Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Jeroen Poeze	Nonprovisional Application Number (if known):	Herewith
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, or the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Scott Cromar/	Date 2019-08-19
Name (Print/Typed) Scott Cromar	Practitioner Registration Number 65066

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☑ *Total of 1 forms are submitted.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 03/31/2021. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	Unknown
Filing Date	Herewith
First Named Inventor	Jeroen Poeze
Title	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
Art Unit	Unknown
Examiner Name	Unknown
Attorney Docket Number	MASCER.002C13

SIGNATURE of Applicant or Patent Practitioner

Signature	/Scott Cromar/	Date (Optional)	2019-08-19
Name	Scott Cromar	Registration Number	65066
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. 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 1.11 and 1.14. This collection is estimated to take 3 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, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..

Document Description: Power of Attorney

PTO/AIA/82B(07-12)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in the attached transmittal letter.

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent):

64735

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent):

Name	Registration Number	Name	Registration Number

Please recognize or change the correspondence address for the application identified in the attached transmittal letter to:

☒ The address associated with the above-mentioned Customer Number.

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant:

☐ Inventor or Joint Inventor

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor

☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (*e.g.*, a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document)

SIGNATURE of Applicant for Patent

Signature	/TCM/	Date	7/12/13
Name	Thomas McClenahan	Telephone	(949) 297-7000
Title and Company	Executive Vice President and General Counsel, Masimo Corporation		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms for more than one signature, see below *.

☒ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. 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 1.11 and 1.14. This collection is estimated to take 3 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, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Please Direct All Correspondence to Customer Number 64735

RESCISSION OF ANY PRIOR DISCLAIMERS AND REQUEST TO REVISIT ART

Inventor	:	Jeroen Poeze
App. No	:	Unknown
Filed	:	Herewith
For	:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
Examiner	:	Unknown
Art Unit	:	Unknown
Conf #	:	Unknown

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

The claims of the present application are different and possibly broader in scope than the claims pursued in the parent application(s). To the extent any prior amendments or characterizations of the scope of any claim or referenced art could be construed as a disclaimer of any subject matter supported by the present disclosure, Applicant hereby rescinds and retracts such disclaimer. Accordingly, the references previously considered in the parent application(s) may need to be re-visited.

Knobbe, Martens, Olson & Bear, LLP

Respectfully submitted,

Dated: August 19, 2019

/Scott Cromar/_____
Scott A. Cromar
Registration No. 65,066
Registered Practitioner
Customer No. 64735
(949) 760-0404

31160660

Electronic Patent Application Fee Transmittal	
Application Number:	
Filing Date:	
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Filer:	Scott Cromar/Frances Tsai
Attorney Docket Number:	MASCER.002C13
Filed as Large Entity	

Filing Fees for Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4000	4000
Pages:				
UTILITY APPL SIZE FEE PER 50 SHEETS >100	1081	1	400	400
Claims:				
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**6260**

Electronic Acknowledgement Receipt	
EFS ID:	36916502
Application Number:	16544713
International Application Number:	
Confirmation Number:	9381
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Customer Number:	64735
Filer:	Scott Cromar/Daniela Lopez
Filer Authorized By:	Scott Cromar
Attorney Docket Number:	MASCER.002C13
Receipt Date:	19-AUG-2019
Filing Date:	
Time Stamp:	19:18:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$6260
RAM confirmation Number	E20198IJ21018224
Deposit Account	111410
Authorized User	Daniela Lopez
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	ADS_002C13.pdf	1258167 4b3777fd12afd210345537484c755e8f3ede9594	no	14
Warnings:					
Information:					
2		SPEC_002C13.pdf	354145 1f62bc77113fe142cd6cb89f85d49f1e9ae0cb85	yes	76

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	74
Claims	75	75
Abstract	76	76

Warnings:					
Information:					
3	Drawings-other than black and white line drawings	FIGS_002.pdf	1408205 92b8e0c474112e2aa02f79b8cbf37c79866938c8	no	65
Warnings:					
Information:					
4	Oath or Declaration filed	DECS_002.pdf	7015133 77c933397b66cf4234c1eb5e45b031263ff31082	no	26
Warnings:					

The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing

Information:

5	TrackOne Request	TRACK1_002C13.pdf	128756 fbc6d2ca513edc039e87a5fa4a413df25c058ae6	no	2
Warnings:					
Information:					
6	Power of Attorney	POA_002C13.pdf	541918 ec3f32b733f282017347f80c4f7b084ad924353c	no	2
Warnings:					
Information:					
7	Miscellaneous Incoming Letter	RESC_002C13.pdf	15864 1b1a83024b39d1063c5f5d686391bbec37979cdb	no	1
Warnings:					
Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	41683 b7e568f78864034699782 86f79e276e4b9d33728	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	10763871		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jeroen		Poeze	

Residence Information (Select One) ● US Residency Non US Residency Active US Military Service

City	Rancho Santa Margarita	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	53 Tierra Seguro		
Address 2			
City	Rancho Santa Margarita	State/Province	CA
Postal Code	92688	Country	US

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Marcelo		Lamego	

Residence Information (Select One) ◉ US Residency Non US Residency Active US Military Service

City	Cupertino	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	10292 Orange Avenue		
Address 2			
City	Cupertino	State/Province	CA
Postal Code	95014	Country	US

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Sean		Merritt	

Residence Information (Select One) ◉ US Residency Non US Residency Active US Military Service

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

City	Lake Forest	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	25111 Paseo Arboleda		
Address 2			
City	Lake Forest	State/Province	CA
Postal Code	92630	Country	US

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Cristiano		Dalvi	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Lake Forest	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	23972 Oswego St.		
Address 2			
City	Lake Forest	State/Province	CA
Postal Code	92630	Country	US

Inventor 5 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Hung		Vo	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Fountain Valley	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	18849 Teton Cir		
Address 2			
City	Fountain Valley	State/Province	CA
Postal Code	92708	Country	US

Inventor 6 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Johannes		Bruinsma	

Residence Information (Select One) ○ US Residency ● Non US Residency ○ Active US Military Service

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

City	Opeinde	Country of Residence i	NL

Mailing Address of Inventor:

Address 1	Teije Blauwsingel 45		
Address 2			
City	Opeinde	State/Province	
Postal Code	9218 RT	Country i	NL

Inventor 7 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Ferdyan		Lesmana	

Residence Information (Select One) (•) US Residency ( ) Non US Residency Active US Military Service

City	Irvine	State/Province	CA	Country of Residence i	US

Mailing Address of Inventor:

Address 1	42 New Season		
Address 2			
City	Irvine	State/Province	CA
Postal Code	92602	Country i	US

Inventor 8 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Massi	Joe E.	Kiani	

Residence Information (Select One) (•) US Residency ( ) Non US Residency Active US Military Service

City	Laguna Niguel	State/Province	CA	Country of Residence i	US

Mailing Address of Inventor:

Address 1	1 Point Catalina		
Address 2			
City	Laguna Niguel	State/Province	CA
Postal Code	92677	Country i	US

Inventor 9 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Greg		Olsen	

Residence Information (Select One) (•) US Residency ( ) Non US Residency Active US Military Service

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

City	Lake Forest	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	24498 Copper Cliff Court		
Address 2			
City	Lake Forest	**State/Province**	CA
Postal Code	92630	**Country**	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	64735		
Email Address	efiling@knobbe.com	Add Email	Remove Email

Application Information:

Title of the Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS		
Attorney Docket Number	MASCER.002C13	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	65	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	◯ Limited Recognition (37 CFR 11.9)
Customer Number	64735		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
	Continuation of	16/534949	2019-08-07		
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/534949	Continuation of	16/409515	2019-05-10	10376191	2019-08-13
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/409515	Continuation of	16/261326	2019-01-29	10292628	2019-05-21
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/261326	Continuation of	16/212537	2018-12-06	10258266	2019-04-16
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/212537	Continuation of	14/981290	2015-12-28	10335068	2019-07-02

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14/981290	Continuation of	12/829352	2010-07-01	9277880	2016-03-08
Prior Application Status	Abandoned				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
12/829352	Continuation of	12/534827	2009-08-03		
Prior Application Status	Expired				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
12/534827	Claims benefit of provisional	61/086060	2008-08-04		
Prior Application Status	Expired				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
12/534827	Claims benefit of provisional	61/086108	2008-08-04		
Prior Application Status	Expired				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
12/534827	Claims benefit of provisional	61/086063	2008-08-04		
Prior Application Status	Expired				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
12/534827	Claims benefit of provisional	61/086057	2008-08-04		
Prior Application Status	Expired				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
12/534827	Claims benefit of provisional	61/091732	2008-08-25		
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
12/829352	Continuation in part of	12/497528	2009-07-02	8577431	2013-11-05
Prior Application Status	Expired				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
12/497528	Claims benefit of provisional	61/086060	2008-08-04		

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497528	Claims benefit of provisional	61/086108	2008-08-04
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497528	Claims benefit of provisional	61/086063	2008-08-04
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497528	Claims benefit of provisional	61/086057	2008-08-04
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497528	Claims benefit of provisional	61/078228	2008-07-03
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497528	Claims benefit of provisional	61/078207	2008-07-03
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497528	Claims benefit of provisional	61/091732	2008-08-25
Prior Application Status	Patented		Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
12/497528	Continuation in part of	29/323408	2008-08-25	D606659	2009-12-22
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
12/497528	Continuation in part of	29/323409	2008-08-25	D621516	2010-08-10
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
12/829352	Continuation in part of	12/497523	2009-07-02	8437825	2013-05-07

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497523	Claims benefit of provisional	61/086060	2008-08-04
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497523	Claims benefit of provisional	61/086108	2008-08-04
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497523	Claims benefit of provisional	61/086063	2008-08-04
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497523	Claims benefit of provisional	61/086057	2008-08-04
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497523	Claims benefit of provisional	61/078228	2008-07-03
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497523	Claims benefit of provisional	61/078207	2008-07-03
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12/497523	Claims benefit of provisional	61/091732	2008-08-25
Prior Application Status	Patented		Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
12/497523	Continuation in part of	29/323408	2008-08-25	D606659	2009-12-22
Prior Application Status	Patented				Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
12/497523	Continuation in part of	29/323409	2008-08-25	D621516	2010-08-10

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

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Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Masimo Corporation		
Mailing Address Information For Applicant:			
Address 1	52 Discovery		
Address 2			
City	Irvine	**State/Province**	CA
Country	US	Postal Code	92618
Phone Number		Fax Number	
Email Address			

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Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Scott Cromar/			Date (YYYY-MM-DD)	2019-08-19
First Name	Scott	Last Name	Cromar	Registration Number	65066

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MASCER.002C13
	Application Number	
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

This collection of information is required by 37 CFR 1.76. 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 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet 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, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Patent Application No. 16/534949, filed August 7, 2019, which is a continuation of U.S. Patent Application No. 16/409515, filed May 10, 2019, which is a continuation of U.S. Patent Application No. 16/261326, filed January 29, 2019, which is a continuation of U.S. Patent Application No. 16/212,537, filed December 6, 2018, which is a continuation of U.S. Patent Application No. 14/981,290 filed December 28, 2015, which is a continuation of U.S. Patent Application No. 12/829,352 filed July 1, 2010, which is a continuation of U.S. Patent Application No. 12/534,827 filed August 3, 2009, which claims the benefit of priority under 35 U.S.C. § 119(e) of the following U.S. Provisional Patent Application Nos. 61/086,060 filed August 4, 2008, 61/086,108 filed August 4, 2008, 61/086,063 filed August 4, 2008, 61/086,057 filed August 4, 2008, and 61/091,732 filed August 25, 2008. U.S. Patent Application No. 12/829,352 is also a continuation-in-part of U.S. Patent Application No. 12/497,528 filed July 2, 2009, which claims the benefit of priority under 35 U.S.C. § 119(e) of the following U.S. Provisional Patent Application Nos. 61/086,060 filed August 4, 2008, 61/086,108 filed August 4, 2008, 61/086,063 filed August 4, 2008, 61/086,057 filed August 4, 2008, 61/078,228 filed July 3, 2008, 61/078,207 filed July 3, 2008, and 61/091,732 filed August 25, 2008. U.S. Patent Application No. 12/497,528 also claims the benefit of priority under 35 U.S.C. § 120 as a continuation-in-part of the following U.S. Design Patent Application Nos. 29/323,409 filed August 25, 2008 and 29/323,408 filed August 25, 2008. U.S. Patent Application No. 12/829,352 is also a continuation-in-part of U.S. Patent Application No. 12/497,523 filed July 2, 2009, which claims the benefit of priority under 35 U.S.C. § 119(e) of the following U.S. Provisional Patent Application Nos. 61/086,060 filed August 4, 2008, 61/086,108 filed August 4, 2008, 61/086,063 filed August 4, 2008, 61/086,057 filed August 4, 2008, 61/078,228 filed July 3, 2008, 61/078,207 filed July 3, 2008, and 61/091,732

filed August 25, 2008. U.S. Patent Application No. 12/497,523 also claims the benefit of priority under 35 U.S.C. § 120 as a continuation-in-part of the following U.S. Design Patent Application Nos. 29/323,409 filed August 25, 2008 and 29/323,408 filed August 25, 2008.

[0002] This application is related to the following U.S. Patent Applications:

App. No.	Filing Date	Title	Attorney Docket
12/497,528	7/2/09	*Noise Shielding for Noninvasive Device*	MASCER.006A
12/497,523	7/2/09	*Contoured Protrusion for Improving Spectroscopic Measurement of Blood Constituents*	MASCER.007A
12/497,506	7/2/09	*Heat Sink for Noninvasive Medical Sensor*	MASCER.011A
12/534,812	8/3/09	*Multi-Stream Sensor Front Ends for Non-Invasive Measurement of Blood Constituents*	MASCER.003A
12/534,823	8/3/09	*Multi-Stream Sensor for Non-Invasive Measurement of Blood Constituents*	MASCER.004A
12/534,825	8/3/09	*Multi-Stream Emitter for Non-Invasive Measurement of Blood Constituents*	CERCA.005A

[0003] The foregoing applications are hereby incorporated by reference in their entirety.

BACKGROUND

[0004] The standard of care in caregiver environments includes patient monitoring through spectroscopic analysis using, for example, a pulse oximeter. Devices capable of spectroscopic analysis generally include a light source(s) transmitting optical radiation into or reflecting off a measurement site, such as, body tissue carrying pulsing blood. After attenuation by tissue and fluids of the

measurement site, a photodetection device(s) detects the attenuated light and outputs a detector signal(s) responsive to the detected attenuated light. A signal processing device(s) process the detector(s) signal(s) and outputs a measurement indicative of a blood constituent of interest, such as glucose, oxygen, met hemoglobin, total hemoglobin, other physiological parameters, or other data or combinations of data useful in determining a state or trend of wellness of a patient.

[0005] In noninvasive devices and methods, a sensor is often adapted to position a finger proximate the light source and light detector. For example, noninvasive sensors often include a clothespin-shaped housing that includes a contoured bed conforming generally to the shape of a finger.

SUMMARY

[0006] This disclosure describes embodiments of noninvasive methods, devices, and systems for measuring a blood constituent or analyte, such as oxygen, carbon monoxide, methemoglobin, total hemoglobin, glucose, proteins, glucose, lipids, a percentage thereof (e.g., saturation) or for measuring many other physiologically relevant patient characteristics. These characteristics can relate, for example, to pulse rate, hydration, trending information and analysis, and the like.

[0007] In an embodiment, the system includes a noninvasive sensor and a patient monitor communicating with the noninvasive sensor. The non-invasive sensor may include different architectures to implement some or all of the disclosed features. In addition, an artisan will recognize that the non-invasive sensor may include or may be coupled to other components, such as a network interface, and the like. Moreover, the patient monitor may include a display device, a network interface communicating with any one or combination of a computer network, a handheld computing device, a mobile phone, the Internet, or the like. In addition, embodiments may include multiple optical sources that emit light at a plurality of wavelengths and that are arranged from the perspective of the light detector(s) as a point source.

[0008] In an embodiment, a noninvasive device is capable of producing a signal responsive to light attenuated by tissue at a measurement site. The device may comprise an optical source and a plurality of photodetectors. The optical source is configured to emit optical radiation at least at wavelengths between about 1600 nm and about 1700 nm. The photodetectors are configured to detect the optical radiation from said optical source after attenuation by the tissue of the measurement site and each output a respective signal stream responsive to the detected optical radiation.

[0009] In an embodiment, a noninvasive, physiological sensor is capable of outputting a signal responsive to a blood analyte present in a monitored patient. The sensor may comprise a sensor housing, an optical source, and photodetectors. The optical source is positioned by the housing with respect to a tissue site of a patient when said housing is applied to the patient. The photodetectors are

positioned by the housing with respect to said tissue site when the housing is applied to the patient with a variation in path length among at least some of the photodetectors from the optical source. The photodetectors are configured to detect a sequence of optical radiation from the optical source after attenuation by tissue of the tissue site. The photodetectors may be each configured to output a respective signal stream responsive to the detected sequence of optical radiation. An output signal responsive to one or more of the signal streams is then usable to determine the blood analyte based at least in part on the variation in path length.

[0010] In an embodiment, a method of measuring an analyte based on multiple streams of optical radiation measured from a measurement site is provided. A sequence of optical radiation pulses is emitted to the measurement site. At a first location, a first stream of optical radiation is detected from the measurement site. At least at one additional location different from the first location, an additional stream of optical radiation is detected from the measurement site. An output measurement value indicative of the analyte is then determined based on the detected streams of optical radiation.

[0011] In various embodiments, the present disclosure relates to an interface for a noninvasive sensor that comprises a front-end adapted to receive an input signals from optical detectors and provide corresponding output signals. In an embodiment, the front-end is comprised of switched-capacitor circuits that are capable of handling multiple streams of signals from the optical detectors. In another embodiment, the front-end comprises transimpedance amplifiers that are capable of handling multiple streams of input signals. In addition, the transimpedance amplifiers may be configured based on the characteristics of the transimpedance amplifier itself, the characteristics of the photodiodes, and the number of photodiodes coupled to the transimpedance amplifier.

[0012] In disclosed embodiments, the front-ends are employed in noninvasive sensors to assist in measuring and detecting various analytes. The disclosed noninvasive sensor may also include, among other things, emitters and detectors positioned to produce multi-stream sensor information. An artisan will recognize that the noninvasive sensor may have different architectures and may

include or be coupled to other components, such as a display device, a network interface, and the like. An artisan will also recognize that the front-ends may be employed in any type of noninvasive sensor.

[0013] In an embodiment, a front-end interface for a noninvasive, physiological sensor comprises: a set of inputs configured to receive signals from a plurality of detectors in the sensor; a set of transimpedance amplifiers configured to convert the signals from the plurality of detectors into an output signal having a stream for each of the plurality of detectors; and an output configured to provide the output signal.

[0014] In an embodiment, a front-end interface for a noninvasive, physiological sensor comprises: a set of inputs configured to receive signals from a plurality of detectors in the sensor; a set of switched capacitor circuits configured to convert the signals from the plurality of detectors into a digital output signal having a stream for each of the plurality of detectors; and an output configured to provide the digital output signal.

[0015] In an embodiment, a conversion processor for a physiological, noninvasive sensor comprises: a multi-stream input configured to receive signals from a plurality of detectors in the sensor, wherein the signals are responsive to optical radiation from a tissue site; a modulator that converts the multi-stream input into a digital bit-stream; and a signal processor that produces an output signal from the digital bit-stream.

[0016] In an embodiment, a front-end interface for a noninvasive, physiological sensor comprises: a set of inputs configured to receive signals from a plurality of detectors in the sensor; a set of respective transimpedance amplifiers for each detector configured to convert the signals from the plurality of detectors into an output signal having a stream for each of the plurality of detectors; and an output configured to provide the output signal.

[0017] In certain embodiments, a noninvasive sensor interfaces with tissue at a measurement site and deforms the tissue in a way that increases signal gain in certain desired wavelengths.

[0018] In some embodiments, a detector for the sensor may comprise a set of photodiodes that are arranged in a spatial configuration. This spatial configuration may allow, for example, signal analysis for measuring analytes like glucose. In various embodiments, the detectors can be arranged across multiple locations in a spatial configuration. The spatial configuration provides a geometry having a diversity of path lengths among the detectors. For example, the detector in the sensor may comprise multiple detectors that are arranged to have a sufficient difference in mean path length to allow for noise cancellation and noise reduction.

[0019] In an embodiment, a physiological, noninvasive detector is configured to detect optical radiation from a tissue site. The detector comprises a set of photodetectors and a conversion processor. The set of photodetectors each provide a signal stream indicating optical radiation from the tissue site. The set of photodetectors are arranged in a spatial configuration that provides a variation in path lengths between at least some of the photodetectors. The conversion processor that provides information indicating an analyte in the tissue site based on ratios of pairs of the signal streams.

[0020] The present disclosure, according to various embodiments, relates to noninvasive methods, devices, and systems for measuring a blood analyte, such as glucose. In the present disclosure, blood analytes are measured noninvasively based on multi-stream infrared and near-infrared spectroscopy. In some embodiments, an emitter may include one or more sources that are configured as a point optical source. In addition, the emitter may be operated in a manner that allows for the measurement of an analyte like glucose. In embodiments, the emitter may comprise a plurality of LEDs that emit a sequence of pulses of optical radiation across a spectrum of wavelengths. In addition, in order to achieve the desired SNR for detecting analytes like glucose, the emitter may be driven using a progression from low power to higher power. The emitter may also have its duty cycle modified to achieve a desired SNR.

