries foreign to the United States, whose duty it is to issue patents on applications as aforesaid, to issue all Letters Patent for said improvements to the said ASSIGNEE, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

AND WE HEREBY covenant and agree that we will communicate to the said ASSIGNEE, its successors, legal representatives and assigns, any facts known to us respecting said improvements, and testify in any legal proceeding, sign all lawful papers, execute all divisional, continuing and reissue applications, make all rightful oaths and generally do everything possible to aid the said ASSIGNEE, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for said improvements in all countries.

IN TESTIMONY WHEREOF, I hereunto set my hand and seal this 31 day of August, 2000.

Massi E. Kiani

STATE OF California
COUNTY OF Orange } ss.

On August 31, 2000, before me, Genevieve B. Barton, personally appeared personally known to me (or proved to me on the basis of satisfactory evidence) to be the person(s) whose name(s) is/are subscribed to the within instrument, and acknowledged to me that executed the same in authorized capacity(ies), and that by signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

[SEAL]

GENEVIEVE B. BARTON
Commission # 1110977
Notary Public — California
Orange County
My Comm. Expires Sep 11, 2000

Genevieve B. Barton
Notary Signature

IN TESTIMONY WHEREOF, I hereunto set my hand and seal this 31st day of August, 2000

Mohamed Kheir

STATE OF California
COUNTY OF Orange } ss.

On August 31 2000, before me, Genevieve B Barton, personally appeared personally known to me (or proved to me on the basis of satisfactory evidence) to be the person(s) whose name(s) is/are subscribed to the within instrument, and acknowledged to me that executed the same in authorized capacity(ies), and that by signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

[SEAL]

GENEVIEVE B. BARTON
Commission # 1110977
Notary Public — California
Orange County
My Comm. Expires Sep 11, 2000

Genevieve B. Barton
Notary Signature

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082200

MASIMO.172A PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Masimo Corporation
App. No.	:	09/595,081
Filed	:	June 16, 2000
For	:	PULSE OXIMETER PROBE OFF DETECTION SYSTEM
Examiner	:	Unknown

ESTABLISHMENT OF RIGHT OF ASSIGNEE TO TAKE ACTION
AND
REVOCATION AND POWER OF ATTORNEY

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

The undersigned is empowered to act on behalf of the assignee below (the "Assignee"). A true copy of the original Assignment of the above-captioned application from the inventor(s) to the Assignee is attached hereto. This Assignment represents the entire chain of title of this invention from the Inventor(s) to the Assignee.

I declare that all statements made herein are true, and that all statements made upon information and belief are believed to be 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 18 U.S.C. § 1001, and that willful, false statements may jeopardize the validity of the application, or any patent issuing thereon.

The undersigned hereby revokes any previous powers of attorney in the subject application, and hereby appoints the registrants of Knobbe, Martens, Olson & Bear, LLP, 620 Newport Center Drive, Sixteenth Floor, Newport Beach, California 92660, Telephone (949) 760-0404, **Customer No. 20,995**, as its attorneys with full power of substitution and

App. No. : 09/ ,081
Filed : Jun. ,6, 2000

revocation to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected herewith. This appointment is to be to the exclusion of the inventor(s) and his attorney(s) in accordance with the provisions of 37 C.F.R. § 3.71.

Please use **Customer No. 20,995** for all communications.

Masimo Corporation

Dated: 9-5-00

By: _____
Joe E. Kiani

Title: President and C.E.O.

Address: 2852 Kelvin Avenue
Irvine, CA 92614

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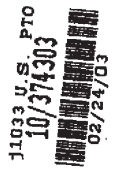
MASIMO.172DV1 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE



Applicants	:	Massi E. Kiani, et al.	Group Art Unit Unknown
App. No.	:	Unknown	
Filed	:	Herewith	
For	:	PULSE OXIMETER PROBE-OFF DETECTION SYSTEM	
Examiner	:	Unknown	

INFORMATION DISCLOSURE STATEMENT

United States Patent and Trademark Office
P.O. Box 2327
Arlington, VA 22202

Dear Sir:

Enclosed is form PTO-1449 listing sixteen (16) references, one of which is enclosed. Fifteen (15) of the references are of record in parent U.S. Patent Application No. 09/595,081, filed June 16, 2000, entitled "Pulse Oximeter Probe-Off Detection System." Because the 15 references are of record in the parent application, copies are not being submitted herewith. If the Examiner has difficulty accessing the application or the Examiner otherwise needs additional copies of the cited references, the Applicants will provide the same upon receipt of specific request in subsequent Office correspondences. The Applicants respectfully request consideration of cited references and that the appropriate indication of consideration be made on the enclosed form PTO-1449.