[0021] In an embodiment, a multi-stream emitter for a noninvasive, physiological device configured to transmit optical radiation in a tissue site comprises: a set of optical sources arranged as a point optical source; and a driver

configured to drive the at least one light emitting diode and at least one optical source to transmit near-infrared optical radiation at sufficient power to measure an analyte in tissue that responds to near-infrared optical radiation.

[0022] In an embodiment, an emitter for a noninvasive, physiological device configured to transmit optical radiation in a tissue site comprises: a point optical source comprising an optical source configured to transmit infrared and near-infrared optical radiation to a tissue site; and a driver configured to drive the point optical source at a sufficient power and noise tolerance to effectively provide attenuated optical radiation from a tissue site that indicates an amount of glucose in the tissue site.

[0023] In an embodiment, a method of transmitting a stream of pulses of optical radiation in a tissue site is provided. At least one pulse of infrared optical radiation having a first pulse width is transmitted at a first power. At least one pulse of near-infrared optical radiation is transmitted at a power that is higher than the first power.

[0024] In an embodiment, a method of transmitting a stream of pulses of optical radiation in a tissue site is provided. At least one pulse of infrared optical radiation having a first pulse width is transmitted at a first power. At least one pulse of near-infrared optical radiation is then transmitted, at a second power that is higher than the first power.

[0025] For purposes of summarizing the disclosure, certain aspects, advantages and novel features of the inventions have been described herein. It is to be understood that not necessarily all such advantages can be achieved in accordance with any particular embodiment of the inventions disclosed herein. Thus, the inventions disclosed herein can be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other advantages as can be taught or suggested herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] Throughout the drawings, reference numbers can be re-used to indicate correspondence between referenced elements. The drawings are provided to illustrate embodiments of the inventions described herein and not to limit the scope thereof.

[0027] FIGURE 1 illustrates a block diagram of an example data collection system capable of noninvasively measuring one or more blood analytes in a monitored patient, according to an embodiment of the disclosure;

[0028] FIGURES 2A – 2D illustrate an exemplary handheld monitor and an exemplary noninvasive optical sensor of the patient monitoring system of Figure 1, according to embodiments of the disclosure;

[0029] FIGURES 3A – 3C illustrate side and perspective views of an exemplary noninvasive sensor housing including a finger bed protrusion and heat sink, according to an embodiment of the disclosure;

[0030] FIGURE 3D illustrates a side view of another example noninvasive sensor housing including a heat sink, according to an embodiment of the disclosure;

[0031] FIGURE 3E illustrates a perspective view of an example noninvasive sensor detector shell including example detectors, according to an embodiment of the disclosure;

[0032] FIGURE 3F illustrates a side view of an example noninvasive sensor housing including a finger bed protrusion and heat sink, according to an embodiment of the disclosure;

[0033] FIGURES 4A through 4C illustrate top elevation, side and top perspective views of an example protrusion, according to an embodiment of the disclosure;

[0034] FIGURE 5 illustrates an example graph depicting possible effects of a protrusion on light transmittance, according to an embodiment of the disclosure;

[0035] FIGURES 6A through 6D illustrate perspective, front elevation, side and top views of another example protrusion, according to an embodiment of the disclosure;

[0036] FIGURE 6E illustrates an example sensor incorporating the protrusion of FIGURES 6A through 6D, according to an embodiment of the disclosure;

[0037] FIGURES 7A through 7B illustrate example arrangements of conductive glass that may be employed in the system of FIGURE 1, according to embodiments of the disclosure;

[0038] FIGURES 8A through 8D illustrate an example top elevation view, side views, and a bottom elevation view of the conductive glass that may be employed in the system of FIGURE 1, according to embodiments of the disclosure;

[0039] FIGURE 9 shows example comparative results obtained by an embodiment of a sensor;

[0040] FIGURES 10A and 10B illustrate comparative noise floors of various embodiments of the present disclosure;

[0041] FIGURE 11A illustrates an exemplary emitter that may be employed in the sensor, according to an embodiment of the disclosure;

[0042] FIGURE 11B illustrates a configuration of emitting optical radiation into a measurement site for measuring blood constituents, according to an embodiment of the disclosure;

[0043] FIGURE 11C illustrates another exemplary emitter that may be employed in the sensor according to an embodiment of the disclosure;

[0044] FIGURE 11D illustrates another exemplary emitter that may be employed in the sensor according to an embodiment of the disclosure;

[0045] FIGURE 12A illustrates an example detector portion that may be employed in an embodiment of a sensor, according to an embodiment of the disclosure;

[0046] FIGURES 12B through 12D illustrate exemplary arrangements of detectors that may be employed in an embodiment of the sensor, according to some embodiments of the disclosure;

[0047] FIGURES 12E through 12H illustrate exemplary structures of photodiodes that may be employed in embodiments of the detectors, according to some embodiments of the disclosure;

[0048] FIGURE 13 illustrates an example multi-stream operation of the system of FIGURE 1, according to an embodiment of the disclosure;

[0049] FIGURE 14A illustrates another example detector portion having a partially cylindrical protrusion that can be employed in an embodiment of a sensor, according to an embodiment of the disclosure;

[0050] FIGURE 14B depicts a front elevation view of the partially cylindrical protrusion of FIGURE 14A;

[0051] FIGURES 14C through 14E illustrate embodiments of a detector submount;

[0052] FIGURES 14F through 14H illustrate embodiment of portions of a detector shell;

[0053] FIGURE 14I illustrates a cutaway view of an embodiment of a sensor;

[0054] FIGURES 15A through 15F illustrate embodiments of sensors that include heat sink features;

[0055] FIGURES 15G and 15H illustrate embodiments of connector features that can be used with any of the sensors described herein;

[0056] FIGURE 15I illustrates an exemplary architecture for a transimpedance-based front-end that may be employed in any of the sensors described herein;

[0057] FIGURE 15J illustrates an exemplary noise model for configuring the transimpedance-based front-ends shown in FIGURE 15I;

[0058] FIGURE 15K shows different architectures and layouts for various embodiments of a sensor and its detectors;

[0059] FIGURE 15L illustrates an exemplary architecture for a switched-capacitor-based front-end that may be employed in any of the sensors described herein;

[0060] FIGURES 16A and 16B illustrate embodiments of disposable optical sensors;

[0061] FIGURE 17 illustrates an exploded view of certain components of an example sensor; and

[0062] FIGURES 18 through 22 illustrate various results obtained by an exemplary sensor of the disclosure.

DETAILED DESCRIPTION

[0063] The present disclosure generally relates to non-invasive medical devices. In the present disclosure, a sensor can measure various blood constituents or analytes noninvasively using multi-stream spectroscopy. In an embodiment, the multi-stream spectroscopy can employ visible, infrared and near infrared wavelengths. As disclosed herein, the sensor is capable of noninvasively measuring blood analytes or percentages thereof (e.g., saturation) based on various combinations of features and components.

[0064] In various embodiments, the present disclosure relates to an interface for a noninvasive glucose sensor that comprises a front-end adapted to receive an input signals from optical detectors and provide corresponding output signals. The front-end may comprise, among other things, switched capacitor circuits or transimpedance amplifiers. In an embodiment, the front-end may comprise switched capacitor circuits that are configured to convert the output of sensor's detectors into a digital signal. In another embodiment, the front-end may comprise transimpedance amplifiers. These transimpedance amplifiers may be configured to match one or more photodiodes in a detector based on a noise model that accounts for characteristics, such as the impedance, of the transimpedance amplifier, characteristics of each photodiode, such as the impedance, and the number of photodiodes coupled to the transimpedance amplifier.

[0065] In the present disclosure, the front-ends are employed in a sensor that measures various blood analytes noninvasively using multi-stream spectroscopy. In an embodiment, the multi-stream spectroscopy can employ visible, infrared and near infrared wavelengths. As disclosed herein, the sensor is capable of noninvasively measuring blood analytes, such as glucose, total hemoglobin, methemoglobin, oxygen content, and the like, based on various combinations of features and components.

[0066] In an embodiment, a physiological sensor includes a detector housing that can be coupled to a measurement site, such as a patient's finger. The sensor housing can include a curved bed that can generally conform to the shape of the measurement site. In addition, the curved bed can include a protrusion shaped

to increase an amount of light radiation from the measurement site. In an embodiment, the protrusion is used to thin out the measurement site. This allows the light radiation to pass through less tissue, and accordingly is attenuated less. In an embodiment, the protrusion can be used to increase the area from which attenuated light can be measured. In an embodiment, this is done through the use of a lens which collects attenuated light exiting the measurement site and focuses onto one or more detectors. The protrusion can advantageously include plastic, including a hard opaque plastic, such as a black or other colored plastic, helpful in reducing light noise. In an embodiment, such light noise includes light that would otherwise be detected at a photodetector that has not been attenuated by tissue of the measurement site of a patient sufficient to cause the light to adequately included information indicative of one or more physiological parameters of the patient. Such light noise includes light piping.

[0067] In an embodiment, the protrusion can be formed from the curved bed, or can be a separate component that is positionable with respect to the bed. In an embodiment, a lens made from any appropriate material is used as the protrusion. The protrusion can be convex in shape. The protrusion can also be sized and shaped to conform the measurement site into a flat or relatively flat surface. The protrusion can also be sized to conform the measurement site into a rounded surface, such as, for example, a concave or convex surface. The protrusion can include a cylindrical or partially cylindrical shape. The protrusion can be sized or shaped differently for different types of patients, such as an adult, child, or infant. The protrusion can also be sized or shaped differently for different measurement sites, including, for example, a finger, toe, hand, foot, ear, forehead, or the like. The protrusion can thus be helpful in any type of noninvasive sensor. The external surface of the protrusion can include one or more openings or windows. The openings can be made from glass to allow attenuated light from a measurement site, such as a finger, to pass through to one or more detectors. Alternatively, some of all of the protrusion can be a lens, such as a partially cylindrical lens.

[0068] The sensor can also include a shielding, such as a metal enclosure as described below or embedded within the protrusion to reduce noise. The shielding can be constructed from a conductive material, such as copper, in the form of a metal cage or enclosure, such as a box. The shielding can include a second set of one or more openings or windows. The second set of openings can be made from glass and allow light that has passed through the first set of windows of the external surface of the protrusion to pass through to one or more detectors that can be enclosed, for example, as described below.

[0069] In various embodiments, the shielding can include any substantially transparent, conductive material placed in the optical path between an emitter and a detector. The shielding can be constructed from a transparent material, such as glass, plastic, and the like. The shielding can have an electrically conductive material or coating that is at least partially transparent. The electrically conductive coating can be located on one or both sides of the shielding, or within the body of the shielding. In addition, the electrically conductive coating can be uniformly spread over the shielding or may be patterned. Furthermore, the coating can have a uniform or varying thickness to increase or optimize its shielding effect. The shielding can be helpful in virtually any type of noninvasive sensor that employs spectroscopy.

[0070] In an embodiment, the sensor can also include a heat sink. In an embodiment, the heat sink can include a shape that is functional in its ability to dissipate excess heat and aesthetically pleasing to the wearer. For example, the heat sink can be configured in a shape that maximizes surface area to allow for greater dissipation of heat. In an embodiment, the heat sink includes a metalicized plastic, such as plastic including carbon and aluminum to allow for improved thermal conductivity and diffusivity. In an embodiment, the heat sink can advantageously be inexpensively molded into desired shapes and configurations for aesthetic and functional purposes. For example, the shape of the heat sink can be a generally curved surface and include one or more fins, undulations, grooves or channels, or combs.

[0071] The sensor can include photocommunicative components, such as an emitter, a detector, and other components. The emitter can include a plurality of sets of optical sources that, in an embodiment, are arranged together as a point source. The various optical sources can emit a sequence of optical radiation pulses at different wavelengths towards a measurement site, such as a patient's finger. Detectors can then detect optical radiation from the measurement site. The optical sources and optical radiation detectors can operate at any appropriate wavelength, including, as discussed herein, infrared, near infrared, visible light, and ultraviolet. In addition, the optical sources and optical radiation detectors can operate at any appropriate wavelength, and such modifications to the embodiments desirable to operate at any such wavelength will be apparent to those skilled in the art.

[0072] In certain embodiments, multiple detectors are employed and arranged in a spatial geometry. This spatial geometry provides a diversity of path lengths among at least some of the detectors and allows for multiple bulk and pulsatile measurements that are robust. Each of the detectors can provide a respective output stream based on the detected optical radiation, or a sum of output streams can be provided from multiple detectors. In some embodiments, the sensor can also include other components, such as one or more heat sinks and one or more thermistors.

[0073] The spatial configuration of the detectors provides a geometry having a diversity of path lengths among the detectors. For example, a detector in the sensor may comprise multiple detectors that are arranged to have a sufficient difference in mean path length to allow for noise cancellation and noise reduction. In addition, walls may be used to separate individual photodetectors and prevent mixing of detected optical radiation between the different locations on the measurement site. A window may also be employed to facilitate the passing of optical radiation at various wavelengths for measuring glucose in the tissue.

[0074] In the present disclosure, a sensor may measure various blood constituents or analytes noninvasively using spectroscopy and a recipe of various features. As disclosed herein, the sensor is capable of non-invasively measuring blood analytes, such as, glucose, total hemoglobin, methemoglobin, oxygen content,

and the like. In an embodiment, the spectroscopy used in the sensor can employ visible, infrared and near infrared wavelengths. The sensor may comprise an emitter, a detector, and other components. In some embodiments, the sensor may also comprise other components, such as one or more heat sinks and one or more thermistors.

[0075] In various embodiments, the sensor may also be coupled to one or more companion devices that process and/or display the sensor's output. The companion devices may comprise various components, such as a sensor front-end, a signal processor, a display, a network interface, a storage device or memory, etc.

[0076] A sensor can include photocommunicative components, such as an emitter, a detector, and other components. The emitter is configured as a point optical source that comprises a plurality of LEDs that emit a sequence of pulses of optical radiation across a spectrum of wavelengths. In some embodiments, the plurality of sets of optical sources may each comprise at least one top-emitting LED and at least one super luminescent LED. In some embodiments, the emitter comprises optical sources that transmit optical radiation in the infrared or near-infrared wavelengths suitable for detecting blood analytes like glucose. In order to achieve the desired SNR for detecting analytes like glucose, the emitter may be driven using a progression from low power to higher power. In addition, the emitter may have its duty cycle modified to achieve a desired SNR.

[0077] The emitter may be constructed of materials, such as aluminum nitride and may include a heat sink to assist in heat dissipation. A thermistor may also be employed to account for heating effects on the LEDs. The emitter may further comprise a glass window and a nitrogen environment to improve transmission from the sources and prevent oxidative effects.

[0078] The sensor can be coupled to one or more monitors that process and/or display the sensor's output. The monitors can include various components, such as a sensor front end, a signal processor, a display, etc.

[0079] The sensor can be integrated with a monitor, for example, into a handheld unit including the sensor, a display and user controls. In other embodiments, the sensor can communicate with one or more processing devices.

The communication can be via wire(s), cable(s), flex circuit(s), wireless technologies, or other suitable analog or digital communication methodologies and devices to perform those methodologies. Many of the foregoing arrangements allow the sensor to be attached to the measurement site while the device is attached elsewhere on a patient, such as the patient's arm, or placed at a location near the patient, such as a bed, shelf or table. The sensor or monitor can also provide outputs to a storage device or network interface.

[0080] Reference will now be made to the Figures to discuss embodiments of the present disclosure.

[0081] **FIGURE 1** illustrates an example of a data collection system 100. In certain embodiments, the data collection system 100 noninvasively measure a blood analyte, such as oxygen, carbon monoxide, methemoglobin, total hemoglobin, glucose, proteins, glucose, lipids, a percentage thereof (e.g., saturation) or for measuring many other physiologically relevant patient characteristics. The system 100 can also measure additional blood analytes and/or other physiological parameters useful in determining a state or trend of wellness of a patient.

[0082] The data collection system 100 can be capable of measuring optical radiation from the measurement site. For example, in some embodiments, the data collection system 100 can employ photodiodes defined in terms of area. In an embodiment, the area is from about 1 mm^2 – 5 mm^2 (or higher) that are capable of detecting about 100 nanoamps (nA) or less of current resulting from measured light at full scale. In addition to having its ordinary meaning, the phrase "at full scale" can mean light saturation of a photodiode amplifier (not shown). Of course, as would be understood by a person of skill in the art from the present disclosure, various other sizes and types of photodiodes can be used with the embodiments of the present disclosure.

[0083] The data collection system 100 can measure a range of approximately about 2 nA to about 100 nA full scale. The data collection system 100 can also include sensor front-ends that are capable of processing and amplifying current from the detector(s) at signal-to-noise ratios (SNRs) of about 100 decibels (dB) or more, such as about 120 dB in order to measure various desired

analytes. The data collection system 100 can operate with a lower SNR if less accuracy is desired for an analyte like glucose.

[0084] The data collection system 100 can measure analyte concentrations, including glucose, at least in part by detecting light attenuated by a measurement site 102. The measurement site 102 can be any location on a patient's body, such as a finger, foot, ear lobe, or the like. For convenience, this disclosure is described primarily in the context of a finger measurement site 102. However, the features of the embodiments disclosed herein can be used with other measurement sites 102.

[0085] In the depicted embodiment, the system 100 includes an optional tissue thickness adjuster or tissue shaper 105, which can include one or more protrusions, bumps, lenses, or other suitable tissue-shaping mechanisms. In certain embodiments, the tissue shaper 105 is a flat or substantially flat surface that can be positioned proximate the measurement site 102 and that can apply sufficient pressure to cause the tissue of the measurement site 102 to be flat or substantially flat. In other embodiments, the tissue shaper 105 is a convex or substantially convex surface with respect to the measurement site 102. Many other configurations of the tissue shaper 105 are possible. Advantageously, in certain embodiments, the tissue shaper 105 reduces thickness of the measurement site 102 while preventing or reducing occlusion at the measurement site 102. Reducing thickness of the site can advantageously reduce the amount of attenuation of the light because there is less tissue through which the light must travel. Shaping the tissue in to a convex (or alternatively concave) surface can also provide more surface area from which light can be detected.

[0086] The embodiment of the data collection system 100 shown also includes an optional noise shield 103. In an embodiment, the noise shield 103 can be advantageously adapted to reduce electromagnetic noise while increasing the transmittance of light from the measurement site 102 to one or more detectors 106 (described below). For example, the noise shield 103 can advantageously include a conductive coated glass or metal grid electrically communicating with one or more other shields of the sensor 101 or electrically grounded. In an embodiment where

the noise shield 103 includes conductive coated glass, the coating can advantageously include indium tin oxide. In an embodiment, the indium tin oxide includes a surface resistivity ranging from approximately 30 ohms per square inch to about 500 ohms per square inch. In an embodiment, the resistivity is approximately 30, 200, or 500 ohms per square inch. As would be understood by a person of skill in the art from the present disclosure, other resistivities can also be used which are less than about 30 ohms or more than about 500 ohms. Other conductive materials transparent or substantially transparent to light can be used instead.

[0087] In some embodiments, the measurement site 102 is located somewhere along a non-dominant arm or a non-dominant hand, e.g., a right-handed person's left arm or left hand. In some patients, the non-dominant arm or hand can have less musculature and higher fat content, which can result in less water content in that tissue of the patient. Tissue having less water content can provide less interference with the particular wavelengths that are absorbed in a useful manner by blood analytes like glucose. Accordingly, in some embodiments, the data collection system 100 can be used on a person's non-dominant hand or arm.

[0088] The data collection system 100 can include a sensor 101 (or multiple sensors) that is coupled to a processing device or physiological monitor 109. In an embodiment, the sensor 101 and the monitor 109 are integrated together into a single unit. In another embodiment, the sensor 101 and the monitor 109 are separate from each other and communicate one with another in any suitable manner, such as via a wired or wireless connection. The sensor 101 and monitor 109 can be attachable and detachable from each other for the convenience of the user or caregiver, for ease of storage, sterility issues, or the like. The sensor 101 and the monitor 109 will now be further described.

[0089] In the depicted embodiment shown in **FIGURE 1**, the sensor 101 includes an emitter 104, a tissue shaper 105, a set of detectors 106, and a front-end interface 108. The emitter 104 can serve as the source of optical radiation transmitted towards measurement site 102. As will be described in further detail below, the emitter 104 can include one or more sources of optical radiation, such as LEDs, laser diodes, incandescent bulbs with appropriate frequency-selective filters,

combinations of the same, or the like. In an embodiment, the emitter 104 includes sets of optical sources that are capable of emitting visible and near-infrared optical radiation.

[0090] In some embodiments, the emitter 104 is used as a point optical source, and thus, the one or more optical sources of the emitter 104 can be located within a close distance to each other, such as within about a 2 mm to about 4 mm. The emitters 104 can be arranged in an array, such as is described in U.S. Publication No. 2006/0211924, filed Sept. 21, 2006, titled "Multiple Wavelength Sensor Emitters," the disclosure of which is hereby incorporated by reference in its entirety. In particular, the emitters 104 can be arranged at least in part as described in paragraphs [0061] through [0068] of the aforementioned publication, which paragraphs are hereby incorporated specifically by reference. Other relative spatial relationships can be used to arrange the emitters 104.

[0091] For analytes like glucose, currently available non-invasive techniques often attempt to employ light near the water absorbance minima at or about 1600 nm. Typically, these devices and methods employ a single wavelength or single band of wavelengths at or about 1600 nm. However, to date, these techniques have been unable to adequately consistently measure analytes like glucose based on spectroscopy.

[0092] In contrast, the emitter 104 of the data collection system 100 can emit, in certain embodiments, combinations of optical radiation in various bands of interest. For example, in some embodiments, for analytes like glucose, the emitter 104 can emit optical radiation at three (3) or more wavelengths between about 1600 nm to about 1700 nm. In particular, the emitter 104 can emit optical radiation at or about 1610 nm, about 1640 nm, and about 1665 nm. In some circumstances, the use of three wavelengths within about 1600 nm to about 1700 nm enable sufficient SNRs of about 100 dB, which can result in a measurement accuracy of about 20 mg/dL or better for analytes like glucose.

[0093] In other embodiments, the emitter 104 can use two (2) wavelengths within about 1600 nm to about 1700 nm to advantageously enable SNRs of about 85 dB, which can result in a measurement accuracy of about 25-30 mg/dL or better

for analytes like glucose. Furthermore, in some embodiments, the emitter 104 can emit light at wavelengths above about 1670 nm. Measurements at these wavelengths can be advantageously used to compensate or confirm the contribution of protein, water, and other non-hemoglobin species exhibited in measurements for analytes like glucose conducted between about 1600 nm and about 1700 nm. Of course, other wavelengths and combinations of wavelengths can be used to measure analytes and/or to distinguish other types of tissue, fluids, tissue properties, fluid properties, combinations of the same or the like.

[0094] For example, the emitter 104 can emit optical radiation across other spectra for other analytes. In particular, the emitter 104 can employ light wavelengths to measure various blood analytes or percentages (e.g., saturation) thereof. For example, in one embodiment, the emitter 104 can emit optical radiation in the form of pulses at wavelengths about 905 nm, about 1050 nm, about 1200 nm, about 1300 nm, about 1330 nm, about 1610 nm, about 1640 nm, and about 1665 nm. In another embodiment, the emitter 104 can emit optical radiation ranging from about 860 nm to about 950 nm, about 950 nm to about 1100 nm, about 1100 nm to about 1270 nm, about 1250 nm to about 1350 nm, about 1300 nm to about 1360 nm, and about 1590 nm to about 1700 nm. Of course, the emitter 104 can transmit any of a variety of wavelengths of visible or near-infrared optical radiation.

[0095] Due to the different responses of analytes to the different wavelengths, certain embodiments of the data collection system 100 can advantageously use the measurements at these different wavelengths to improve the accuracy of measurements. For example, the measurements of water from visible and infrared light can be used to compensate for water absorbance that is exhibited in the near-infrared wavelengths.

[0096] As briefly described above, the emitter 104 can include sets of light-emitting diodes (LEDs) as its optical source. The emitter 104 can use one or more top-emitting LEDs. In particular, in some embodiments, the emitter 104 can include top-emitting LEDs emitting light at about 850 nm to 1350 nm.

[0097] The emitter 104 can also use super luminescent LEDs (SLEDs) or side-emitting LEDs. In some embodiments, the emitter 104 can employ SLEDs or

side-emitting LEDs to emit optical radiation at about 1600 nm to about 1800 nm. Emitter 104 can use SLEDs or side-emitting LEDs to transmit near infrared optical radiation because these types of sources can transmit at high power or relatively high power, e.g., about 40 mW to about 100 mW. This higher power capability can be useful to compensate or overcome the greater attenuation of these wavelengths of light in tissue and water. For example, the higher power emission can effectively compensate and/or normalize the absorption signal for light in the mentioned wavelengths to be similar in amplitude and/or effect as other wavelengths that can be detected by one or more photodetectors after absorption. However, the embodiments of the present disclosure do not necessarily require the use of high power optical sources. For example, some embodiments may be configured to measure analytes, such as total hemoglobin (tHb), oxygen saturation (SpO_2), carboxyhemoglobin, methemoglobin, etc., without the use of high power optical sources like side emitting LEDs. Instead, such embodiments may employ other types of optical sources, such as top emitting LEDs. Alternatively, the emitter 104 can use other types of sources of optical radiation, such as a laser diode, to emit near-infrared light into the measurement site 102.

[0098] In addition, in some embodiments, in order to assist in achieving a comparative balance of desired power output between the LEDs, some of the LEDs in the emitter 104 can have a filter or covering that reduces and/or cleans the optical radiation from particular LEDs or groups of LEDs. For example, since some wavelengths of light can penetrate through tissue relatively well, LEDs, such as some or all of the top-emitting LEDs can use a filter or covering, such as a cap or painted dye. This can be useful in allowing the emitter 104 to use LEDs with a higher output and/or to equalize intensity of LEDs.

[0099] The data collection system 100 also includes a driver 111 that drives the emitter 104. The driver 111 can be a circuit or the like that is controlled by the monitor 109. For example, the driver 111 can provide pulses of current to the emitter 104. In an embodiment, the driver 111 drives the emitter 104 in a progressive fashion, such as in an alternating manner. The driver 111 can drive the emitter 104 with a series of pulses of about 1 milliwatt (mW) for some wavelengths

that can penetrate tissue relatively well and from about 40 mW to about 100 mW for other wavelengths that tend to be significantly absorbed in tissue. A wide variety of other driving powers and driving methodologies can be used in various embodiments.

[0100] The driver 111 can be synchronized with other parts of the sensor 101 and can minimize or reduce jitter in the timing of pulses of optical radiation emitted from the emitter 104. In some embodiments, the driver 111 is capable of driving the emitter 104 to emit optical radiation in a pattern that varies by less than about 10 parts-per-million.

[0101] The detectors 106 capture and measure light from the measurement site 102. For example, the detectors 106 can capture and measure light transmitted from the emitter 104 that has been attenuated or reflected from the tissue in the measurement site 102. The detectors 106 can output a detector signal 107 responsive to the light captured or measured. The detectors 106 can be implemented using one or more photodiodes, phototransistors, or the like.

[0102] In addition, the detectors 106 can be arranged with a spatial configuration to provide a variation of path lengths among at least some of the detectors 106. That is, some of the detectors 106 can have the substantially, or from the perspective of the processing algorithm, effectively, the same path length from the emitter 104. However, according to an embodiment, at least some of the detectors 106 can have a different path length from the emitter 104 relative to other of the detectors 106. Variations in path lengths can be helpful in allowing the use of a bulk signal stream from the detectors 106. In some embodiments, the detectors 106 may employ a linear spacing, a logarithmic spacing, or a two or three dimensional matrix of spacing, or any other spacing scheme in order to provide an appropriate variation in path lengths.

[0103] The front end interface 108 provides an interface that adapts the output of the detectors 106, which is responsive to desired physiological parameters. For example, the front end interface 108 can adapt a signal 107 received from one or more of the detectors 106 into a form that can be processed by the monitor 109, for example, by a signal processor 110 in the monitor 109. The

front end interface 108 can have its components assembled in the sensor 101, in the monitor 109, in connecting cabling (if used), combinations of the same, or the like. The location of the front end interface 108 can be chosen based on various factors including space desired for components, desired noise reductions or limits, desired heat reductions or limits, and the like.

[0104] The front end interface 108 can be coupled to the detectors 106 and to the signal processor 110 using a bus, wire, electrical or optical cable, flex circuit, or some other form of signal connection. The front end interface 108 can also be at least partially integrated with various components, such as the detectors 106. For example, the front end interface 108 can include one or more integrated circuits that are on the same circuit board as the detectors 106. Other configurations can also be used.

[0105] The front end interface 108 can be implemented using one or more amplifiers, such as transimpedance amplifiers, that are coupled to one or more analog to digital converters (ADCs) (which can be in the monitor 109), such as a sigma-delta ADC. A transimpedance-based front end interface 108 can employ single-ended circuitry, differential circuitry, and/or a hybrid configuration. A transimpedance-based front end interface 108 can be useful for its sampling rate capability and freedom in modulation/demodulation algorithms. For example, this type of front end interface 108 can advantageously facilitate the sampling of the ADCs being synchronized with the pulses emitted from the emitter 104.

[0106] The ADC or ADCs can provide one or more outputs into multiple channels of digital information for processing by the signal processor 110 of the monitor 109. Each channel can correspond to a signal output from a detector 106.

[0107] In some embodiments, a programmable gain amplifier (PGA) can be used in combination with a transimpedance-based front end interface 108. For example, the output of a transimpedance-based front end interface 108 can be output to a PGA that is coupled with an ADC in the monitor 109. A PGA can be useful in order to provide another level of amplification and control of the stream of signals from the detectors 106. Alternatively, the PGA and ADC components can

be integrated with the transimpedance-based front end interface 108 in the sensor 101.

[0108] In another embodiment, the front end interface 108 can be implemented using switched-capacitor circuits. A switched-capacitor-based front end interface 108 can be useful for, in certain embodiments, its resistor-free design and analog averaging properties. In addition, a switched-capacitor-based front end interface 108 can be useful because it can provide a digital signal to the signal processor 110 in the monitor 109.

[0109] As shown in **FIGURE 1**, the monitor 109 can include the signal processor 110 and a user interface, such as a display 112. The monitor 109 can also include optional outputs alone or in combination with the display 112, such as a storage device 114 and a network interface 116. In an embodiment, the signal processor 110 includes processing logic that determines measurements for desired analytes, such as glucose, based on the signals received from the detectors 106. The signal processor 110 can be implemented using one or more microprocessors or subprocessors (e.g., cores), digital signal processors, application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), combinations of the same, and the like.

[0110] The signal processor 110 can provide various signals that control the operation of the sensor 101. For example, the signal processor 110 can provide an emitter control signal to the driver 111. This control signal can be useful in order to synchronize, minimize, or reduce jitter in the timing of pulses emitted from the emitter 104. Accordingly, this control signal can be useful in order to cause optical radiation pulses emitted from the emitter 104 to follow a precise timing and consistent pattern. For example, when a transimpedance-based front end interface 108 is used, the control signal from the signal processor 110 can provide synchronization with the ADC in order to avoid aliasing, cross-talk, and the like. As also shown, an optional memory 113 can be included in the front-end interface 108 and/or in the signal processor 110. This memory 113 can serve as a buffer or storage location for the front-end interface 108 and/or the signal processor 110, among other uses.

[0111] The user interface 112 can provide an output, e.g., on a display, for presentation to a user of the data collection system 100. The user interface 112 can be implemented as a touch-screen display, an LCD display, an organic LED display, or the like. In addition, the user interface 112 can be manipulated to allow for measurement on the non-dominant side of patient. For example, the user interface 112 can include a flip screen, a screen that can be moved from one side to another on the monitor 109, or can include an ability to reorient its display indicia responsive to user input or device orientation. In alternative embodiments, the data collection system 100 can be provided without a user interface 112 and can simply provide an output signal to a separate display or system.

[0112] A storage device 114 and a network interface 116 represent other optional output connections that can be included in the monitor 109. The storage device 114 can include any computer-readable medium, such as a memory device, hard disk storage, EEPROM, flash drive, or the like. The various software and/or firmware applications can be stored in the storage device 114, which can be executed by the signal processor 110 or another processor of the monitor 109. The network interface 116 can be a serial bus port (RS-232/RS-485), a Universal Serial Bus (USB) port, an Ethernet port, a wireless interface (e.g., WiFi such as any 802.1x interface, including an internal wireless card), or other suitable communication device(s) that allows the monitor 109 to communicate and share data with other devices. The monitor 109 can also include various other components not shown, such as a microprocessor, graphics processor, or controller to output the user interface 112, to control data communications, to compute data trending, or to perform other operations.

[0113] Although not shown in the depicted embodiment, the data collection system 100 can include various other components or can be configured in different ways. For example, the sensor 101 can have both the emitter 104 and detectors 106 on the same side of the measurement site 102 and use reflectance to measure analytes. The data collection system 100 can also include a sensor that measures the power of light emitted from the emitter 104.

[0114] **FIGURES 2A** through **2D** illustrate example monitoring devices 200 in which the data collection system 100 can be housed. Advantageously, in certain embodiments, some or all of the example monitoring devices 200 shown can have a shape and size that allows a user to operate it with a single hand or attach it, for example, to a patient's body or limb. Although several examples are shown, many other monitoring device configurations can be used to house the data collection system 100. In addition, certain of the features of the monitoring devices 200 shown in FIGURES 2A through 2D can be combined with features of the other monitoring devices 200 shown.

[0115] Referring specifically to **FIGURE 2A**, an example monitoring device 200A is shown, in which a sensor 201a and a monitor 209a are integrated into a single unit. The monitoring device 200A shown is a handheld or portable device that can measure glucose and other analytes in a patient's finger. The sensor 201a includes an emitter shell 204a and a detector shell 206a. The depicted embodiment of the monitoring device 200A also includes various control buttons 208a and a display 210a.

[0116] The sensor 201a can be constructed of white material used for reflective purposes (such as white silicone or plastic), which can increase the usable signal at the detector 106 by forcing light back into the sensor 201a. Pads in the emitter shell 204a and the detector shell 206a can contain separated windows to prevent or reduce mixing of light signals, for example, from distinct quadrants on a patient's finger. In addition, these pads can be made of a relatively soft material, such as a gel or foam, in order to conform to the shape, for example, of a patient's finger. The emitter shell 204a and the detector shell 206a can also include absorbing black or grey material portions to prevent or reduce ambient light from entering into the sensor 201a.

[0117] In some embodiments, some or all portions of the emitter shell 204a and/or detector shell 206a can be detachable and/or disposable. For example, some or all portions of the shells 204a and 206a can be removable pieces. The removability of the shells 204a and 206a can be useful for sanitary purposes or for sizing the sensor 201a to different patients. The monitor 209a can include a

fitting, slot, magnet, or other connecting mechanism to allow the sensor 201c to be removably attached to the monitor 209a.

[0118] The monitoring device 200a also includes optional control buttons 208a and a display 210a that can allow the user to control the operation of the device. For example, a user can operate the control buttons 208a to view one or more measurements of various analytes, such as glucose. In addition, the user can operate the control buttons 208a to view other forms of information, such as graphs, histograms, measurement data, trend measurement data, parameter combination views, wellness indications, and the like. Many parameters, trends, alarms and parameter displays could be output to the display 210a, such as those that are commercially available through a wide variety of noninvasive monitoring devices from Masimo® Corporation of Irvine, California.

[0119] Furthermore, the controls 208a and/or display 210a can provide functionality for the user to manipulate settings of the monitoring device 200a, such as alarm settings, emitter settings, detector settings, and the like. The monitoring device 200a can employ any of a variety of user interface designs, such as frames, menus, touch-screens, and any type of button.

[0120] **FIGURE 2B** illustrates another example of a monitoring device 200B. In the depicted embodiment, the monitoring device 200B includes a finger clip sensor 201b connected to a monitor 209b via a cable 212. In the embodiment shown, the monitor 209b includes a display 210b, control buttons 208b and a power button. Moreover, the monitor 209b can advantageously include electronic processing, signal processing, and data storage devices capable of receiving signal data from said sensor 201b, processing the signal data to determine one or more output measurement values indicative of one or more physiological parameters of a monitored patient, and displaying the measurement values, trends of the measurement values, combinations of measurement values, and the like.

[0121] The cable 212 connecting the sensor 201b and the monitor 209b can be implemented using one or more wires, optical fiber, flex circuits, or the like. In some embodiments, the cable 212 can employ twisted pairs of conductors in order to minimize or reduce cross-talk of data transmitted from the sensor 201b to

the monitor 209b. Various lengths of the cable 212 can be employed to allow for separation between the sensor 201b and the monitor 209b. The cable 212 can be fitted with a connector (male or female) on either end of the cable 212 so that the sensor 201b and the monitor 209b can be connected and disconnected from each other. Alternatively, the sensor 201b and the monitor 209b can be coupled together via a wireless communication link, such as an infrared link, radio frequency channel, or any other wireless communication protocol and channel.

[0122] The monitor 209b can be attached to the patient. For example, the monitor 209b can include a belt clip or straps (see, e.g., FIGURE 2C) that facilitate attachment to a patient's belt, arm, leg, or the like. The monitor 209b can also include a fitting, slot, magnet, LEMO snap-click connector, or other connecting mechanism to allow the cable 212 and sensor 201b to be attached to the monitor 209B.

[0123] The monitor 209b can also include other components, such as a speaker, power button, removable storage or memory (e.g., a flash card slot), an AC power port, and one or more network interfaces, such as a universal serial bus interface or an Ethernet port. For example, the monitor 209b can include a display 210b that can indicate a measurement for glucose, for example, in mg/dL. Other analytes and forms of display can also appear on the monitor 209b.

[0124] In addition, although a single sensor 201b with a single monitor 209b is shown, different combinations of sensors and device pairings can be implemented. For example, multiple sensors can be provided for a plurality of differing patient types or measurement sites or even patient fingers.

[0125] **FIGURE 2C** illustrates yet another example of monitoring device 200C that can house the data collection system 100. Like the monitoring device 200B, the monitoring device 200C includes a finger clip sensor 201c connected to a monitor 209c via a cable 212. The cable 212 can have all of the features described above with respect to FIGURE 2B. The monitor 209c can include all of the features of the monitor 200B described above. For example, the monitor 209c includes buttons 208c and a display 210c. The monitor 209c shown also includes straps 214c that allow the monitor 209c to be attached to a patient's limb or the like.

[0126] **FIGURE 2D** illustrates yet another example of monitoring device 200D that can house the data collection system 100. Like the monitoring devices 200B and 200C, the monitoring device 200D includes a finger clip sensor 201d connected to a monitor 209d via a cable 212. The cable 212 can have all of the features described above with respect to FIGURE 2B. In addition to having some or all of the features described above with respect to FIGURES 2B and 2C, the monitoring device 200D includes an optional universal serial bus (USB) port 216 and an Ethernet port 218. The USB port 216 and the Ethernet port 218 can be used, for example, to transfer information between the monitor 209d and a computer (not shown) via a cable. Software stored on the computer can provide functionality for a user to, for example, view physiological data and trends, adjust settings and download firmware updates to the monitor 209b, and perform a variety of other functions. The USB port 216 and the Ethernet port 218 can be included with the other monitoring devices 200A, 200B, and 200C described above.

[0127] **FIGURES 3A** through **3C** illustrate more detailed examples of embodiments of a sensor 301a. The sensor 301a shown can include all of the features of the sensors 100 and 200 described above.

[0128] Referring to **FIGURE 3A**, the sensor 301a in the depicted embodiment is a clothespin-shaped clip sensor that includes an enclosure 302a for receiving a patient's finger. The enclosure 302a is formed by an upper section or emitter shell 304a, which is pivotably connected with a lower section or detector shell 306a. The emitter shell 304a can be biased with the detector shell 306a to close together around a pivot point 303a and thereby sandwich finger tissue between the emitter and detector shells 304a, 306a.

[0129] In an embodiment, the pivot point 303a advantageously includes a pivot capable of adjusting the relationship between the emitter and detector shells 304a, 306a to effectively level the sections when applied to a tissue site. In another embodiment, the sensor 301a includes some or all features of the finger clip described in U.S. Publication No. 2006/0211924, incorporated above, such as a spring that causes finger clip forces to be distributed along the finger. Paragraphs

[0096] through [0105], which describe this feature, are hereby specifically incorporated by reference.

[0130] The emitter shell 304a can position and house various emitter components of the sensor 301a. It can be constructed of reflective material (e.g., white silicone or plastic) and/or can be metallic or include metalicized plastic (e.g., including carbon and aluminum) to possibly serve as a heat sink. The emitter shell 304a can also include absorbing opaque material, such as, for example, black or grey colored material, at various areas, such as on one or more flaps 307a, to reduce ambient light entering the sensor 301a.

[0131] The detector shell 306a can position and house one or more detector portions of the sensor 301a. The detector shell 306a can be constructed of reflective material, such as white silicone or plastic. As noted, such materials can increase the usable signal at a detector by forcing light back into the tissue and measurement site (see FIGURE 1). The detector shell 306a can also include absorbing opaque material at various areas, such as lower area 308a, to reduce ambient light entering the sensor 301a.

[0132] Referring to **FIGURES 3B** and **3C**, an example of finger bed 310 is shown in the sensor 301b. The finger bed 310 includes a generally curved surface shaped generally to receive tissue, such as a human digit. The finger bed 310 includes one or more ridges or channels 314. Each of the ridges 314 has a generally convex shape that can facilitate increasing traction or gripping of the patient's finger to the finger bed. Advantageously, the ridges 314 can improve the accuracy of spectroscopic analysis in certain embodiments by reducing noise that can result from a measurement site moving or shaking loose inside of the sensor 301a. The ridges 314 can be made from reflective or opaque materials in some embodiments to further increase SNR. In other implementations, other surface shapes can be used, such as, for example, generally flat, concave, or convex finger beds 310.

[0133] Finger bed 310 can also include an embodiment of a tissue thickness adjuster or protrusion 305. The protrusion 305 includes a measurement site contact area 370 (see FIGURE 3C) that can contact body tissue of a

measurement site. The protrusion 305 can be removed from or integrated with the finger bed 310. Interchangeable, different shaped protrusions 305 can also be provided, which can correspond to different finger shapes, characteristics, opacity, sizes, or the like.

[0134] Referring specifically to **FIGURE 3C**, the contact area 370 of the protrusion 305 can include openings or windows 320, 321, 322, and 323. When light from a measurement site passes through the windows 320, 321, 322, and 323, the light can reach one or more photodetectors (see FIGURE 3E). In an embodiment, the windows 320, 321, 322, and 323 mirror specific detector placements layouts such that light can impinge through the protrusion 305 onto the photodetectors. Any number of windows 320, 321, 322, and 323 can be employed in the protrusion 305 to allow light to pass from the measurement site to the photodetectors.