This Information Disclosure Statement is being filed before the receipt of a first Office Action on the merits, and presumably no fee is required in accordance with 37 C.F.R. § 1.97(b)(3).

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: February 24, 2003

By: _____
John M. Grover
Registration No. 42,610
Attorney of Record
Customer No. 20,995
(949) 760-0404

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012103

FORM PTO-1449 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY. DOCKET NO. MASIMO.172DV1	APPLICATION NO. Unknown
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	APPLICANT Massi E. Kiani, et al	
(USE SEVERAL SHEETS IF NECESSARY)	FILING DATE Herewith	GROUP Unknown

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE (IF APPROPRIATE)
	1	6,035,223	03/2000	Baker, Jr.			
	2	5,823,950	10/1998	Diab, et al.			
	3	5,782,757	07/1998	Diab, et al.			
	4	5,758,644	06/1998	Diab, et al.			
	5	5,503,148	04/1996	Pologe, et al.			
	6	5,469,845	11/1995	DeLonzor, et al.			
	7	5,370,114	12/1994	Wong, et al.			
	8	5,226,417	07/1993	Swedlow, et al.			
	9	4,603,700	08/1986	Nichols, et al.			
	10	4,561,440	12/1985	Kubo, et al.			
	11	4,331,161	05/1982	Patel			
	12	4,295,475	10/1981	Torzala			

FOREIGN PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
	13	DE 197 28 902 A1	11/1999	Germany				
	14	EP 0315 040 A1	10/1989	European				
	15	EP 0182 197 A2	05/1986	European				
	16	GB 2061 496 A	05/1981	United Kingdom				

EXAMINER INITIAL		OTHER DOCUMENTS (INCLUDING AUTHOR, TITLE, DATE, PERTINENT PAGES, ETC.)

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012103

EXAMINER	DATE CONSIDERED 4/7/2004

*EXAMINER: INITIAL IF CITATION CONSIDERED, WHETHER OR NOT CITATION IS IN CONFORMANCE WITH MPEP 609; DRAW LINE THROUGH CITATION IF NOT IN CONFORMANCE AND NOT CONSIDERED, INCLUDE COPY OF THIS FORM WITH NEXT COMMUNICATION TO APPLICANT.

55

Notice of Allowability	Application No. 10/374,303	Applicant(s) KIANI ET AL.	
	Examiner Matthew J Kremer	Art Unit 3736	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☐ This communication is responsive to _____.

2. ☒ The allowed claim(s) is/are *1-16*.

3. ☒ The drawings filed on *24 February 2003* are accepted by the Examiner.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date 2
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____.
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

REASONS FOR ALLOWANCE

1. The following is an examiner's statement of reasons for allowance.

In regard to claim 1, U.S. Patent 5,761,540 to White teaches an illumination device, a light sensitive detector (a camera), and a microlouver filter. White does not teach a pulse oximeter probe that includes a flexible body but teaches a device for illuminating an object to be observed by a machine vision camera. In regard to claim 9, U.S. Patent 6,035,223 to Baker, Jr. teaches an oximeter that determines whether a probe is off the patient by determining if the detected intensity is greatly increased. The prior art does not teach or suggest a pulse oximeter that determines whether a probe is off the patient by determining if the detected intensity is substantially attenuated. In regard to claim 15, U.S. Patent 5,923,021 to Dvorkis et al. teaches a sensor that includes a light source and a plurality of louvers. (Abstract and Fig. 3 of Dvorkis). Dvorkis teaches the use of a detector (Abstract of Dvorkis) but does not teach the particulars of the detector. One with skill in the art would know that a suitable detector would detect a range of wavelengths. (column 2, lines 20-23 of U.S. Patent 5,635,700 to Fazekas). However, even when the teachings of Fazekas are combined with the teachings of Dvorkis, the combination does not teach all the elements of the invention of claim 15. The Dvorkis/Fazekas combination teaches a detector that detects a wavelength range, which inherently includes first and second wavelengths; the use of a light source (Abstract of Dvorkis); and a plurality of louvers positions over the detector (Fig. 3 of Dvorkis). The Dvorkis/Fazekas combination does not teach that the plurality of louvers is positioned to accept light from the at least one light emission device