[0135] The windows 320, 321, 322, and 323 can also include shielding, such as an embedded grid of wiring or a conductive glass coating, to reduce noise from ambient light or other electromagnetic noise. The windows 320, 321, 322, and 323 can be made from materials, such as plastic or glass. In some embodiments, the windows 320, 321, 322, and 323 can be constructed from conductive glass, such as indium tin oxide (ITO) coated glass. Conductive glass can be useful because its shielding is transparent, and thus allows for a larger aperture versus a window with an embedded grid of wiring. In addition, in certain embodiments, the conductive glass does not need openings in its shielding (since it is transparent), which enhances its shielding performance. For example, some embodiments that employ the conductive glass can attain up to an about 40% to about 50% greater signal than non-conductive glass with a shielding grid. In addition, in some embodiments, conductive glass can be useful for shielding noise from a greater variety of directions than non-conductive glass with a shielding grid.

[0136] Turning to **FIGURE 3B**, the sensor 301a can also include a shielding 315a, such as a metal cage, box, metal sheet, perforated metal sheet, a metal layer on a non-metal material, or the like. The shielding 315a is provided in the depicted embodiment below or embedded within the protrusion 305 to reduce

noise. The shielding 315a can be constructed from a conductive material, such as copper. The shielding 315a can include one or more openings or windows (not shown). The windows can be made from glass or plastic to thereby allow light that has passed through the windows 320, 321, 322, and 323 on an external surface of the protrusion 305 (see FIGURE 3C) to pass through to one or more photodetectors that can be enclosed or provided below (see FIGURE 3E).

[0137] In some embodiments, the shielding cage for shielding 315a can be constructed in a single manufactured component with or without the use of conductive glass. This form of construction may be useful in order to reduce costs of manufacture as well as assist in quality control of the components. Furthermore, the shielding cage can also be used to house various other components, such as sigma delta components for various embodiments of front end interfaces 108.

[0138] In an embodiment, the photodetectors can be positioned within or directly beneath the protrusion 305 (see FIGURE 3E). In such cases, the mean optical path length from the emitters to the detectors can be reduced and the accuracy of blood analyte measurement can increase. For example, in one embodiment, a convex bump of about 1 mm to about 3 mm in height and about 10 mm^2 to about 60 mm^2 was found to help signal strength by about an order of magnitude versus other shapes. Of course other dimensions and sizes can be employed in other embodiments. Depending on the properties desired, the length, width, and height of the protrusion 305 can be selected. In making such determinations, consideration can be made of protrusion's 305 effect on blood flow at the measurement site and mean path length for optical radiation passing through openings 320, 321, 322, and 323. Patient comfort can also be considered in determining the size and shape of the protrusion.

[0139] In an embodiment, the protrusion 305 can include a pliant material, including soft plastic or rubber, which can somewhat conform to the shape of a measurement site. Pliant materials can improve patient comfort and tactility by conforming the measurement site contact area 370 to the measurement site. Additionally, pliant materials can minimize or reduce noise, such as ambient light.

Alternatively, the protrusion 305 can be made from a rigid material, such as hard plastic or metal.

[0140] Rigid materials can improve measurement accuracy of a blood analyte by conforming the measurement site to the contact area 370. The contact area 370 can be an ideal shape for improving accuracy or reducing noise. Selecting a material for the protrusion 305 can include consideration of materials that do not significantly alter blood flow at the measurement site. The protrusion 305 and the contact area 370 can include a combination of materials with various characteristics.

[0141] The contact area 370 serves as a contact surface for the measurement site. For example, in some embodiments, the contact area 370 can be shaped for contact with a patient's finger. Accordingly, the contact area 370 can be sized and shaped for different sizes of fingers. The contact area 370 can be constructed of different materials for reflective purposes as well as for the comfort of the patient. For example, the contact area 370 can be constructed from materials having various hardness and textures, such as plastic, gel, foam, and the like.

[0142] The formulas and analysis that follow with respect to **FIGURE 5** provide insight into how selecting these variables can alter transmittance and intensity gain of optical radiation that has been applied to the measurement site. These examples do not limit the scope of this disclosure.

[0143] Referring to **FIGURE 5**, a plot 500 is shown that illustrates examples of effects of embodiments of the protrusion 305 on the SNR at various wavelengths of light. As described above, the protrusion 305 can assist in conforming the tissue and effectively reduce its mean path length. In some instances, this effect by the protrusion 305 can have significant impact on increasing the SNR.

[0144] According to the Beer Lambert law, a transmittance of light (I) can be expressed as follows: $I = I_o * e^{-m*b*c}$, where I_o is the initial power of light being transmitted, m is the path length traveled by the light, and the component "b*c" corresponds to the bulk absorption of the light at a specific wavelength of light. For light at about 1600 nm to about 1700 nm, for example, the bulk absorption component is generally around 0.7 mm^{-1}. Assuming a typical finger thickness of

about 12 mm and a mean path length of 20 mm due to tissue scattering, then $I = I_o * e^{(-20*0.7)}$.

[0145] In an embodiment where the protrusion 305 is a convex bump, the thickness of the finger can be reduced to 10 mm (from 12 mm) for some fingers and the effective light mean path is reduced to about 16.6 mm from 20 mm (see box 510). This results in a new transmittance, $I_1 = I_o * e^{(-16.6*0.7)}$. A curve for a typical finger (having a mean path length of 20 mm) across various wavelengths is shown in the plot 500 of **FIGURE 5**. The plot 500 illustrates potential effects of the protrusion 305 on the transmittance. As illustrated, comparing I and I_1 results in an intensity gain of $e^{(-16.6*0.7)}/e^{(-20*0.7)}$, which is about a 10 times increase for light in the about 1600 nm to about 1700 nm range. Such an increase can affect the SNR at which the sensor can operate. The foregoing gains can be due at least in part to the about 1600 nm to about 1700 nm range having high values in bulk absorptions (water, protein, and the like), e.g., about 0.7 mm^{-1}. The plot 500 also shows improvements in the visible/near-infrared range (about 600 nm to about 1300 nm).

[0146] Turning again to **FIGURES 3A** through **3C**, an example heat sink 350a is also shown. The heat sink 350a can be attached to, or protrude from an outer surface of, the sensor 301a, thereby providing increased ability for various sensor components to dissipate excess heat. By being on the outer surface of the sensor 301a in certain embodiments, the heat sink 350a can be exposed to the air and thereby facilitate more efficient cooling. In an embodiment, one or more of the emitters (see FIGURE 1) generate sufficient heat that inclusion of the heat sink 350a can advantageously allows the sensor 301a to remain safely cooled. The heat sink 350a can include one or more materials that help dissipate heat, such as, for example, aluminum, steel, copper, carbon, combinations of the same, or the like. For example, in some embodiments, the emitter shell 304a can include a heat conducting material that is also readily and relatively inexpensively moldable into desired shapes and forms.

[0147] In some embodiments, the heat sink 350a includes metalicized plastic. The metalicized plastic can include aluminum and carbon, for example. The material can allow for improved thermal conductivity and diffusivity, which can

increase commercial viability of the heat sink. In some embodiments, the material selected to construct the heat sink 350a can include a thermally conductive liquid crystalline polymer, such as CoolPoly® D5506, commercially available from Cool Polymers®, Inc. of Warwick, Rhode Island. Such a material can be selected for its electrically non-conductive and dielectric properties so as, for example, to aid in electrical shielding. In an embodiment, the heat sink 350a provides improved heat transfer properties when the sensor 301a is active for short intervals of less than a full day's use. In an embodiment, the heat sink 350a can advantageously provide improved heat transfers in about three (3) to about four (4) minute intervals, for example, although a heat sink 350a can be selected that performs effectively in shorter or longer intervals.

[0148] Moreover, the heat sink 350a can have different shapes and configurations for aesthetic as well as for functional purposes. In an embodiment, the heat sink is configured to maximize heat dissipation, for example, by maximizing surface area. In an embodiment, the heat sink 350a is molded into a generally curved surface and includes one or more fins, undulations, grooves, or channels. The example heat sink 350a shown includes fins 351a (see FIGURE 3A).

[0149] An alternative shape of a sensor 301b and heat sink 350b is shown in **FIGURE 3D**. The sensor 301b can include some or all of the features of the sensor 301a. For example, the sensor 301b includes an enclosure 302b formed by an emitter shell 304b and a detector shell 306b, pivotably connected about a pivot 303a. The emitter shell 304b can also include absorbing opaque material on one or more flaps 307b, and the detector shell 306a can also include absorbing opaque material at various areas, such as lower area 308b.

[0150] However, the shape of the sensor 301b is different in this embodiment. In particular, the heat sink 350b includes comb protrusions 351b. The comb protrusions 351b are exposed to the air in a similar manner to the fins 351a of the heat sink 350a, thereby facilitating efficient cooling of the sensor 301b.

[0151] **FIGURE 3E** illustrates a more detailed example of a detector shell 306b of the sensor 301b. The features described with respect to the detector shell 306b can also be used with the detector shell 306a of the sensor 301a.

[0152] As shown, the detector shell 306b includes detectors 316. The detectors 316 can have a predetermined spacing 340 from each other, or a spatial relationship among one another that results in a spatial configuration. This spatial configuration can purposefully create a variation of path lengths among detectors 316 and the emitter discussed above.

[0153] In the depicted embodiment, the detector shell 316 can hold multiple (e.g., two, three, four, etc.) photodiode arrays that are arranged in a two-dimensional grid pattern. Multiple photodiode arrays can also be useful to detect light piping (e.g., light that bypasses measurement site 102). In the detector shell 316, walls can be provided to separate the individual photodiode arrays to prevent or reduce mixing of light signals from distinct quadrants. In addition, the detector shell 316 can be covered by windows of transparent material, such as glass, plastic, or the like, to allow maximum or increased transmission of power light captured. In various embodiments, the transparent materials used can also be partially transparent or translucent or can otherwise pass some or all of the optical radiation passing through them. As noted, this window can include some shielding in the form of an embedded grid of wiring, or a conductive layer or coating.

[0154] As further illustrated by **FIGURE 3E**, the detectors 316 can have a spatial configuration of a grid. However, the detectors 316 can be arranged in other configurations that vary the path length. For example, the detectors 316 can be arranged in a linear array, a logarithmic array, a two-dimensional array, a zig-zag pattern, or the like. Furthermore, any number of the detectors 316 can be employed in certain embodiments.

[0155] **FIGURE 3F** illustrates another embodiment of a sensor 301f. The sensor 301f can include some or all of the features of the sensor 301a of FIGURE 3A described above. For example, the sensor 301f includes an enclosure 302f formed by an upper section or emitter shell 304f, which is pivotably connected with a lower section or detector shell 306f around a pivot point 303f. The emitter shell 304f can also include absorbing opaque material on various areas, such as on one or more flaps 307f, to reduce ambient light entering the sensor 301f. The detector shell 306f can also include absorbing opaque material at various areas, such as a

lower area 308f. The sensor 301f also includes a heat sink 350f, which includes fins 351f.

[0156] In addition to these features, the sensor 301f includes a flex circuit cover 360, which can be made of plastic or another suitable material. The flex circuit cover 360 can cover and thereby protect a flex circuit (not shown) that extends from the emitter shell 304f to the detector shell 306f. An example of such a flex circuit is illustrated in U.S. Publication No. 2006/0211924, incorporated above (see FIGURE 46 and associated description, which is hereby specifically incorporated by reference). The flex circuit cover 360 is shown in more detail below in FIGURE 17.

[0157] In addition, sensors 301a-f has extra length – extends to second joint on finger - Easier to place, harder to move due to cable, better for light piping.

[0158] **FIGURES 4A** through **4C** illustrate example arrangements of a protrusion 405, which is an embodiment of the protrusion 305 described above. In an embodiment, the protrusion 405 can include a measurement site contact area 470. The measurement site contact area 470 can include a surface that molds body tissue of a measurement site, such as a finger, into a flat or relatively flat surface.

[0159] The protrusion 405 can have dimensions that are suitable for a measurement site such as a patient's finger. As shown, the protrusion 405 can have a length 400, a width 410, and a height 430. The length 400 can be from about 9 to about 11 millimeters, e.g., about 10 millimeters. The width 410 can be from about 7 to about 9 millimeters, e.g., about 8 millimeters. The height 430 can be from about 0.5 millimeters to about 3 millimeters, e.g., about 2 millimeters. In an embodiment, the dimensions 400, 410, and 430 can be selected such that the measurement site contact area 470 includes an area of about 80 square millimeters, although larger and smaller areas can be used for different sized tissue for an adult, an adolescent, or infant, or for other considerations.

[0160] The measurement site contact area 470 can also include differently shaped surfaces that conform the measurement site into different shapes. For example, the measurement site contact area 470 can be generally curved and/or convex with respect to the measurement site. The measurement site contact area

470 can be other shapes that reduce or even minimize air between the protrusion 405 and/or the measurement site. Additionally, the surface pattern of the measurement site contact area 470 can vary from smooth to bumpy, e.g., to provide varying levels of grip.

[0161] In **FIGURES 4A** and **4C**, openings or windows 420, 421, 422, and 423 can include a wide variety of shapes and sizes, including for example, generally square, circular, triangular, or combinations thereof. The windows 420, 421, 422, and 423 can be of non-uniform shapes and sizes. As shown, the windows 420, 421, 422, and 423 can be evenly spaced out in a grid like arrangement. Other arrangements or patterns of arranging the windows 420, 421, 422, and 423 are possible. For example, the windows 420, 421, 422, and 423 can be placed in a triangular, circular, or linear arrangement. In some embodiments, the windows 420, 421, 422, and 423 can be placed at different heights with respect to the finger bed 310 of FIGURE 3. The windows 420, 421, 422, and 423 can also mimic or approximately mimic a configuration of, or even house, a plurality of detectors.

[0162] **FIGURES 6A** through **6D** illustrate another embodiment of a protrusion 605 that can be used as the tissue shaper 105 described above or in place of the protrusions 305, 405 described above. The depicted protrusion 605 is a partially cylindrical lens having a partial cylinder 608 and an extension 610. The partial cylinder 608 can be a half cylinder in some embodiments; however, a smaller or greater portion than half of a cylinder can be used. Advantageously, in certain embodiments, the partially cylindrical protrusion 605 focuses light onto a smaller area, such that fewer detectors can be used to detect the light attenuated by a measurement site.

[0163] **FIGURE 6A** illustrates a perspective view of the partially cylindrical protrusion 605. **FIGURE 6B** illustrates a front elevation view of the partially cylindrical protrusion 605. **FIGURE 6C** illustrates a side view of the partially cylindrical protrusion 605. **FIGURE 6D** illustrates a top view of the partially cylindrical protrusion 605.

[0164] Advantageously, in certain embodiments, placing the partially cylindrical protrusion 605 over the photodiodes in any of the sensors described

above adds multiple benefits to any of the sensors described above. In one embodiment, the partially cylindrical protrusion 605 penetrates into the tissue and reduces the path length of the light traveling in the tissue, similar to the protrusions described above.

[0165] The partially cylindrical protrusion 605 can also collect light from a large surface and focus down the light to a smaller area. As a result, in certain embodiments, signal strength per area of the photodiode can be increased. The partially cylindrical protrusion 605 can therefore facilitate a lower cost sensor because, in certain embodiments, less photodiode area can be used to obtain the same signal strength. Less photodiode area can be realized by using smaller photodiodes or fewer photodiodes (see, e.g., FIGURE 14). If fewer or smaller photodiodes are used, the partially cylindrical protrusion 605 can also facilitate an improved SNR of the sensor because fewer or smaller photodiodes can have less dark current.

[0166] The dimensions of the partially cylindrical protrusion 605 can vary based on, for instance, a number of photodiodes used with the sensor. Referring to **FIGURE 6C**, the overall height of the partially cylindrical protrusion 605 (measurement "a") in some implementations is about 1 to about 3 mm. A height in this range can allow the partially cylindrical protrusion 605 to penetrate into the pad of the finger or other tissue and reduce the distance that light travels through the tissue. Other heights, however, of the partially cylindrical protrusion 605 can also accomplish this objective. For example, the chosen height of the partially cylindrical protrusion 605 can be selected based on the size of the measurement site, whether the patient is an adult or child, and so on. In an embodiment, the height of the protrusion 605 is chosen to provide as much tissue thickness reduction as possible while reducing or preventing occlusion of blood vessels in the tissue.

[0167] Referring to **FIGURE 6D**, the width of the partially cylindrical protrusion 605 (measurement "b") can be about 3 to about 5 mm. In one embodiment, the width is about 4 mm. In one embodiment, a width in this range provides good penetration of the partially cylindrical protrusion 605 into the tissue to reduce the path length of the light. Other widths, however, of the partially cylindrical

protrusion 605 can also accomplish this objective. For example, the width of the partially cylindrical protrusion 605 can vary based on the size of the measurement site, whether the patient is an adult or child, and so on. In addition, the length of the protrusion 605 could be about 10 mm, or about 8 mm to about 12 mm, or smaller than 8 mm or greater than 12 mm.

[0168] In certain embodiments, the focal length (*f*) for the partially cylindrical protrusion 605 can be expressed as: $f = \frac{R}{n-1}$, where *R* is the radius of curvature of the partial cylinder 608 and *n* is the index of refraction of the material used. In certain embodiments, the radius of curvature can be between about 1.5 mm and about 2 mm. In another embodiment, the partially cylindrical protrusion 605 can include a material, such as nBK7 glass, with an index of refraction of around 1.5 at 1300 nm, which can provide focal lengths of between about 3 mm and about 4 mm.

[0169] A partially cylindrical protrusion 605 having a material with a higher index of refraction such as nSF11 glass (e.g., n=1.75 at 1300 nm) can provide a shorter focal length and possibly a smaller photodiode chip, but can also cause higher reflections due to the index of refraction mismatch with air. Many types of glass or plastic can be used with index of refraction values ranging from, for example, about 1.4 to about 1.9. The index of refraction of the material of the protrusion 605 can be chosen to improve or optimize the light focusing properties of the protrusion 605. A plastic partially cylindrical protrusion 605 could provide the cheapest option in high volumes but can also have some undesired light absorption peaks at wavelengths higher than 1500 nm. Other focal lengths and materials having different indices of refraction can be used for the partially cylindrical protrusion 605.

[0170] Placing a photodiode at a given distance below the partially cylindrical protrusion 605 can facilitate capturing some or all of the light traveling perpendicular to the lens within the active area of the photodiode (see FIGURE 14). Different sizes of the partially cylindrical protrusion 605 can use different sizes of photodiodes. The extension 610 added onto the bottom of the partial cylinder 608 is

used in certain embodiments to increase the height of the partially cylindrical protrusion 605. In an embodiment, the added height is such that the photodiodes are at or are approximately at the focal length of the partially cylindrical protrusion 605. In an embodiment, the added height provides for greater thinning of the measurement site. In an embodiment, the added height assists in deflecting light piped through the sensor. This is because light piped around the sensor passes through the side walls of the added height without being directed toward the detectors. The extension 610 can also further facilitate the protrusion 605 increasing or maximizing the amount of light that is provided to the detectors. In some embodiments, the extension 610 can be omitted.

[0171] **FIGURE 6E** illustrates another view of the sensor 301f of FIGURE 3F, which includes an embodiment of a partially cylindrical protrusion 605b. Like the sensor 301A shown in FIGURES 3B and 3C, the sensor 301f includes a finger bed 310f. The finger bed 310f includes a generally curved surface shaped generally to receive tissue, such as a human digit. The finger bed 310f also includes the ridges or channels 314 described above with respect to FIGURES 3B and 3C.

[0172] The example of finger bed 310f shown also includes the protrusion 605b, which includes the features of the protrusion 605 described above. In addition, the protrusion 605b also includes chamfered edges 607 on each end to provide a more comfortable surface for a finger to slide across (see also FIGURE 14D). In another embodiment, the protrusion 605b could instead include a single chamfered edge 607 proximal to the ridges 314. In another embodiment, one or both of the chamfered edges 607 could be rounded.

[0173] The protrusion 605b also includes a measurement site contact area 670 that can contact body tissue of a measurement site. The protrusion 605b can be removed from or integrated with the finger bed 310f. Interchangeable, differently shaped protrusions 605b can also be provided, which can correspond to different finger shapes, characteristics, opacity, sizes, or the like.

[0174] **FIGURES 7A** and **7B** illustrate block diagrams of sensors 701 that include example arrangements of conductive glass or conductive coated glass for shielding. Advantageously, in certain embodiments, the shielding can provide

increased SNR. The features of the sensors 701 can be implemented with any of the sensors 101, 201, 301 described above. Although not shown, the partially cylindrical protrusion 605 of FIGURE 6 can also be used with the sensors 701 in certain embodiments.

[0175] For example, referring specifically to **FIGURE 7A**, the sensor 701a includes an emitter housing 704a and a detector housing 706. The emitter housing 704a includes LEDs 104. The detector housing 706a includes a tissue bed 710a with an opening or window 703a, the conductive glass 730a, and one or more photodiodes for detectors 106 provided on a submount 707a.

[0176] During operation, a finger 102 can be placed on the tissue bed 710a and optical radiation can be emitted from the LEDs 104. Light can then be attenuated as it passes through or is reflected from the tissue of the finger 102. The attenuated light can then pass through the opening 703a in the tissue bed 710a. Based on the received light, the detectors 106 can provide a detector signal 107, for example, to the front end interface 108 (see FIGURE 1).

[0177] In the depicted embodiment, the conductive glass 730 is provided in the opening 703. The conductive glass 730 can thus not only permit light from the finger to pass to the detectors 106, but it can also supplement the shielding of the detectors 106 from noise. The conductive glass 730 can include a stack or set of layers. In **FIGURE 7A**, the conductive glass 730a is shown having a glass layer 731 proximate the finger 102 and a conductive layer 733 electrically coupled to the shielding 790a.

[0178] In an embodiment, the conductive glass 730a can be coated with a conductive, transparent or partially transparent material, such as a thin film of indium tin oxide (ITO). To supplement electrical shielding effects of a shielding enclosure 790a, the conductive glass 730a can be electrically coupled to the shielding enclosure 790a. The conductive glass 730a can be electrically coupled to the shielding 704a based on direct contact or via other connection devices, such as a wire or another component.

[0179] The shielding enclosure 790a can be provided to encompass the detectors 106 to reduce or prevent noise. For example, the shielding enclosure

790a can be constructed from a conductive material, such as copper, in the form of a metal cage. The shielding or enclosure a can include an opaque material to not only reduce electrical noise, but also ambient optical noise.

[0180] In some embodiments, the shielding enclosure 790a can be constructed in a single manufactured component with or without the use of conductive glass. This form of construction may be useful in order to reduce costs of manufacture as well as assist in quality control of the components. Furthermore, the shielding enclosure 790a can also be used to house various other components, such as sigma delta components for various embodiments of front end interfaces 108.

[0181] Referring to **FIGURE 7B**, another block diagram of an example sensor 701b is shown. A tissue bed 710b of the sensor 701b includes a protrusion 705b, which is in the form of a convex bump. The protrusion 705b can include all of the features of the protrusions or tissue shaping materials described above. For example, the protrusion 705b includes a contact area 370 that comes in contact with the finger 102 and which can include one or more openings 703b. One or more components of conductive glass 730b can be provided in the openings 703. For example, in an embodiment, each of the openings 703 can include a separate window of the conductive glass 730b. In an embodiment, a single piece of the conductive glass 730b can used for some or all of the openings 703b. The conductive glass 730b is smaller than the conductive glass 730a in this particular embodiment.

[0182] A shielding enclosure 790b is also provided, which can have all the features of the shielding enclosure 790a. The shielding enclosure 790b is smaller than the shielding enclosure 790a; however, a variety of sizes can be selected for the shielding enclosures 790.

[0183] In some embodiments, the shielding enclosure 790b can be constructed in a single manufactured component with or without the use of conductive glass. This form of construction may be useful in order to reduce costs of manufacture as well as assist in quality control of the components. Furthermore, the shielding enclosure 790b can also be used to house various other components,

such as sigma delta components for various embodiments of front end interfaces 108.

[0184] **FIGURES 8A** through **8D** illustrate a perspective view, side views, and a bottom elevation view of the conductive glass described above with respect to the sensors 701a, 701b. As shown in the perspective view of **FIGURE 8A** and side view of **FIGURE 8B**, the conductive glass 730 includes the electrically conductive material 733 described above as a coating on the glass layer 731 described above to form a stack. In an embodiment where the electrically conductive material 733 includes indium tin oxide, surface resistivity of the electrically conductive material 733 can range approximately from 30 ohms per square inch to 500 ohms per square inch, or approximately 30, 200, or 500 ohms per square inch. As would be understood by a person of skill in the art from the present disclosure, other resistivities can also be used which are less than 30 ohms or more than 500 ohms. Other transparent, electrically conductive materials can be used as the material 733.

[0185] Although the conductive material 733 is shown spread over the surface of the glass layer 731, the conductive material 733 can be patterned or provided on selected portions of the glass layer 731. Furthermore, the conductive material 733 can have uniform or varying thickness depending on a desired transmission of light, a desired shielding effect, and other considerations.

[0186] In **FIGURE 8C**, a side view of a conductive glass 830a is shown to illustrate an embodiment where the electrically conductive material 733 is provided as an internal layer between two glass layers 731, 835. Various combinations of integrating electrically conductive material 733 with glass are possible. For example, the electrically conductive material 733 can be a layer within a stack of layers. This stack of layers can include one or more layers of glass 731, 835, as well as one or more layers of conductive material 733. The stack can include other layers of materials to achieve desired characteristics.

[0187] In **FIGURE 8D**, a bottom perspective view is shown to illustrate an embodiment where a conductive glass 830b can include conductive material 837 that occupies or covers a portion of a glass layer 839. This embodiment can be useful, for example, to create individual, shielded windows for detectors 106, such

as those shown in FIGURE 3C. The conductive material 837 can be patterned to include an area 838 to allow light to pass to detectors 106 and one or more strips 841 to couple to the shielding 704 of FIGURE 7.

[0188] Other configurations and patterns for the conductive material can be used in certain embodiments, such as, for example, a conductive coating lining periphery edges, a conductive coating outlaid in a pattern including a grid or other pattern, a speckled conductive coating, coating outlaid in lines in either direction or diagonally, varied thicknesses from the center out or from the periphery in, or other suitable patterns or coatings that balance the shielding properties with transparency considerations.

[0189] **FIGURE 9** depicts an example graph 900 that illustrates comparative results obtained by an example sensor having components similar to those disclosed above with respect to FIGURES 7 and 8. The graph 900 depicts the results of the percentage of transmission of varying wavelengths of light for different types of windows used in the sensors described above.

[0190] A line 915 on the graph 900 illustrates example light transmission of a window made from plain glass. As shown, the light transmission percentage of varying wavelengths of light is approximately 90% for a window made from plain glass. A line 920 on the graph 900 demonstrates an example light transmission percentage for an embodiment in which a window is made from glass having an ITO coating with a surface resistivity of 500 ohms per square inch. A line 925 on the graph 900 shows an example light transmission for an embodiment in which a window is made from glass that includes a coating of ITO oxide with a surface resistivity of 200 ohms per square inch. A line 930 on the graph 900 shows an example light transmission for an embodiment in which a window is made from glass that includes a coating of ITO oxide with a surface resistivity of 30 ohms per square inch.

[0191] The light transmission percentage for a window with currently available embedded wiring can have a light transmission percentage of approximately 70%. This lower percentage of light transmission can be due to the opacity of the wiring employed in a currently available window with wiring.

Accordingly, certain embodiments of glass coatings described herein can employ, for example, ITO coatings with different surface resistivity depending on the desired light transmission, wavelengths of light used for measurement, desired shielding effect, and other criteria.

[0192] **FIGURES 10A** through **10B** illustrate comparative noise floors of example implementations of the sensors described above. Noise can include optical noise from ambient light and electro-magnetic noise, for example, from surrounding electrical equipment. In **FIGURE 10A**, a graph 1000 depicts possible noise floors for different frequencies of noise for an embodiment in which one of the sensors described above included separate windows for four (4) detectors 106. One or more of the windows included an embedded grid of wiring as a noise shield. Symbols 1030 - 1033 illustrate the noise floor performance for this embodiment. As can be seen, the noise floor performance can vary for each of the openings and based on the frequency of the noise.

[0193] In **FIGURE 10B**, a graph 1050 depicts a noise floor for frequencies of noise 1070 for an embodiment in which the sensor included separate openings for four (4) detectors 106 and one or more windows that include an ITO coating. In this embodiment, a surface resistivity of the ITO used was about 500 ohms per square inch. Symbols 1080 - 1083 illustrate the noise floor performance for this embodiment. As can be seen, the noise floor performance for this embodiment can vary less for each of the openings and provide lower noise floors in comparison to the embodiment of **FIGURE 10A**.

[0194] **FIGURE 11A** illustrates an example structure for configuring the set of optical sources of the emitters described above. As shown, an emitter 104 can include a driver 1105, a thermistor 1120, a set of top-emitting LEDs 1102 for emitting red and/or infrared light, a set of side-emitting LEDs 1104 for emitting near infrared light, and a submount 1106.

[0195] The thermistor 1120 can be provided to compensate for temperature variations. For example, the thermistor 1120 can be provided to allow for wavelength centroid and power drift of LEDs 1102 and 1104 due to heating. In addition, other thermistors ~~(not shown)~~ can be employed, for example, to measure a

temperature of a measurement site. The temperature can be displayed on a display device and used by a caregiver. Such a temperature can also be helpful in correcting for wavelength drift due to changes in water absorption, which can be temperature dependent, thereby providing more accurate data useful in detecting blood analytes like glucose. In addition, using a thermistor or other type of temperature sensitive device may be useful for detecting extreme temperatures at the measurement site that are too hot or too cold. The presence of low perfusion may also be detected, for example, when the finger of a patient has become too cold. Moreover, shifts in temperature at the measurement site can alter the absorption spectrum of water and other tissue in the measurement cite. A thermistor's temperature reading can be used to adjust for the variations in absorption spectrum changes in the measurement site.

[0196] The driver 1105 can provide pulses of current to the emitter 1104. In an embodiment, the driver 1105 drives the emitter 1104 in a progressive fashion, for example, in an alternating manner based on a control signal from, for example, a processor (e.g., the processor 110). For example, the driver 1105 can drive the emitter 1104 with a series of pulses to about 1 milliwatt (mW) for visible light to light at about 1300 nm and from about 40 mW to about 100 mW for light at about 1600 nm to about 1700 nm. However, a wide number of driving powers and driving methodologies can be used. The driver 1105 can be synchronized with other parts of the sensor and can minimize or reduce any jitter in the timing of pulses of optical radiation emitted from the emitter 1104. In some embodiments, the driver 1105 is capable of driving the emitter 1104 to emit an optical radiation in a pattern that varies by less than about 10 parts-per-million; however other amounts of variation can be used.

[0197] The submount 1106 provides a support structure in certain embodiments for aligning the top-emitting LEDs 1102 and the side-emitting LEDs 1104 so that their optical radiation is transmitted generally towards the measurement site. In some embodiments, the submount 1106 is also constructed of aluminum nitride (AlN) or beryllium oxide (BEO) for heat dissipation, although

other materials or combinations of materials suitable for the submount 1106 can be used.

[0198] **FIGURE 11B** illustrates a configuration of emitting optical radiation into a measurement site for measuring a blood constituent or analyte like glucose. In some embodiments, emitter 104 may be driven in a progressive fashion to minimize noise and increase SNR of sensor 101. For example, emitter 104 may be driven based on a progression of power/current delivered to LEDs 1102 and 1104.

[0199] In some embodiments, emitter 104 may be configured to emit pulses centered about 905 nm, about 1050 nm, about 1200 nm, about 1300 nm, about 1330 nm, about 1610 nm, about 1640 nm, and about 1665 nm. In another embodiment, the emitter 104 may emit optical radiation ranging from about 860 nm to about 950 nm, about 950 nm to about 1100 nm, about 1100 nm to about 1270 nm, about 1250 nm to about 1350 nm, about 1300 nm to about 1360 nm, and about 1590 nm to about 1700 nm. Of course, emitter 104 may be configured to transmit any of a variety of wavelengths of visible, or near-infrared optical radiation.

[0200] For purposes of illustration, **FIGURE 11B** shows a sequence of pulses of light at wavelengths of around 905 nm, around 1200 nm, around 1300 nm, and around 1330 nm from top emitting LEDs 1102. **FIGURE 11B** also shows that emitter 104 may then emit pulses centered at around 1630 nm, around 1660 nm, and around 1615 nm from side emitting LEDs 1104. Emitter 104 may be progressively driven at higher power/current. This progression may allow driver circuit 105 to stabilize in its operations, and thus, provide a more stable current/power to LEDs 1102 and 1104.

[0201] For example, as shown in **FIGURE 11B**, the sequence of optical radiation pulses are shown having a logarithmic-like progression in power/current. In some embodiments, the timing of these pulses is based on a cycle of about 400 slots running at 48 kHz (e.g. each time slot may be approximately 0.02 ms or 20 microseconds). An artisan will recognize that term “slots” includes its ordinary meaning, which includes a time period that may also be expressed in terms of a frequency. In the example shown, pulses from top emitting LEDs 1102 may have a pulse width of about 40 time slots (e.g., about 0.8 ms) and an off period of about 4

time slots in between. In addition, pulses from side emitting LEDs 1104 (e.g., or a laser diode) may have a pulse width of about 60 time slots (e.g., about 1.25 ms) and a similar off period of about 4 time slots. A pause of about 70 time slots (e.g. 1.5 ms) may also be provided in order to allow driver circuit 1105 to stabilize after operating at higher current/power.

[0202] As shown in **FIGURE 11B**, top emitting LEDs 1102 may be initially driven with a power to approximately 1 mW at a current of about 20-100 mA. Power in these LEDs may also be modulated by using a filter or covering of black dye to reduce power output of LEDs. In this example, top emitting LEDs 1102 may be driven at approximately 0.02 to 0.08 mW. The sequence of the wavelengths may be based on the current requirements of top emitting LEDs 502 for that particular wavelength. Of course, in other embodiments, different wavelengths and sequences of wavelengths may be output from emitter 104.

[0203] Subsequently, side emitting LEDs 1104 may be driven at higher powers, such as about 40-100 mW and higher currents of about 600-800 mA. This higher power may be employed in order to compensate for the higher opacity of tissue and water in measurement site 102 to these wavelengths. For example, as shown, pulses at about 1630 nm, about 1660 nm, and about 1615 nm may be output with progressively higher power, such as at about 40 mW, about 50 mW, and about 60 mW, respectively. In this embodiment, the order of wavelengths may be based on the optical characteristics of that wavelength in tissue as well as the current needed to drive side emitting LEDs 1104. For example, in this embodiment, the optical pulse at about 1615 nm is driven at the highest power due to its sensitivity in detecting analytes like glucose and the ability of light at this wavelength to penetrate tissue. Of course, different wavelengths and sequences of wavelengths may be output from emitter 104.

[0204] As noted, this progression may be useful in some embodiments because it allows the circuitry of driver circuit 1105 to stabilize its power delivery to LEDs 1102 and 1104. Driver circuit 1105 may be allowed to stabilize based on the duty cycle of the pulses or, for example, by configuring a variable waiting period to

allow for stabilization of driver circuit 1105. Of course, other variations in power/current and wavelength may also be employed in the present disclosure.

[0205] Modulation in the duty cycle of the individual pulses may also be useful because duty cycle can affect the signal noise ratio of the system 100. That is, as the duty cycle is increased so may the signal to noise ratio.

[0206] Furthermore, as noted above, driver circuit 1105 may monitor temperatures of the LEDs 1102 and 1104 using the thermistor 1120 and adjust the output of LEDs 1102 and 1104 accordingly. Such a temperature may be to help sensor 101 correct for wavelength drift due to changes in water absorption, which can be temperature dependent.

[0207] **FIGURE 11C** illustrates another exemplary emitter that may be employed in the sensor according to an embodiment of the disclosure. As shown, the emitter 104 can include components mounted on a substrate 1108 and on submount 1106. In particular, top-emitting LEDs 1102 for emitting red and/or infrared light may be mounted on substrate 1108. Side emitting LEDS 1104 may be mounted on submount 1106. As noted, side-emitting LEDs 1104 may be included in emitter 104 for emitting near infrared light.

[0208] As also shown, the sensor of **FIGURE 11C** may include a thermistor 1120. As noted, the thermistor 1120 can be provided to compensate for temperature variations. The thermistor 1120 can be provided to allow for wavelength centroid and power drift of LEDs 1102 and 1104 due to heating. In addition, other thermistors (not shown) can be employed, for example, to measure a temperature of a measurement site. Such a temperature can be helpful in correcting for wavelength drift due to changes in water absorption, which can be temperature dependent, thereby providing more accurate data useful in detecting blood analytes like glucose.

[0209] In some embodiments, the emitter 104 may be implemented without the use of side emitting LEDs. For example, certain blood constituents, such as total hemoglobin, can be measured by embodiments of the disclosure without the use of side emitting LEDs. **FIGURE 11D** illustrates another exemplary emitter that may be employed in the sensor according to an embodiment of the

disclosure. In particular, an emitter 104 that is configured for a blood constituent, such as total hemoglobin, is shown. The emitter 104 can include components mounted on a substrate 1108. In particular, top-emitting LEDs 1102 for emitting red and/or infrared light may be mounted on substrate 1108.

[0210] As also shown, the emitter of **FIGURE 11D** may include a thermistor 1120. The thermistor 1120 can be provided to compensate for temperature variations. The thermistor 1120 can be provided to allow for wavelength centroid and power drift of LEDs 1102 due to heating.

[0211] **FIGURE 12A** illustrates a detector submount 1200 having photodiode detectors that are arranged in a grid pattern on the detector submount 1200 to capture light at different quadrants from a measurement site. One detector submount 1200 can be placed under each window of the sensors described above, or multiple windows can be placed over a single detector submount 1200. The detector submount 1200 can also be used with the partially cylindrical protrusion 605 described above with respect to FIGURE 6.

[0212] The detectors include photodiode detectors 1-4 that are arranged in a grid pattern on the submount 1200 to capture light at different quadrants from the measurement site. As noted, other patterns of photodiodes, such as a linear row, or logarithmic row, can also be employed in certain embodiments.

[0213] As shown, the detectors 1-4 may have a predetermined spacing from each other, or spatial relationship among one another that result in a spatial configuration. This spatial configuration can be configured to purposefully create a variation of path lengths among detectors 106 and the point light source discussed above.

[0214] Detectors may hold multiple (e.g., two, three, four, etc.) photodiode arrays that are arranged in a two-dimensional grid pattern. Multiple photodiode arrays may also be useful to detect light piping (i.e., light that bypasses measurement site 102). As shown, walls may separate the individual photodiode arrays to prevent mixing of light signals from distinct quadrants. In addition, as noted, the detectors may be covered by windows of transparent material, such as glass, plastic, etc., to allow maximum transmission of power light captured. As

noted, this window may comprise some shielding in the form of an embedded grid of wiring, or a conductive layer or coating.

[0215] **FIGURES 12B through 12D** illustrate a simplified view of exemplary arrangements and spatial configurations of photodiodes for detectors 106. As shown, detectors 106 may comprise photodiode detectors 1-4 that are arranged in a grid pattern on detector submount 1200 to capture light at different quadrants from measurement site 102.

[0216] As noted, other patterns of photodiodes may also be employed in embodiments of the present disclosure, including, for example, stacked or other configurations recognizable to an artisan from the disclosure herein. For example, detectors 106 may be arranged in a linear array, a logarithmic array, a two-dimensional array, and the like. Furthermore, an artisan will recognize from the disclosure herein that any number of detectors 106 may be employed by embodiments of the present disclosure.

[0217] For example, as shown in **FIGURE 12B**, detectors 106 may comprise photodiode detectors 1-4 that are arranged in a substantially linear configuration on submount 1200. In this embodiment shown, photodiode detectors 1-4 are substantially equally spaced apart (e.g., where the distance D is substantially the same between detectors 1-4).

[0218] In **FIGURE 12C**, photodiode detectors 1-4 may be arranged in a substantially linear configuration on submount 1200, but may employ a substantially progressive, substantially logarithmic, or substantially semi-logarithmic spacing (e.g., where distances D1 > D2 > D3). This arrangement or pattern may be useful for use on a patient's finger and where the thickness of the finger gradually increases.

[0219] In **FIGURE 12D**, a different substantially grid pattern on submount 1200 of photodiode detectors 1-4 is shown. As noted, other patterns of detectors may also be employed in embodiments of the present invention.

[0220] **FIGURES 12E through 12H** illustrate several embodiments of photodiodes that may be used in detectors 106. As shown in these figures, a photodiode 1202 of detector 106 may comprise a plurality of active areas 1204.

These active areas 204 may be coupled together via a common cathode 1206 or anode 1208 in order to provide a larger effective detection area.

[0221] In particular, as shown in **FIGURE 12E**, photodiode 1202 may comprise two (2) active areas 1204a and 1204b. In **FIGURE 12F**, photodiode 1202 may comprise four (4) active areas 1204c-f. In **FIGURE 12G**, photodiode 1202 may comprise three (3) active areas 1204g-i. In **FIGURE 12H**, photodiode 1202 may comprise nine (9) active areas 1204j-r. The use of smaller active areas may be useful because smaller active areas can be easier to fabricate and can be fabricated with higher purity. However, one skilled in the art will recognize that various sizes of active areas may be employed in the photodiode 1202.

[0222] **FIGURE 13** illustrates an example multi-stream process 1300. The multi-stream process 1300 can be implemented by the data collection system 100 and/or by any of the sensors described above. As shown, a control signal from a signal processor 1310 controls a driver 1305. In response, an emitter 1304 generates a pulse sequence 1303 from its emitter (e.g., its LEDs) into a measurement site or sites 1302. As described above, in some embodiments, the pulse sequence 1303 is controlled to have a variation of about 10 parts per million or less. Of course, depending on the analyte desired, the tolerated variation in the pulse sequence 1303 can be greater (or smaller).

[0223] In response to the pulse sequence 1300, detectors 1 to n (n being an integer) in a detector 1306 capture optical radiation from the measurement site 1302 and provide respective streams of output signals. Each signal from one of detectors 1-n can be considered a stream having respective time slots corresponding to the optical pulses from emitter sets 1-n in the emitter 1304. Although n emitters and n detectors are shown, the number of emitters and detectors need not be the same in certain implementations.

[0224] A front end interface 1308 can accept these multiple streams from detectors 1-n and deliver one or more signals or composite signal(s) back to the signal processor 1310. A stream from the detectors 1-n can thus include measured light intensities corresponding to the light pulses emitted from the emitter 1304.

[0225] The signal processor 1310 can then perform various calculations to measure the amount of glucose and other analytes based on these multiple streams of signals. In order to help explain how the signal processor 1310 can measure analytes like glucose, a primer on the spectroscopy employed in these embodiments will now be provided.

[0226] Spectroscopy is premised upon the Beer-Lambert law. According to this law, the properties of a material, e.g., glucose present in a measurement site, can be deterministically calculated from the absorption of light traveling through the material. Specifically, there is a logarithmic relation between the transmission of light through a material and the concentration of a substance and also between the transmission and the length of the path traveled by the light. As noted, this relation is known as the Beer-Lambert law.

[0227] The Beer-Lambert law is usually written as:

[0228] Absorbance $A = m*b*c$, where:

[0229] m is the wavelength-dependent molar absorptivity coefficient (usually expressed in units of M^{-1} cm^{-1});

[0230] b is the mean path length; and

[0231] c is the analyte concentration (e.g., the desired parameter).