originating from a general direction of the at least one light emission device wherein the louvers accept the light when the sensor is properly applied to tissue of a patient. In regard to claim 15, U.S. Patent 4,945,239 to Wist et al. teaches a sensor that includes a light source, a light detector, and a pinhole box in front of the detector but does not teach or suggest a sensor that includes a plurality of louvers. In regard to claim 16, Wist teaches blocking light originating from an angle oblique to a proximate relationship between the detector and a light source but does not teach or suggest the step of indicating a probe off condition.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Kremer whose telephone number is 703-605-0421. The examiner can normally be reached on Mon. through Fri. between 8:30 a.m. - 5:00 p.m.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mary Beth Jones can be reached on 703-308-3400. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew Kremer
Assistant Examiner
Art Unit 3736

Notice of References Cited	Application/Control No. 10/374,303	Applicant(s)/Patent Under Reexamination KIANI ET AL.	
	Examiner Matthew J Kremer	Art Unit 3736	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-5,635,700 A	06-1997	Fazekas, Peter	235/462.06
	B	US-5,923,021 A	07-1999	Dvorkis et al.	235/455
	C	US-6,035,223 A	03-2000	Baker, Jr., Clark R.	600/323
	D	US-5,761,540 A	06-1998	White, Timothy P.	396/4
	E	US-4,945,239 A	07-1990	Wist et al.	600/473
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
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NOTICE OF ALLOWANCE AND FEE(S) DUE

20995 7590 04/13/2004

KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

EXAMINER	
KREMER, MATTHEW J	
ART UNIT	PAPER NUMBER
3736	3

DATE MAILED: 04/13/2004

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/374,303	02/24/2003	Massi E. Kiani	MASIMO.172DV1	5982

TITLE OF INVENTION: PULSE OXIMETER PROBE-OFF DETECTION SYSTEM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1330	$300	$1630	07/13/2004

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:
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B. If the status is changed, pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above and notify the United States Patent and Trademark Office of the change in status, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check the box below and enclose the PUBLICATION FEE and 1/2 the ISSUE FEE shown above.

☐ Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

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IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (Rev. 11/03) Approved for use through 04/30/2004.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
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Alexandria, Virginia 22313-1450
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CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)

20995 7590 04/13/2004

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FOURTEENTH FLOOR
IRVINE, CA 92614

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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO, on the date indicated below.

(Depositor's name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/374,303	02/24/2003	Massi E. Kiani	MASIMO.172DV1	5982

TITLE OF INVENTION: PULSE OXIMETER PROBE-OFF DETECTION SYSTEM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1330	$300	$1630	07/13/2004

EXAMINER	ART UNIT	CLASS-SUBCLASS
KREMER, MATTHEW J	3736	600-322000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the USPTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent); ☐ individual ☐ corporation or other private group entity ☐ government

4a. The following fee(s) are enclosed:

☐ Issue Fee

☐ Publication Fee

☐ Advance Order - # of Copies _____

4b. Payment of Fee(s):

☐ A check in the amount of the fee(s) is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

Director for Patents is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.

(Authorized Signature) (Date)

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, Alexandria, Virginia 22313-1450.

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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/374,303	02/24/2003	Massi E. Kiani	MASIMO.172DV1	5982

20995 7590 04/13/2004

KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

EXAMINER	
KREMER, MATTHEW J	

ART UNIT	PAPER NUMBER
3736	3

DATE MAILED: 04/13/2004

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 0 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 0 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) system (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (703) 305-1383. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.

PTOL-85 (Rev. 11/03) Approved for use through 04/30/2004.

PATENT

Case Docket No. MASIMO.172DV1
Date: June 22, 2004

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants	:	Massi E. Kiani et al.
Appl. No.	:	10/374,303
Filed	:	February 24, 2003
For	:	PULSE OXIMETER PROBE-OFF DETECTION SYSTEM
Group Art Unit	:	3736
Class/Sub-Class:		600/322000
Examiner	:	Matthew J. Kremer

CERTIFICATE OF MAILING

I hereby certify that this correspondence and all marked attachments are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated below and are addressed to: Mail Stop Issue Fee, Commissioner for Patents, United States Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450, on

June 22, 2004
(Date)

John M. Grover, Reg. No. 42,610

TRANSMITTAL LETTER

MAIL STOP ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Enclosed for filing is the Issue Fee for the above-identified application:

(X) a Form PTOL-85;

(X) a check in the amount of $1,630 to cover the issue fee; and

(X) a return prepaid postcard.

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

John M. Grover
Registration No. 42,610
Attorney of Record
Customer No. 20,995
(949) 760-0404

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061704

Knobbe Martens Olson & Bear LLP
Intellectual Property Law

2040 Main Street
Fourteenth Floor
Irvine, CA 92614
Tel 949-760-0404
Fax 949-760-9502
www.kmob.com

John M. Grover
jgrover@kmob.com

MAIL STOP ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF MAILING BY "EXPRESS MAIL"

Attorney Docket No.:		MASIMO.172DV1
Applicants	:	Massi E. Kiani et al.
For	:	PULSE OXIMETER PROBE-OFF DETECTION SYSTEM
Attorney	:	John M. Grover
"Express Mail" Mailing Label No.	:	EV 307990841 US
Date of Deposit	:	June 22, 2004

I hereby certify that the accompanying

Transmittal Letter; Form PTOL-85; Check for Filing Fee; Return Prepaid Postcard

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Nelson Merida

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061704

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John M. Grover, Reg. No. 42,610 (Depositor's name)
(Signature)
6/22/2004 (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/374,303	02/24/2003	Masai E. Kiani	MASIMO.172DV1	5982

TITLE OF INVENTION: PULSE OXIMETER PROBE-OFF DETECTION SYSTEM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1330	$300	$1630	07/13/2004

EXAMINER	ART UNIT	CLASS-SUBCLASS
KREMER, MATTHEW J	3736	600-322000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

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1 Knobbe, Martens,
2 Olson, & Bear, LLP
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the USPTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Masimo Corporation
(B) RESIDENCE: (CITY and STATE OR COUNTRY): 40 Parker Irvine, CA 92618

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ individual ☒ corporation or other private group entity ☐ government

4a. The following fee(s) are enclosed:
☒ Issue Fee
☒ Publication Fee
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s):
☒ A check in the amount of the fee(s) is enclosed.
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Director for Patents is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.

John M. Grover
(Authorized Signature) Reg. No. 42,610 (Date) 6/22/2004

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

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06/25/2004 RMEBRAHI 00000070 10374303
01 FC:1501 1330.00 OP
02 FC:1504 300.00 OP

TRANSMIT THIS FORM WITH FEE(S)

File History Content Report

The following content is missing from the original file history record obtained from the United States Patent and Trademark Office. No additional information is available.

Document Date - 2004-08-03

Document Title - USPTO Grant

File History Content Report

The following content is missing from the original file history record obtained from the United States Patent and Trademark Office. No additional information is available.

Document Date - 2007-06-18

Document Title - Certificate of Correction - Post Issue Communication

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,771,994 B2
APPLICATION NO. : 10/374303
DATED : August 3, 2004
INVENTOR(S) : Massi E. Kiani

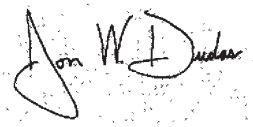
It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

At column 2, line 36, delete "embodimet" and insert -- embodiment --, therefore.

At column 6, line 3, delete "haveing" and insert -- having --, therefore.

Signed and Sealed this

Seventeenth Day of July, 2007



JON W. DUDAS
Director of the United States Patent and Trademark Office

File History Content Report

The following content is missing from the original file history record obtained from the United States Patent and Trademark Office. No additional information is available.

Document Date - 2011-08-02

Document Title - USPTO Communication Re: Change of Address

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO.	: 6,771,994
APPLICATION NO.	: 10/374,303
ISSUE DATE	: August 3, 2004
INVENTOR(S)	: Massi E. Kiani

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

At column 2, line 36, delete "embodimet" and insert - - embodiment - -, therefore.