[0232] In spectroscopy, instruments attempt to obtain the analyte concentration (c) by relating absorbance (A) to transmittance (T). Transmittance is a proportional value defined as:

[0233] $T = I / I_o$, where:

[0234] I is the light intensity measured by the instrument from the measurement site; and

[0235] I_o is the initial light intensity from the emitter.

[0236] Absorbance (A) can be equated to the transmittance (T) by the equation:

[0237] $A = - \log T$

[0238] Therefore, substituting equations from above:

[0239] $A = - \log (I / I_o)$

[0240] In view of this relationship, spectroscopy thus relies on a proportional-based calculation of $-\log(I / I_o)$ and solving for analyte concentration (c).

[0241] Typically, in order to simplify the calculations, spectroscopy will use detectors that are at the same location in order to keep the path length (b) a fixed, known constant. In addition, spectroscopy will employ various mechanisms to definitively know the transmission power (I_o), such as a photodiode located at the light source. This architecture can be viewed as a single channel or single stream sensor, because the detectors are at a single location.

[0242] However, this scheme can encounter several difficulties in measuring analytes, such as glucose. This can be due to the high overlap of absorption of light by water at the wavelengths relevant to glucose as well as other factors, such as high self-noise of the components.

[0243] Embodiments of the present disclosure can employ a different approach that in part allows for the measurement of analytes like glucose. Some embodiments can employ a bulk, non-pulsatile measurement in order to confirm or validate a pulsatile measurement. In addition, both the non-pulsatile and pulsatile measurements can employ, among other things, the multi-stream operation described above in order to attain sufficient SNR. In particular, a single light source having multiple emitters can be used to transmit light to multiple detectors having a spatial configuration.

[0244] A single light source having multiple emitters can allow for a range of wavelengths of light to be used. For example, visible, infrared, and near infrared wavelengths can be employed. Varying powers of light intensity for different wavelengths can also be employed.

[0245] Secondly, the use of multiple-detectors in a spatial configuration allow for a bulk measurement to confirm or validate that the sensor is positioned correctly. This is because the multiple locations of the spatial configuration can provide, for example, topology information that indicates where the sensor has been positioned. Currently available sensors do not provide such information. For example, if the bulk measurement is within a predetermined range of values, then this can indicate that the sensor is positioned correctly in order to perform pulsatile

measurements for analytes like glucose. If the bulk measurement is outside of a certain range or is an unexpected value, then this can indicate that the sensor should be adjusted, or that the pulsatile measurements can be processed differently to compensate, such as using a different calibration curve or adjusting a calibration curve. This feature and others allow the embodiments to achieve noise cancellation and noise reduction, which can be several times greater in magnitude that what is achievable by currently available technology.

[0246] In order to help illustrate aspects of the multi-stream measurement approach, the following example derivation is provided. Transmittance (T) can be expressed as:

[0247] $T = e^{-m*b*c}$

[0248] In terms of light intensity, this equation can also be rewritten as:

[0249] $I / I_o = e^{-m*b*c}$

[0250] Or, at a detector, the measured light (I) can be expressed as:

[0251] $I = I_o * e^{-m*b*c}$

[0252] As noted, in the present disclosure, multiple detectors (1 to n) can be employed, which results in $I_1 \ldots I_n$ streams of measurements. Assuming each of these detectors have their own path lengths, $b_1 \ldots b_n$, from the light source, the measured light intensities can be expressed as:

[0253] $I_n = I_o * e^{-m*b_n*c}$

[0254] The measured light intensities at any two different detectors can be referenced to each other. For example:

[0255] $I_1/I_n = (I_o * e^{-mb_1c})/(I_o * e^{-mb_nc})$

[0256] As can be seen, the terms, I_o, cancel out and, based on exponent algebra, the equation can be rewritten as:

[0257] $I_1/I_n = e^{-m(b_1-b_n)c}$

[0258] From this equation, the analyte concentration (c) can now be derived from bulk signals $I_1 \ldots I_n$ and knowing the respective mean path lengths b_1 and b_n. This scheme also allows for the cancelling out of I_o, and thus, noise generated by the emitter 1304 can be cancelled out or reduced. In addition, since

the scheme employs a mean path length difference, any changes in mean path length and topological variations from patient to patient are easily accounted. Furthermore, this bulk-measurement scheme can be extended across multiple wavelengths. This flexibility and other features allow embodiments of the present disclosure to measure blood analytes like glucose.

[0259] For example, as noted, the non-pulsatile, bulk measurements can be combined with pulsatile measurements to more accurately measure analytes like glucose. In particular, the non-pulsatile, bulk measurement can be used to confirm or validate the amount of glucose, protein, etc. in the pulsatile measurements taken at the tissue at the measurement site(s) 1302. The pulsatile measurements can be used to measure the amount of glucose, hemoglobin, or the like that is present in the blood. Accordingly, these different measurements can be combined to thus determine analytes like blood glucose.

[0260] **FIGURE 14A** illustrates an embodiment of a detector submount 1400a positioned beneath the partially cylindrical protrusion 605 of FIGURE 6 (or alternatively, the protrusion 605b). The detector submount 1400a includes two rows 1408a of detectors 1410a. The partially cylindrical protrusion 605 can facilitate reducing the number and/or size of detectors used in a sensor because the protrusion 605 can act as a lens that focuses light onto a smaller area.

[0261] To illustrate, in some sensors that do not include the partially cylindrical protrusion 605, sixteen detectors can be used, including four rows of four detectors each. Multiple rows of detectors can be used to measure certain analytes, such as glucose or total hemoglobin, among others. Multiple rows of detectors can also be used to detect light piping (e.g., light that bypasses the measurement site). However, using more detectors in a sensor can add cost, complexity, and noise to the sensor.

[0262] Applying the partially cylindrical protrusion 605 to such a sensor, however, could reduce the number of detectors or rows of detectors used while still receiving the substantially same amount of light, due to the focusing properties of the protrusion 605 (see FIGURE 14B). This is the example situation illustrated in **FIGURE 14**—two rows 1408a of detectors 1410a are used instead of four.

Advantageously, in certain embodiments, the resulting sensor can be more cost effective, have less complexity, and have an improved SNR, due to fewer and/or smaller photodiodes.

[0263] In other embodiments, using the partially cylindrical protrusion 605 can allow the number of detector rows to be reduced to one or three rows of four detectors. The number of detectors in each row can also be reduced. Alternatively, the number of rows might not be reduced but the size of the detectors can be reduced. Many other configurations of detector rows and sizes can also be provided.

[0264] **FIGURE 14B** depicts a front elevation view of the partially cylindrical protrusion 605 (or alternatively, the protrusion 605b) that illustrates how light from emitters (not shown) can be focused by the protrusion 605 onto detectors. The protrusion 605 is placed above a detector submount 1400b having one or more detectors 1410b disposed thereon. The submount 1400b can include any number of rows of detectors 1410, although one row is shown.

[0265] Light, represented by rays 1420, is emitted from the emitters onto the protrusion 605. These light rays 1420 can be attenuated by body tissue (not shown). When the light rays 1420 enter the protrusion 605, the protrusion 605 acts as a lens to refract the rays into rays 1422. This refraction is caused in certain embodiments by the partially cylindrical shape of the protrusion 605. The refraction causes the rays 1422 to be focused or substantially focused on the one or more detectors 1410b. Since the light is focused on a smaller area, a sensor including the protrusion 605 can include fewer detectors to capture the same amount of light compared with other sensors.

[0266] **FIGURE 14C** illustrates another embodiment of a detector submount 1400c, which can be disposed under the protrusion 605b (or alternatively, the protrusion 605). The detector submount 1400c includes a single row 1408c of detectors 1410c. The detectors are electrically connected to conductors 1412c, which can be gold, silver, copper, or any other suitable conductive material.

[0267] The detector submount 1400c is shown positioned under the protrusion 605b in a detector subassembly 1450 illustrated in **FIGURE 14D**. A top-

down view of the detector subassembly 1450 is also shown in **FIGURE 14E**. In the detector subassembly 1450, a cylindrical housing 1430 is disposed on the submount 1400c. The cylindrical housing 1430 includes a transparent cover 1432, upon which the protrusion 605b is disposed. Thus, as shown in **FIGURE 14D**, a gap 1434 exists between the detectors 1410c and the protrusion 605b. The height of this gap 1434 can be chosen to increase or maximize the amount of light that impinges on the detectors 1410c.

[0268] The cylindrical housing 1430 can be made of metal, plastic, or another suitable material. The transparent cover 1432 can be fabricated from glass or plastic, among other materials. The cylindrical housing 1430 can be attached to the submount 1400c at the same time or substantially the same time as the detectors 1410c to reduce manufacturing costs. A shape other than a cylinder can be selected for the housing 1430 in various embodiments.

[0269] In certain embodiments, the cylindrical housing 1430 (and transparent cover 1432) forms an airtight or substantially airtight or hermetic seal with the submount 1400c. As a result, the cylindrical housing 1430 can protect the detectors 1410c and conductors 1412c from fluids and vapors that can cause corrosion. Advantageously, in certain embodiments, the cylindrical housing 1430 can protect the detectors 1410c and conductors 1412c more effectively than currently-available resin epoxies, which are sometimes applied to solder joints between conductors and detectors.

[0270] In embodiments where the cylindrical housing 1430 is at least partially made of metal, the cylindrical housing 1430 can provide noise shielding for the detectors 1410c. For example, the cylindrical housing 1430 can be soldered to a ground connection or ground plane on the submount 1400c, which allows the cylindrical housing 1430 to reduce noise. In another embodiment, the transparent cover 1432 can include a conductive material or conductive layer, such as conductive glass or plastic. The transparent cover 1432 can include any of the features of the noise shields 790 described above.

[0271] The protrusion 605b includes the chamfered edges 607 described above with respect to FIGURE 6E. These chamfered edges 607 can allow a patient

to more comfortably slide a finger over the protrusion 605b when inserting the finger into the sensor 301f.

[0272] **FIGURE 14F** illustrates a portion of the detector shell 306f, which includes the detectors 1410c on the substrate 1400c. The substrate 1400c is enclosed by a shielding enclosure 1490, which can include the features of the shielding enclosures 790a, 790b described above (see also FIGURE 17). The shielding enclosure 1490 can be made of metal. The shielding enclosure 1490 includes a window 1492a above the detectors 1410c, which allows light to be transmitted onto the detectors 1410c.

[0273] A noise shield 1403 is disposed above the shielding enclosure 1490. The noise shield 1403, in the depicted embodiment, includes a window 1492a corresponding to the window 1492a. Each of the windows 1492a, 1492b can include glass, plastic, or can be an opening without glass or plastic. In some embodiments, the windows 1492a, 1492b may be selected to have different sizes or shapes from each other.

[0274] The noise shield 1403 can include any of the features of the conductive glass described above. In the depicted embodiment, the noise shield 1403 extends about three-quarters of the length of the detector shell 306f. In other embodiments, the noise shield 1403 could be smaller or larger. The noise shield 1403 could, for instance, merely cover the detectors 1410c, the submount 1400c, or a portion thereof. The noise shield 1403 also includes a stop 1413 for positioning a measurement site within the sensor 301f. Advantageously, in certain embodiments, the noise shield 1403 can reduce noise caused by light piping.

[0275] A thermistor 1470 is also shown. The thermistor 1470 is attached to the submount 1400c and protrudes above the noise shield 1403. As described above, the thermistor 1470 can be employed to measure a temperature of a measurement site. Such a temperature can be helpful in correcting for wavelength drift due to changes in water absorption, which can be temperature dependent, thereby providing more accurate data useful in detecting blood analytes like glucose.

[0276] In the depicted embodiment, the detectors 1410c are not enclosed in the cylindrical housing 1430. In an alternative embodiment, the cylindrical housing 1430 encloses the detectors 1410c and is disposed under the noise shield 1403. In another embodiment, the cylindrical housing 1430 encloses the detectors 1410c and the noise shield 1403 is not used. If both the cylindrical housing 1403 and the noise shield 1403 are used, either or both can have noise shielding features.

[0277] **FIGURE 14G** illustrates the detector shell 306f of FIGURE 14F, with the finger bed 310f disposed thereon. **FIGURE 14H** illustrates the detector shell 306f of FIGURE 14G, with the protrusion 605b disposed in the finger bed 310f.

[0278] **FIGURE 14I** illustrates a cutaway view of the sensor 301f. Not all features of the sensor 301f are shown, such as the protrusion 605b. Features shown include the emitter and detector shells 304f, 306f, the flaps 307f, the heat sink 350f and fins 351f, the finger bed 310f, and the noise shield 1403.

[0279] In addition to these features, emitters 1404 are depicted in the emitter shell 304f. The emitters 1404 are disposed on a submount 1401, which is connected to a circuit board 1419. The emitters 1404 are also enclosed within a cylindrical housing 1480. The cylindrical housing 1480 can include all of the features of the cylindrical housing 1430 described above. For example, the cylindrical housing 1480 can be made of metal, can be connected to a ground plane of the submount 1401 to provide noise shielding, and can include a transparent cover 1482.

[0280] The cylindrical housing 1480 can also protect the emitters 1404 from fluids and vapors that can cause corrosion. Moreover, the cylindrical housing 1480 can provide a gap between the emitters 1404 and the measurement site (not shown), which can allow light from the emitters 1404 to even out or average out before reaching the measurement site.

[0281] The heat sink 350f, in addition to including the fins 351f, includes a protuberance 352f that extends down from the fins 351f and contacts the submount 1401. The protuberance 352f can be connected to the submount 1401, for

example, with thermal paste or the like. The protuberance 352f can sink heat from the emitters 1404 and dissipate the heat via the fins 351f.

[0282] **FIGURES 15A** and **15B** illustrate embodiments of sensor portions 1500A, 1500B that include alternative heat sink features to those described above. These features can be incorporated into any of the sensors described above. For example, any of the sensors above can be modified to use the heat sink features described below instead of or in addition to the heat sink features of the sensors described above.

[0283] The sensor portions 1500A, 1500B shown include LED emitters 1504; however, for ease of illustration, the detectors have been omitted. The sensor portions 1500A, 1500B shown can be included, for example, in any of the emitter shells described above.

[0284] The LEDs 1504 of the sensor portions 1500A, 1500B are connected to a substrate or submount 1502. The submount 1502 can be used in place of any of the submounts described above. The submount 1502 can be a non-electrically conducting material made of any of a variety of materials, such as ceramic, glass, or the like. A cable 1512 is attached to the submount 1502 and includes electrical wiring 1514, such as twisted wires and the like, for communicating with the LEDs 1504. The cable 1512 can correspond to the cables 212 described above.

[0285] Although not shown, the cable 1512 can also include electrical connections to a detector. Only a portion of the cable 1512 is shown for clarity. The depicted embodiment of the cable 1512 includes an outer jacket 1510 and a conductive shield 1506 disposed within the outer jacket 1510. The conductive shield 1506 can be a ground shield or the like that is made of a metal such as braided copper or aluminum. The conductive shield 1506 or a portion of the conductive shield 1506 can be electrically connected to the submount 1502 and can reduce noise in the signal generated by the sensor 1500A, 1500B by reducing RF coupling with the wires 1514. In alternative embodiments, the cable 1512 does not have a conductive shield. For example, the cable 1512 could be a twisted pair cable or the like, with one wire of the twisted pair used as a heat sink.

[0286] Referring specifically to **FIGURE 15A**, in certain embodiments, the conductive shield 1506 can act as a heat sink for the LEDs 1504 by absorbing thermal energy from the LEDs 1504 and/or the submount 1502. An optional heat insulator 1520 in communication with the submount 1502 can also assist with directing heat toward the conductive shield 1506. The heat insulator 1520 can be made of plastic or another suitable material. Advantageously, using the conductive shield 1506 in the cable 1512 as a heat sink can, in certain embodiments, reduce cost for the sensor.

[0287] Referring to **FIGURE 15B**, the conductive shield 1506 can be attached to both the submount 1502 and to a heat sink layer 1530 sandwiched between the submount 1502 and the optional insulator 1520. Together, the heat sink layer 1530 and the conductive shield 1506 in the cable 1512 can absorb at least part of the thermal energy from the LEDs and/or the submount 1502.

[0288] **FIGURES 15C** and **15D** illustrate implementations of a sensor portion 1500C that includes the heat sink features of the sensor portion 1500A described above with respect to FIGURE 15A. The sensor portion 1500C includes the features of the sensor portion 1500A, except that the optional insulator 1520 is not shown. **FIGURE 15D** is a side cutaway view of the sensor portion 1500C that shows the emitters 1504.

[0289] The cable 1512 includes the outer jacket 1510 and the conductive shield 1506. The conductive shield 1506 is soldered to the submount 1502, and the solder joint 1561 is shown. In some embodiments, a larger solder joint 1561 can assist with removing heat more rapidly from the emitters 1504. Various connections 1563 between the submount 1502 and a circuit board 1519 are shown. In addition, a cylindrical housing 1580, corresponding to the cylindrical housing 1480 of FIGURE 14I, is shown protruding through the circuit board 1519. The emitters 1504 are enclosed in the cylindrical housing 1580.

[0290] **FIGURES 15E** and **15F** illustrate implementations of a sensor portion 1500E that includes the heat sink features of the sensor portion 1500B described above with respect to FIGURE 15B. The sensor portion 1500E includes the heat sink layer 1530. The heat sink layer 1530 can be a metal plate, such as a

copper plate or the like. The optional insulator 1520 is not shown. **FIGURE 15F** is a side cutaway view of the sensor portion 1500E that shows the emitters 1504.

[0291] In the depicted embodiment, the conductive shield 1506 of the cable 1512 is soldered to the heat sink layer 1530 instead of the submount 1502. The solder joint 1565 is shown. In some embodiments, a larger solder joint 1565 can assist with removing heat more rapidly from the emitters 1504. Various connections 1563 between the submount 1502 and a circuit board 1519 are shown. In addition, the cylindrical housing 1580 is shown protruding through the circuit board 1519. The emitters 1504 are enclosed in the cylindrical housing 1580.

[0292] **FIGURES 15G** and **15H** illustrate embodiments of connector features that can be used with any of the sensors described above with respect to FIGURES 1 through 15F. Referring to **FIGURE 15G**, the circuit board 1519 includes a female connector 1575 that mates with a male connector 1577 connected to a daughter board 1587. The daughter board 1587 includes connections to the electrical wiring 1514 of the cable 1512. The connected boards 1519, 1587 are shown in **FIGURE 15H**. Also shown is a hole 1573 that can receive the cylindrical housing 1580 described above.

[0293] Advantageously, in certain embodiments, using a daughter board 1587 to connect to the circuit board 1519 can enable connections to be made more easily to the circuit board 1519. In addition, using separate boards can be easier to manufacture than a single circuit board 1519 with all connections soldered to the circuit board 1519.

[0294] **FIGURE 15I** illustrates an exemplary architecture for front-end interface 108 as a transimpedance-based front-end. As noted, front-end interfaces 108 provide an interface that adapts the output of detectors 106 into a form that can be handled by signal processor 110. As shown in this figure, sensor 101 and front-end interfaces 108 may be integrated together as a single component, such as an integrated circuit. Of course, one skilled in the art will recognize that sensor 101 and front end interfaces 108 may comprise multiple components or circuits that are coupled together.

[0295] Front-end interfaces 108 may be implemented using transimpedance amplifiers that are coupled to analog to digital converters in a sigma delta converter. In some embodiments, a programmable gain amplifier (PGA) can be used in combination with the transimpedance-based front-ends. For example, the output of a transimpedance-based front-end may be output to a sigma-delta ADC that comprises a PGA. A PGA may be useful in order to provide another level of amplification and control of the stream of signals from detectors 106. The PGA may be an integrated circuit or built from a set of micro-relays. Alternatively, the PGA and ADC components in converter 900 may be integrated with the transimpedance-based front-end in sensor 101.

[0296] Due to the low-noise requirements for measuring blood analytes like glucose and the challenge of using multiple photodiodes in detector 106, the applicants developed a noise model to assist in configuring front-end 108. Conventionally, those skilled in the art have focused on optimizing the impedance of the transimpedance amplifiers to minimize noise.

[0297] However, the following noise model was discovered by the applicants:

$Noise = \sqrt{aR + bR^2}$, where:

[0298] aR is characteristic of the impedance of the transimpedance amplifier; and

[0299] bR^2 is characteristic of the impedance of the photodiodes in detector and the number of photodiodes in detector 106.

[0300] The foregoing noise model was found to be helpful at least in part due to the high SNR required to measure analytes like glucose. However, the foregoing noise model was not previously recognized by artisans at least in part because, in conventional devices, the major contributor to noise was generally believed to originate from the emitter or the LEDs. Therefore, artisans have generally continued to focus on reducing noise at the emitter.

[0301] However, for analytes like glucose, the discovered noise model revealed that one of the major contributors to noise was generated by the photodiodes. In addition, the amount of noise varied based on the number of

photodiodes coupled to a transimpedance amplifier. Accordingly, combinations of various photodiodes from different manufacturers, different impedance values with the transimpedance amplifiers, and different numbers of photodiodes were tested as possible embodiments.

[0302] In some embodiments, different combinations of transimpedance to photodiodes may be used. For example, detectors 1-4 (as shown, e.g., in **FIGURE 12A**) may each comprise four photodiodes. In some embodiments, each detector of four photodiodes may be coupled to one or more transimpedance amplifiers. The configuration of these amplifiers may be set according to the model shown in **FIGURE 15J**.