At column 6, line 3, delete "haveing" and insert - - having - -, therefore.

MAILING ADDRESS OF SENDER:

John M. Grover
KNOBBE, MARTENS, OLSON & BEAR, LLP
2040 Main Street, 14th Floor
Irvine, California 92614

DOCKET NO. MASIMO.172DV1

PTO/SB/44 Equivalent
3739967:jmo
050807

PATENT APPLICATION FEE DETERMINATION RECORD
Effective January 1, 2003

Application or Docket Number: MASIMO.122DV1

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	18	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	18 minus 20=	* —
INDEPENDENT CLAIMS	4 minus 3 =	* 1
MULTIPLE DEPENDENT CLAIM PRESENT	☐	

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐		OR	OTHER THAN SMALL ENTITY	
RATE	FEE		RATE	FEE
BASIC FEE	$375	OR	BASIC FEE	$750
X$ 9=		OR	X$18=	
X42=		OR	X84=	84
+140=		OR	+280=	
TOTAL		OR	TOTAL	834

CLAIMS AS AMENDED - PART II

AMENDMENT A	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐				

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐				

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐				

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
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FORM PTO-875 (Rev. 1/03) — Patent and Trademark Office U.S. DEPARTMENT OF COMMERCE

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Search results for: pns=(US6771994);
Collections searched: DWPI, US Granted, Australian Innovation, Canadian Applications, US Applications, Australian Granted, French Granted, French Applications, European Granted, Australian Applications, German Utility Models, European Applications, British Applications, British Granted, German Granted, WIPO Applications, Canadian Granted, German Applications, Russian Utility Models, Russian Applications, Chinese Utility Models, Indonesian Simple, Korean Utility Models, Singaporean Applications, Chinese Granted, Indonesian Applications, Korean Granted/Examined, Thai Granted/Examined, Chinese Applications, Japanese Utility Models, Korean Applications, Vietnamese Granted, Indian Granted, Japanese Granted, Malaysian Granted, Vietnamese Applications, Indian Applications, Japanese Applications, Singaporean Granted, Argentinean Utility Models, Argentinean Applications, Mexican Granted, Brazilian Utility Models, Mexican Applications, Brazilian Granted, Brazilian Applications, Other Authorities

Table of Contents

Family 1/1

1 record(s) per family

Record 1/1 US6771994B2 Pulse oximeter probe-off detection system

Publication Number: US6771994B2 20040803

Title: Pulse oximeter probe-off detection system

Title - DWPI: Pulse oximeter probe off detection system determines improper fixation of probe if open condition exists across two electrical contacts contacting skin of patient

Priority Number: US1999140000P | US2000595081A | CA2382319A

Priority Date: 1999-06-18 | 2000-06-16 | 2001-11-09

Application Number: US2003374303A

Application Date: 2003-02-24

Publication Date: 2004-08-03

IPC Class Table:

IPC	Section	Class	Subclass	Class Group	Subgroup
A61B0005145	A	A61	A61B	A61B0005	A61B0005145
A61B000500	A	A61	A61B	A61B0005	A61B000500
A61B00051455	A	A61	A61B	A61B0005	A61B00051455

IPC Class Table - DWPI:

IPC - DWPI	Section - DWPI	Class - DWPI	Subclass - DWPI	Class Group - DWPI	Subgroup - DWPI
A61B000500 (IPC 1-7)	A	A61	A61B	A61B0005	A61B000500 (IPC 1-7)
A61B0005145 (IPC 1-7)	A	A61	A61B	A61B0005	A61B0005145 (IPC 1-7)
A61B00050424 (IPC 1-7)	A	A61	A61B	A61B0005	A61B00050424 (IPC 1-7)
A61B000500	A	A61	A61B	A61B0005	A61B000500
A61B0005145	A	A61	A61B	A61B0005	A61B0005145
A61B00051455	A	A61	A61B	A61B0005	A61B00051455

Assignee/Applicant: Masimo Corporation,Irvine,CA

JP F Terms:

JP FI Codes:

Assignee - Original: Masimo Corporation

Any CPC Table:

Type	Invention	Additional	Version	Office
Current Current	**A61B 5/6843** A61B 5/14552	-	20130101 20130101	EP EP