[0303] Alternatively, each of the photodiodes may be coupled to its own respective transimpedance amplifier. For example, transimpedance amplifiers may be implemented as integrated circuits on the same circuit board as detectors 1-4. In this embodiment, the transimpedance amplifiers may be grouped into an averaging (or summing) circuit, which are known to those skilled in the art, in order to provide an output stream from the detector. The use of a summing amplifier to combine outputs from several transimpedance amplifiers into a single, analog signal may be helpful in improving the SNR relative to what is obtainable from a single transimpedance amplifier. The configuration of the transimpedance amplifiers in this setting may also be set according to the model shown in **FIGURE 15J**.

[0304] As yet another alternative, as noted above with respect to **FIGURES 12E** through **12H**, the photodiodes in detectors 106 may comprise multiple active areas that are grouped together. In some embodiments, each of these active areas may be provided its own respective transimpedance. This form of pairing may allow a transimpedance amplifier to be better matched to the characteristics of its corresponding photodiode or active area of a photodiode.

[0305] As noted, **FIGURE 15J** illustrates an exemplary noise model that may be useful in configuring transimpedance amplifiers. As shown, for a given number of photodiodes and a desired SNR, an optimal impedance value for a transimpedance amplifier could be determined.

[0306] For example, an exemplary "4 PD per stream" sensor 1502 is shown where detector 106 comprises four photodiodes 1502. The photodiodes 1502 are coupled to a single transimpedance amplifier 1504 to produce an output stream 1506. In this example, the transimpedance amplifier comprises 10 MΩ resistors 1508 and 1510. Thus, output stream 1506 is produced from the four photodiodes (PD) 1502. As shown in the graph of **FIGURE 15J**, the model indicates that resistance values of about 10 MΩ may provide an acceptable SNR for analytes like glucose.

[0307] However, as a comparison, an exemplary "1 PD per stream" sensor 1512 is also shown in **FIGURE 15J.** In particular, sensor 1512 may comprise a plurality of detectors 106 that each comprises a single photodiode 1514. In addition, as shown for this example configuration, each of photodiodes 1514 may be coupled to respective transimpedance amplifiers 1516, e.g., 1 PD per stream. Transimpedance amplifiers are shown having 40 MΩ resistors 1518. As also shown in the graph of **FIGURE 15J**, the model illustrates that resistance values of 40 MΩ for resistors 1518 may serve as an alternative to the 4 photodiode per stream architecture of sensor 1502 described above and yet still provide an equivalent SNR.

[0308] Moreover, the discovered noise model also indicates that utilizing a 1 photodiode per stream architecture like that in sensor 1512 may provide enhanced performance because each of transimpedance amplifiers 1516 can be tuned or optimized to its respective photodiodes 1518. In some embodiments, an averaging component 1520 may also be used to help cancel or reduce noise across photodiodes 1518.

[0309] For purposes of illustration, **FIGURE 15K** shows different architectures (e.g., four PD per stream and one PD per stream) for various embodiments of a sensor and how components of the sensor may be laid out on a circuit board or substrate. For example, sensor 1522 may comprise a "4 PD per stream" architecture on a submount 700 in which each detector 106 comprises four (4) photodiodes 1524. As shown for sensor 1522, the output of each set of four

photodiodes 1524 is then aggregated into a single transimpedance amplifier 1526 to produce a signal.

[0310] As another example, a sensor 1528 may comprise a "1 PD per stream" architecture on submount 700 in which each detector 106 comprises four (4) photodiodes 1530. In sensor 1528, each individual photodiode 1530 is coupled to a respective transimpedance amplifier 1532. The output of the amplifiers 1532 may then be aggregated into averaging circuit 1520 to produce a signal.

[0311] As noted previously, one skilled in the art will recognize that the photodiodes and detectors may be arranged in different fashions to optimize the detected light. For example, sensor 1534 illustrates an exemplary "4 PD per stream" sensor in which the detectors 106 comprise photodiodes 1536 arranged in a linear fashion. Likewise, sensor 1538 illustrates an exemplary "1 PD per stream" sensor in which the detectors comprise photodiodes 1540 arranged in a linear fashion.

[0312] Alternatively, sensor 1542 illustrates an exemplary "4 PD per stream" sensor in which the detectors 106 comprise photodiodes 1544 arranged in a two-dimensional pattern, such as a zig-zag pattern. Sensor 1546 illustrates an exemplary "1 PD per stream" sensor in which the detectors comprise photodiodes 1548 also arranged in a zig-zag pattern.

[0313] **FIGURE 15L** illustrates an exemplary architecture for a switched-capacitor-based front-end. As shown, front-end interfaces 108 may be implemented using switched capacitor circuits and any number of front-end interfaces 108 may be implemented. The output of these switched capacitor circuits may then be provided to a digital interface 1000 and signal processor 110. Switched capacitor circuits may be useful in system 100 for their resistor free design and analog averaging properties. In particular, the switched capacitor circuitry provides for analog averaging of the signal that allows for a lower smaller sampling rate (e.g., 2 KHz sampling for analog versus 48 KHz sampling for digital designs) than similar digital designs. In some embodiments, the switched capacitor architecture in front end interfaces 108 may provide a similar or equivalent SNR to other front end designs, such as a sigma delta architecture. In addition, a switched capacitor design in front

end interfaces 108 may require less computational power by signal processor 110 to perform the same amount of decimation to obtain the same SNR.

[0314] **FIGURES 16A** and **16B** illustrate embodiments of disposable optical sensors 1600. In an embodiment, any of the features described above, such as protrusion, shielding, and/or heat sink features, can be incorporated into the disposable sensors 1600 shown. For instance, the sensors 1600 can be used as the sensors 101 in the system 100 described above with respect to FIGURE 1. Moreover, any of the features described above, such as protrusion, shielding, and/or heat sink features, can be implemented in other disposable sensor designs that are not depicted herein.

[0315] The sensors 1600 include an adult/pediatric sensor 1610 for finger placement and a disposable infant/neonate sensor 1602 configured for toe, foot or hand placement. Each sensor 1600 has a tape end 1610 and an opposite connector end 1620 electrically and mechanically interconnected via a flexible coupling 1630. The tape end 1610 attaches an emitter and detector to a tissue site. Although not shown, the tape end 1610 can also include any of the protrusion, shielding, and/or heat sink features described above. The emitter illuminates the tissue site and the detector generates a sensor signal responsive to the light after tissue absorption, such as absorption by pulsatile arterial blood flow within the tissue site.

[0316] The sensor signal is communicated via the flexible coupling 1630 to the connector end 1620. The connector end 1620 can mate with a cable (not shown) that communicates the sensor signal to a monitor (not shown), such as any of the cables or monitors shown above with respect to FIGURES 2A through 2D. Alternatively, the connector end 1620 can mate directly with the monitor.

[0317] **FIGURE 17** illustrates an exploded view of certain of the components of the sensor 301f described above. A heat sink 1751 and a cable 1781 attach to an emitter shell 1704. The emitter shell attaches to a flap housing 1707. The flap housing 1707 includes a receptacle 1709 to receive a cylindrical housing 1480/1580 (not shown) attached to an emitter submount 1702, which is attached to a circuit board 1719.

[0318] A spring 1787 attaches to a detector shell 1706 via pins 1783, 1785, which hold the emitter and detector shells 1704, 1706 together. A support structure 1791 attaches to the detector shell 1706, which provides support for a shielding enclosure 1790. A noise shield 1713 attaches to the shielding enclosure 1790. A detector submount 1700 is disposed inside the shielding enclosure 1790. A finger bed 1710 provides a surface for placement of the patient's finger. Finger bed 1710 may comprise a gripping surface or gripping features, which may assist in placing and stabilizing a patient's finger in the sensor. A partially cylindrical protrusion 1705 may also be disposed in the finger bed 1710. As shown, finger bed 1710 attaches to the noise shield 1703. The noise shield 1703 may be configured to reduce noise, such as from ambient light and electromagnetic noise. For example, the noise shield 1703 may be constructed from materials having an opaque color, such as black or a dark blue, to prevent light piping.

[0319] Noise shield 1703 may also comprise a thermistor 1712. The thermistor 1712 may be helpful in measuring the temperature of a patient's finger. For example, the thermistor 1712 may be useful in detecting when the patient's finger is reaching an unsafe temperature that is too hot or too cold. In addition, the temperature of the patient's finger may be useful in indicating to the sensor the presence of low perfusion as the temperature drops. In addition, the thermistor 1712 may be useful in detecting a shift in the characteristics of the water spectrum in the patient's finger, which can be temperature dependent.

[0320] Moreover, a flex circuit cover 1706 attaches to the pins 1783, 1785. Although not shown, a flex circuit can also be provided that connects the circuit board 1719 with the submount 1700 (or a circuit board to which the submount 1700 is connected). A flex circuit protector 1760 may be provided to provide a barrier or shield to the flex circuit (not shown). In particular, the flex circuit protector 1760 may also prevent any electrostatic discharge to or from the flex circuit. The flex circuit protector 1760 may be constructed from well known materials, such as a plastic or rubber materials.

[0321] **FIGURE 18** shows the results obtained by an exemplary sensor 101 of the present disclosure that was configured for measuring glucose. This

sensor 101 was tested using a pure water ex-vivo sample. In particular, ten samples were prepared that ranged from 0-55 mg/dL. Two samples were used as a training set and eight samples were then used as a test population. As shown, embodiments of the sensor 101 were able to obtain at least a standard deviation of 13 mg/dL in the training set and 11 mg/dL in the test population.

[0322] **FIGURE 19** shows the results obtained by an exemplary sensor 101 of the present disclosure that was configured for measuring glucose. This sensor 101 was tested using a turbid ex-vivo sample. In particular, 25 samples of water/glucose/Liposyn were prepared that ranged from 0-55 mg/dL. Five samples were used as a training set and 20 samples were then used as a test population. As shown, embodiments of sensor 101 were able to obtain at least a standard deviation of 37 mg/dL in the training set and 32 mg/dL in the test population.

[0323] **FIGURES 20** through **22** shows other results that can be obtained by an embodiment of system 100. In **FIGURE 20**, 150 blood samples from two diabetic adult volunteers were collected over a 10-day period. Invasive measurements were taken with a YSI glucometer to serve as a reference measurement. Noninvasive measurements were then taken with an embodiment of system 100 that comprised four LEDs and four independent detector streams. As shown, the system 100 obtained a correlation of about 85% and Arms of about 31 mg/dL.

[0324] In **FIGURE 21**, 34 blood samples were taken from a diabetic adult volunteer collected over a 2-day period. Invasive measurements were also taken with a glucometer for comparison. Noninvasive measurements were then taken with an embodiment of system 100 that comprised four LEDs in emitter 104 and four independent detector streams from detectors 106. As shown, the system 100 was able to attain a correlation of about 90% and Arms of about 22 mg/dL.

[0325] The results shown in **FIGURE 22** relate to total hemoglobin testing with an exemplary sensor 101 of the present disclosure. In particular, 47 blood samples were collected from nine adult volunteers. Invasive measurements were then taken with a CO-oximeter for comparison. Noninvasive measurements were taken with an embodiment of system 100 that comprised four LEDs in emitter 104

and four independent detector channels from detectors 106. Measurements were averaged over 1 minute. As shown, the testing resulted in a correlation of about 93% and Arms of about 0.8 mg/dL.

[0326] Conditional language used herein, such as, among others, "can," "could," "might," "may," “e.g.,” and the like, unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments include, while other embodiments do not include, certain features, elements and/or states. Thus, such conditional language is not generally intended to imply that features, elements and/or states are in any way required for one or more embodiments or that one or more embodiments necessarily include logic for deciding, with or without author input or prompting, whether these features, elements and/or states are included or are to be performed in any particular embodiment.

[0327] While certain embodiments of the inventions disclosed herein have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions disclosed herein. Indeed, the novel methods and systems described herein can be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the methods and systems described herein can be made without departing from the spirit of the inventions disclosed herein. The claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of certain of the inventions disclosed herein.

WHAT IS CLAIMED IS:

1. A noninvasive device capable of producing a signal responsive to light attenuated by tissue at a measurement site, the device comprising:

an optical source configured to emit optical radiation at least at wavelengths between about 1600 nm and about 1700 nm; and

a plurality of photodetectors each configured to detect the optical radiation from said optical source after attenuation by said tissue of said measurement site and each output a respective signal stream responsive to said detected optical radiation.

ABSTRACT OF THE DISCLOSURE

The present disclosure relates to noninvasive methods, devices, and systems for measuring various blood constituents or analytes, such as glucose. In an embodiment, a light source comprises LEDs and super-luminescent LEDs. The light source emits light at at least wavelengths of about 1610 nm, about 1640 nm, and about 1665 nm. In an embodiment, the detector comprises a plurality of photodetectors arranged in a special geometry comprising one of a substantially linear substantially equal spaced geometry, a substantially linear substantially non-equal spaced geometry, and a substantially grid geometry.

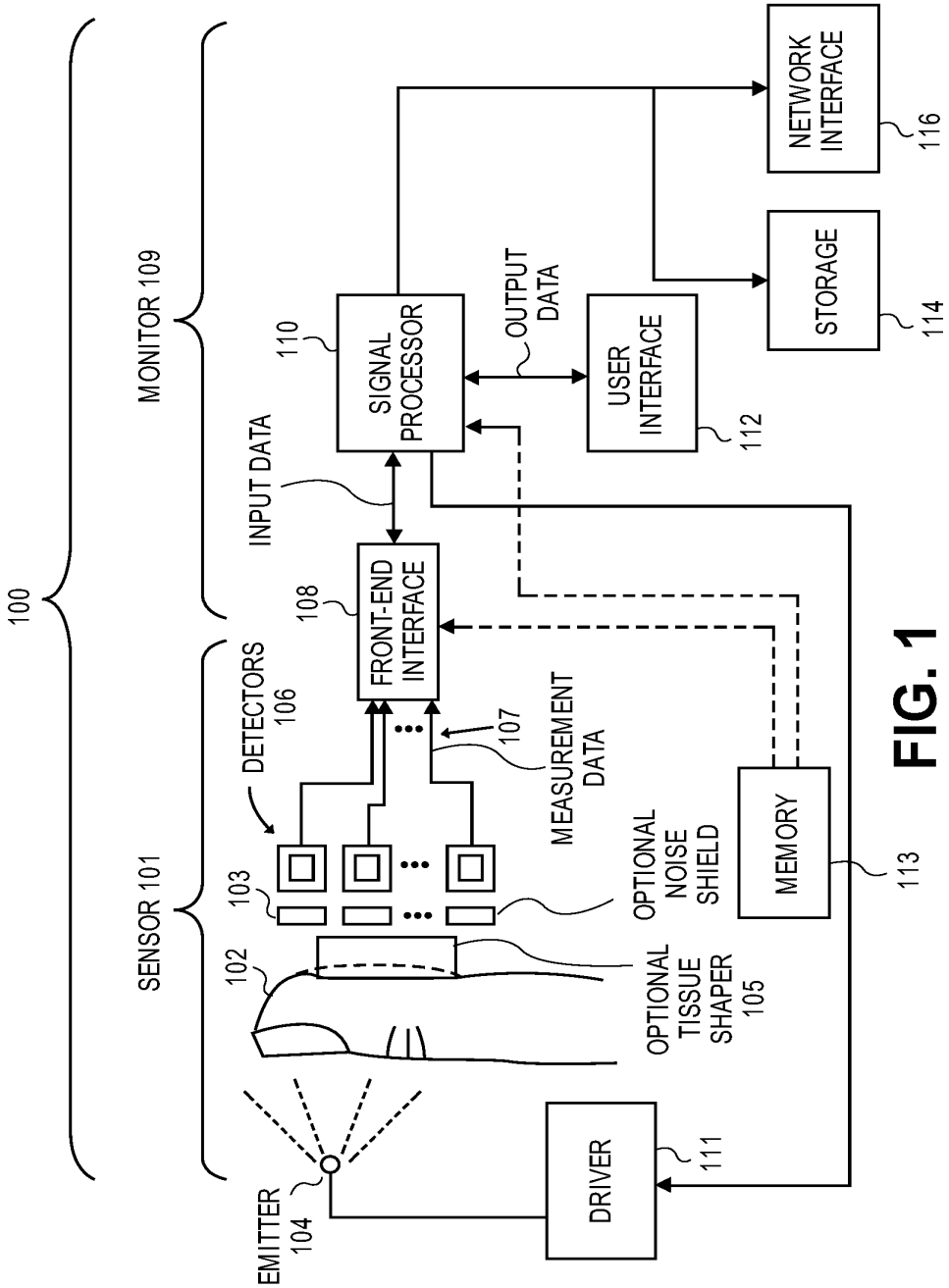

100
MONITOR 109
SENSOR 101
EMITTER
104
DRIVER
111
102
103
DETECTORS
106
OPTIONAL
TISSUE
SHAPER
105
OPTIONAL
NOISE
SHIELD
MEASUREMENT
DATA
107
108
FRONT-END
INTERFACE
INPUT DATA
110
SIGNAL
PROCESSOR
OUTPUT
DATA
USER
INTERFACE
112
MEMORY
113
STORAGE
114
NETWORK
INTERFACE
116