ECLA: A61B000568B5 | A61B00051455N2

Abstract:

The present invention provides a number of improvements that can be incorporated into a pulse oximeter probe to detect when a probe has become dislodged from a patient and/or to prevent a probe-off condition. A probe-off condition occurs when the optical probe becomes partially or completely dislodged from the patient, but continues to detect an AC signal within the operating region of the pulse oximeter. In one aspect, the present invention provides electrical contacts that contact the skin of a patient when the probe is properly attached. In another aspect, the present invention provides a number of louvers placed in front of the sensor's photodetector to filter out oblique light rays that do not originate from a point in front of the detector. Accordingly, if the emitter and photodetector are not properly aligned, the photodetector will not produce a signal within the valid operating range of the pulse oximeter. In accordance with a method of the present invention the pulse oximeter can sound an alarm or display a warning if it determines that the probe is not properly attached to the patient.

Language of Publication: EN

INPADOC Legal Status Table:

Gazette Date	Code	INPADOC Legal Status Impact
2019-08-15	AS	-
Description: ASSIGNMENT MASIMO CORPORATION, CALIFORNIA ASSIGNMENT OF ASSIGNORS INTEREST; ASSIGNORS:KIANI, MASSI E.; DIAB, MOHAMED K.; REEL/FRAME:050068/0744 2000-08-31		
2018-11-07	AS	-
Description: ASSIGNMENT MASIMO AMERICAS, INC., CALIFORNIA RELEASE BY SECURED PARTY; ASSIGNOR:JPMORGAN CHASE BANK, NATIONAL ASSOCIATION; REEL/FRAME:047443/0109 2018-04-05		

2018-11-07	AS	-
Description: ASSIGNMENT MASIMO CORPORATION, CALIFORNIA RELEASE BY SECURED PARTY; ASSIGNOR:JPMORGAN CHASE BANK, NATIONAL ASSOCIATION; REEL/FRAME:047443/0109 2018-04-05		
2016-02-05	SULP	+
Description: SURCHARGE FOR LATE PAYMENT FEE PAYMENT YEAR 11		
2016-02-05	FPAY	+
Description: FEE PAYMENT FEE PAYMENT YEAR 12		
2014-05-27	AS	-
Description: ASSIGNMENT JPMORGAN CHASE BANK, NATIONAL ASSOCIATION, ILLINOI CORRECTIVE ASSIGNMENT TO CORRECT THE NATURE OF CONVEYANCE PREVIOUSLY RECORDED AT REEL: 032784 FRAME: 0864. ASSIGNOR(S) HEREBY CONFIRMS THE SECURITY AGREEMENT; ASSIGNORS:MASIMO AMERICAS, INC.; MASIMO CORPORATION; REEL/FRAME:033032/0426 2014-04-23		
2014-05-27	AS	-
Description: ASSIGNMENT JPMORGAN CHASE BANK, NATIONAL ASSOCIATION, ILLINOIS CORRECTIVE ASSIGNMENT TO CORRECT THE NATURE OF CONVEYANCE PREVIOUSLY RECORDED AT REEL: 032784 FRAME: 0864. ASSIGNOR(S) HEREBY CONFIRMS THE SECURITY AGREEMENT; ASSIGNORS:MASIMO AMERICAS, INC.; MASIMO CORPORATION; REEL/FRAME:033032/0426 2014-04-23		
2014-04-29	AS	-
Description: ASSIGNMENT JPMORGAN CHASE BANK, NATIONAL ASSOCIATION, ILLINOI ASSIGNMENT OF ASSIGNORS INTEREST; ASSIGNORS:MASIMO CORPORATION; MASIMO AMERICAS, INC.; REEL/FRAME:032784/0864 2014-04-23		
2014-04-29	AS	-
Description: ASSIGNMENT JPMORGAN CHASE BANK, NATIONAL ASSOCIATION, ILLINOIS ASSIGNMENT OF ASSIGNORS INTEREST; ASSIGNORS:MASIMO CORPORATION; MASIMO AMERICAS, INC.; REEL/FRAME:032784/0864 2014-04-23		
2011-09-22	FPAY	+
Description: FEE PAYMENT FEE PAYMENT YEAR 8		
2008-01-31	FPAY	+
Description: FEE PAYMENT FEE PAYMENT YEAR 4		
2007-07-17	CC	-
Description: CERTIFICATE OF CORRECTION		

2004-07-15	STCF	-
Description: INFORMATION ON STATUS: PATENT GRANT PATENTED CASE		

Post-Issuance (US): CORR-CERT Certificate of Correction 2007-07-17 2007 2007-08-07 2007 a Certificate of Correction was issued for this patent

Reassignment (US) Table:

Assignee	Assignor	Date Signed	Reel/Frame	Date
MASIMO CORPORATION,IRVINE,CA, US	JPMORGAN CHASE BANK, NATIONAL ASSOCIATION	2018-04-05	047443/0109	2018-11-07
MASIMO AMERICAS INC.,IRVINE,CA,US	-	-	-	-
Conveyance: RELEASE BY SECURED PARTY (SEE DOCUMENT FOR DETAILS). | RELEASE BY SECURED PARTY (SEE DOCUMENT FOR DETAILS).				
Corresponent: PAUL HASTINGS LLP 4747 EXECUTIVE DR. 12TH FLOOR SAN DIEGO, CA 92121 | PAUL HASTINGS LLP 4747 EXECUTIVE DR. 12TH FLOOR SAN DIEGO, CA 92121				
JPMORGAN CHASE BANK NATIONAL ASSOCIATION,CHICAGO,IL, US	MASIMO AMERICAS, INC.	2014-04-23	033032/0426	2014-05-27
	MASIMO CORPORATION	2014-04-23	-	-
Conveyance: CORRECTIVE ASSIGNMENT TO CORRECT THE NATURE OF CONVEYANCE PREVIOUSLY RECORDED AT REEL: 032784 FRAME: 0864. ASSIGNOR(S) HEREBY CONFIRMS THE SECURITY AGREEMENT.				
Corresponent: PATRICK TIERNEY PO BOX 2828 CHICAGO, IL 60690-2828				
JPMORGAN CHASE BANK NATIONAL ASSOCIATION,CHICAGO,IL, US	MASIMO CORPORATION	2014-04-23	032784/0864	2014-04-29
	MASIMO AMERICAS, INC.	2014-04-23	-	-
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).				
Corresponent: PATRICK TIERNEY PO BOX 2828 CHICAGO, IL 60690-2828				
MASIMO CORPORATION,IRVINE,CA, US	KIANI, MASSI E.	2000-08-31	050068/0744	2019-08-15
	DIAB, MOHAMED K.	2000-08-31	-	-
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).				
Corresponent: KNOBBE MARTENS OLSON & BEAR LLP 2040 MAIN STREET 14TH FLOOR IRVINE, CA 92614				

Maintenance Status (US): CC

Litigation (US): 2020-01-09 2020 Masimo Corporation Cercacor Laboratories, Inc. Apple Inc. C.D. California 8:20cv00048

Opposition (EP):

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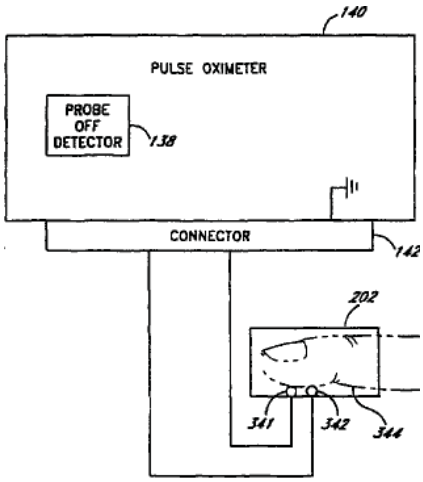

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Assignee - Current US: MASIMO CORPORATION | MASIMO AMERICAS INC.

United States Patent and Trademark Office

Office of the Commissioner for Patents

PULSE OXIMETER PROBE-OFF DETECTION SYSTEM

PATENT #	APPLICATION #	FILING DATE	ISSUE DATE
6771994	10374303	02/24/2003	08/03/2004

Payment Window Status

No maintenance fees are due.

WINDOW	STATUS	FEES
11.5 Year	Closed	Paid

Window	First Day to Pay	Surcharge Starts	Last Day to Pay	Status	Fees
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Patent Holder Information

Customer # 64735

Entity Status UNDISCOUNTED

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