FIG. 1

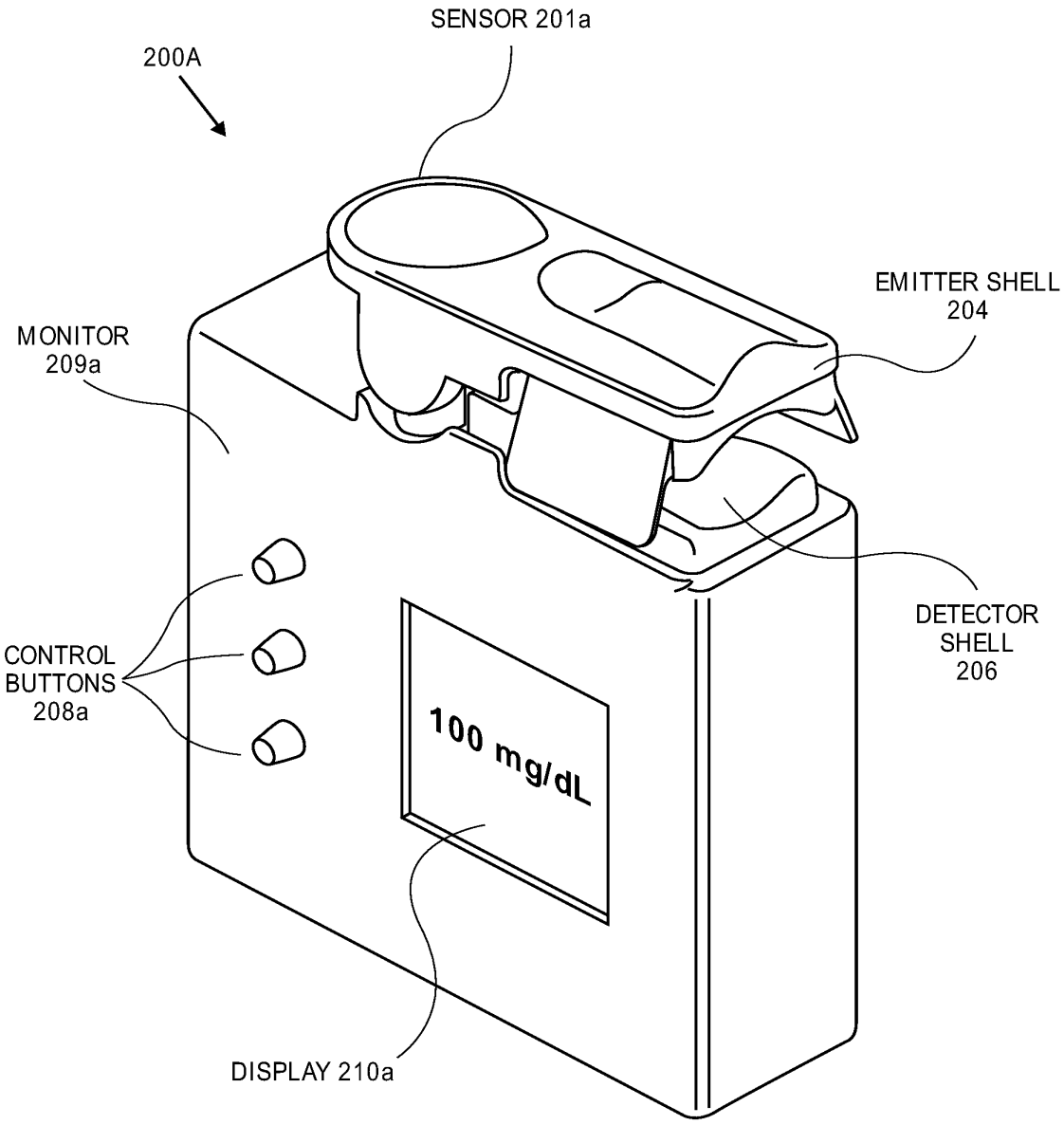

SENSOR 201a
200A
EMITTER SHELL
204
MONITOR
209a
DETECTOR
SHELL
206
CONTROL
BUTTONS
208a
100 mg/dL
DISPLAY 210a

FIG. 2A

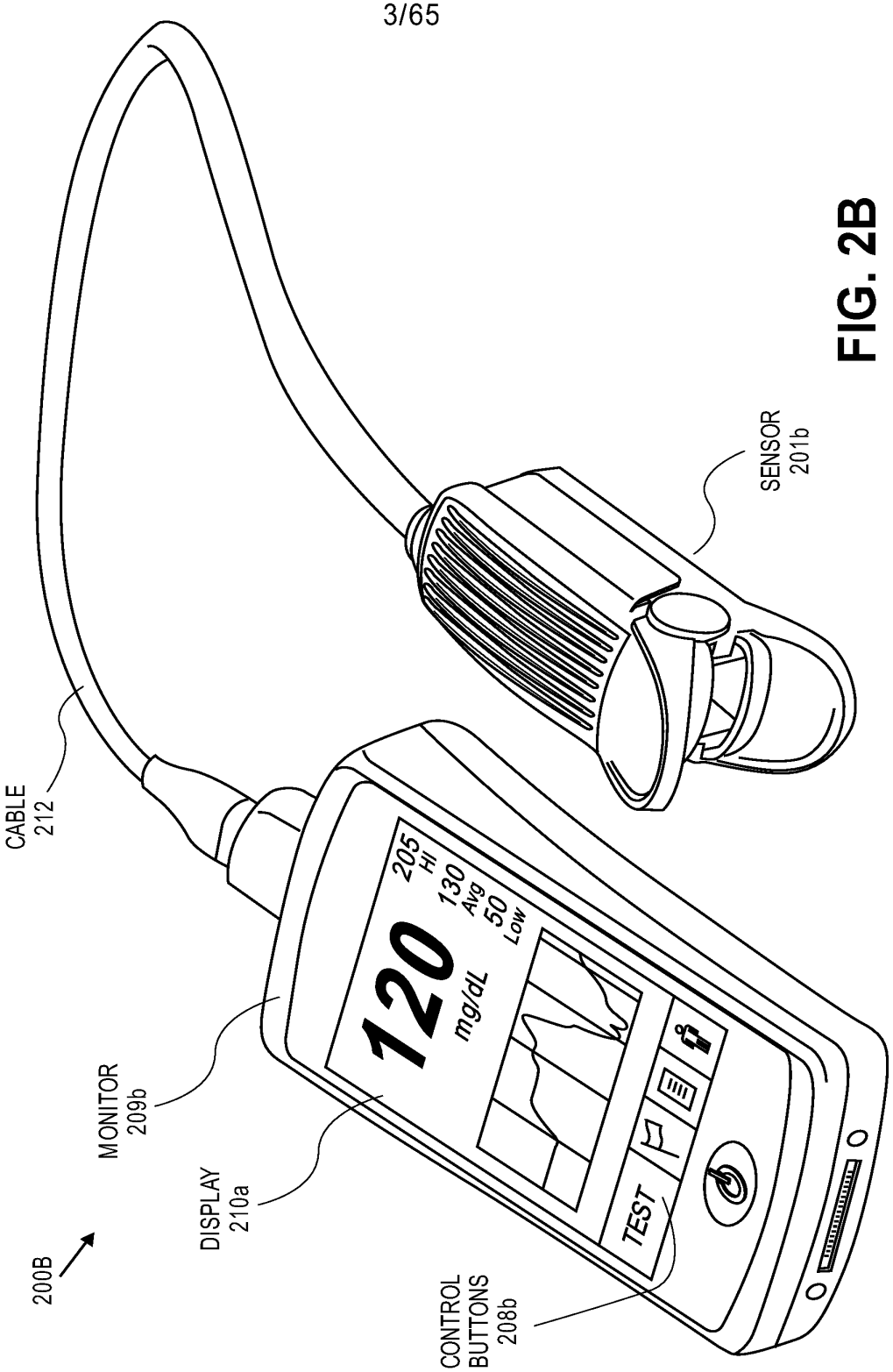

CABLE
212
SENSOR
201b
MONITOR
209b
DISPLAY
210a
200B
CONTROL
BUTTONS
208b
205
HI
130
Avg
50
Low
120
mg/dL
TEST

FIG. 2B

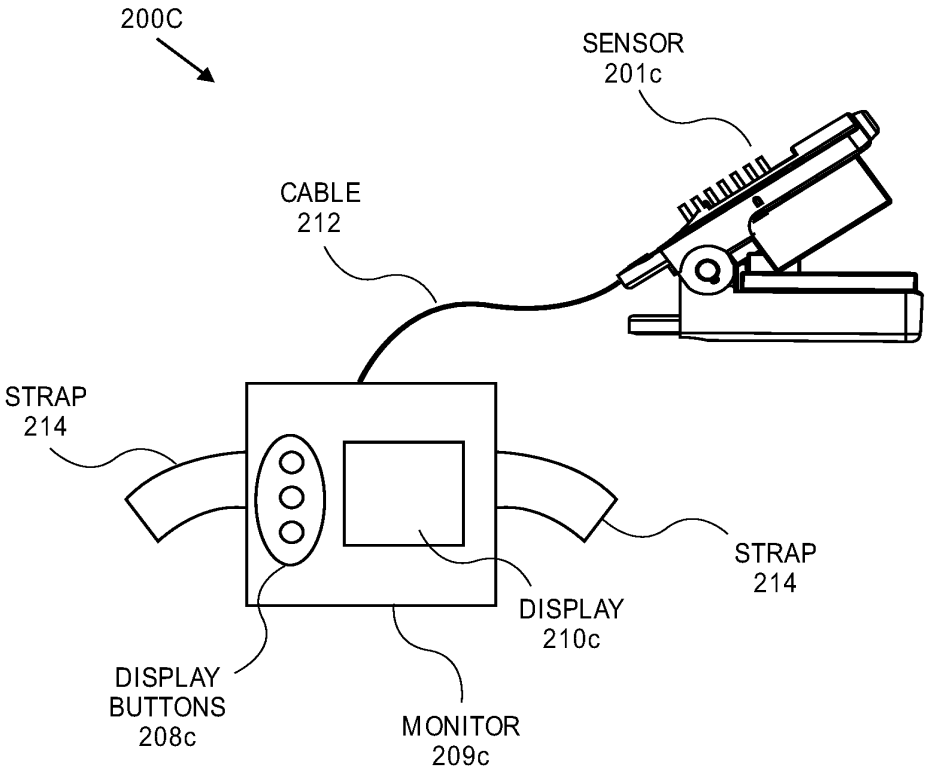

200C
SENSOR
201c
CABLE
212
STRAP
214
STRAP
214
DISPLAY
210c
DISPLAY
BUTTONS
208c
MONITOR
209c

FIG. 2C

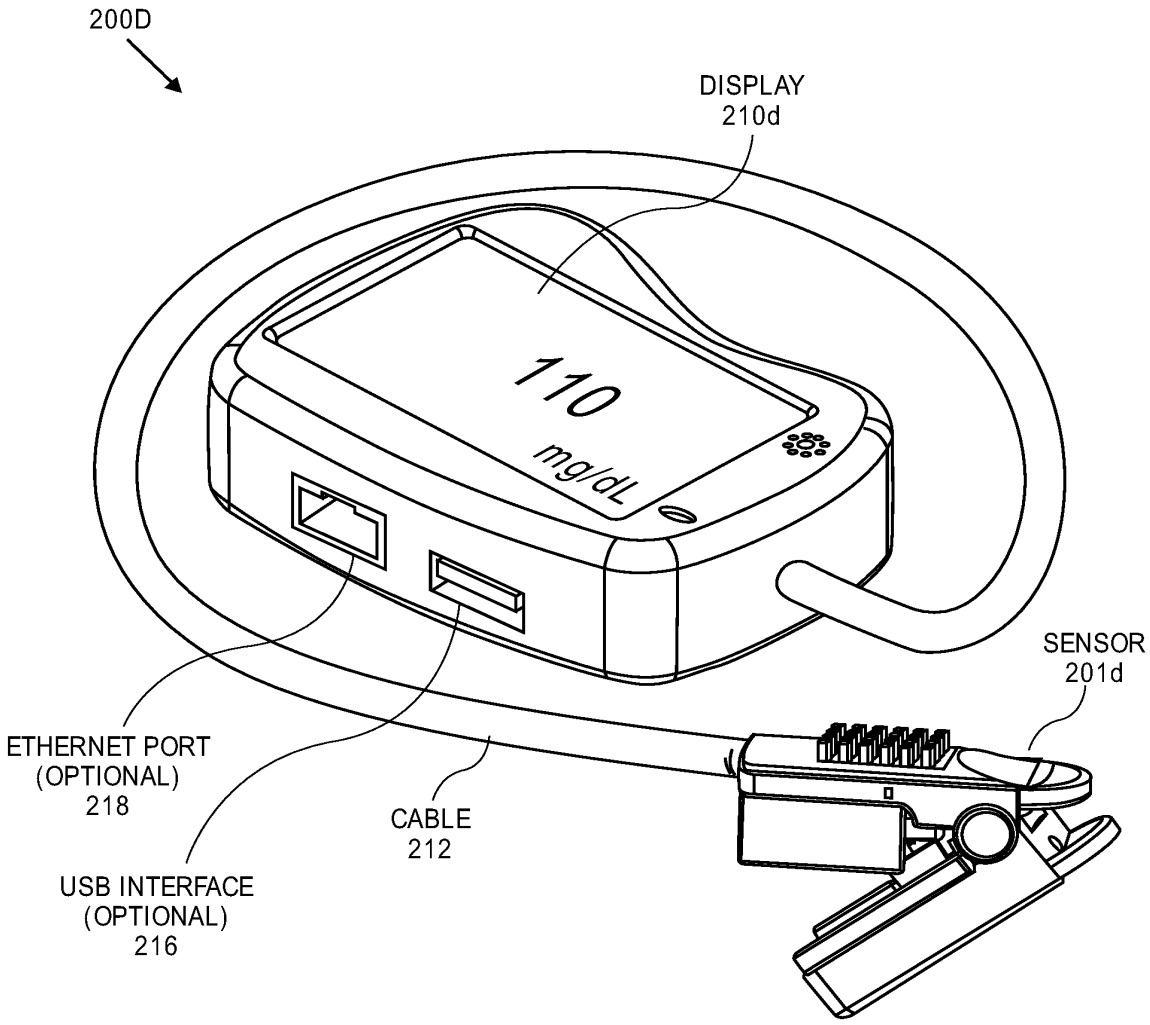

200D
DISPLAY
210d
110
mg/dL
SENSOR
201d
ETHERNET PORT
(OPTIONAL)
218
CABLE
212
USB INTERFACE
(OPTIONAL)
216

FIG. 2D

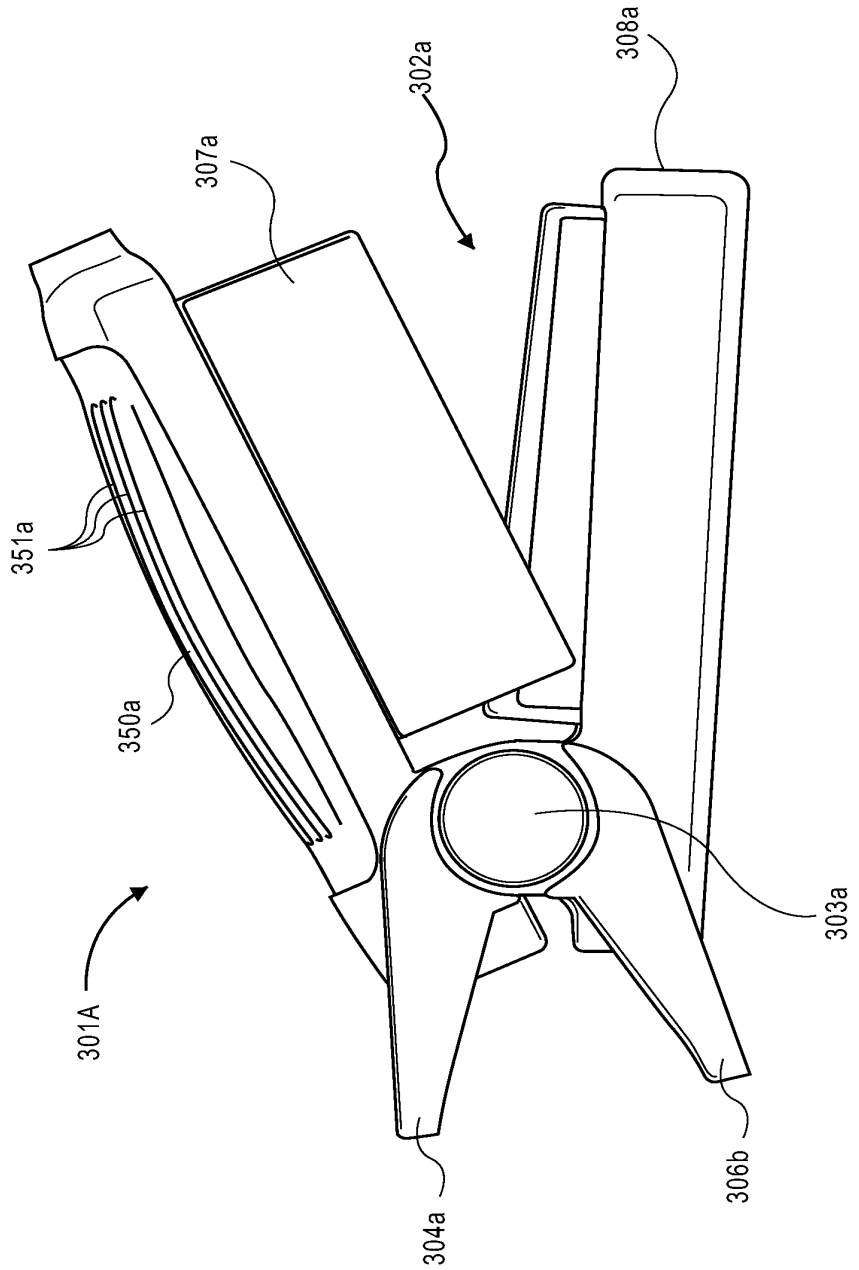


FIG. 3A

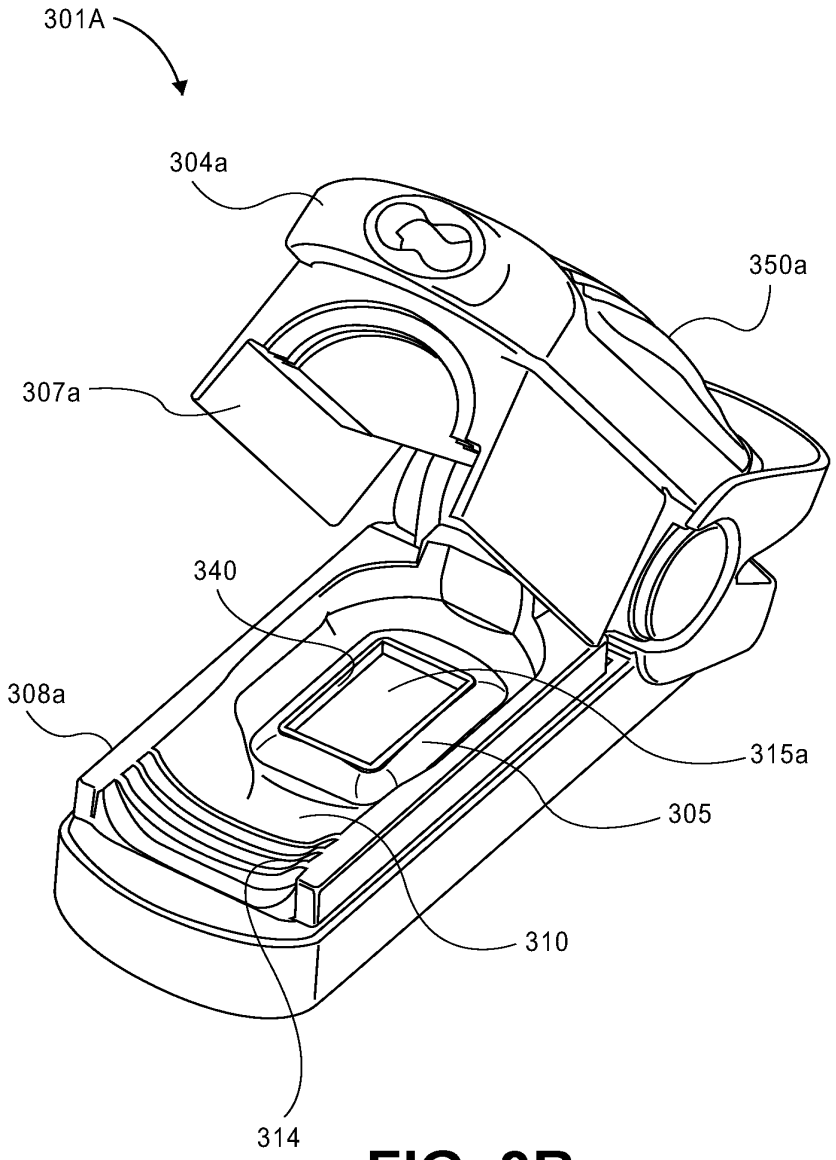


FIG. 3B

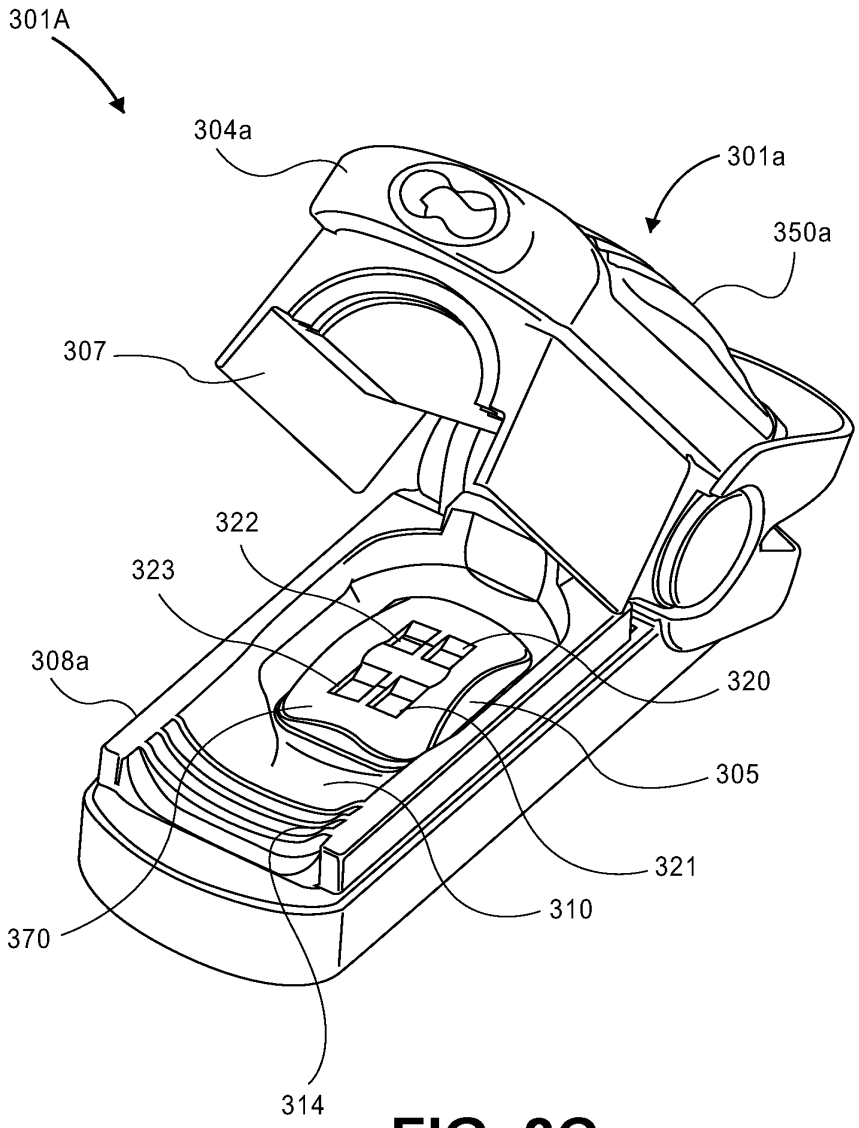


FIG. 3C

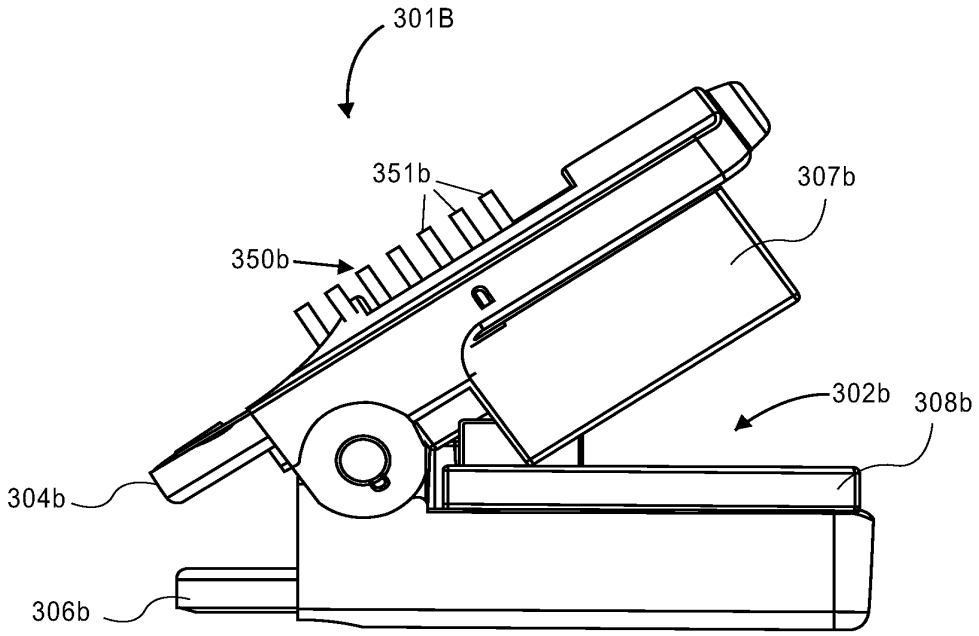


FIG. 3D

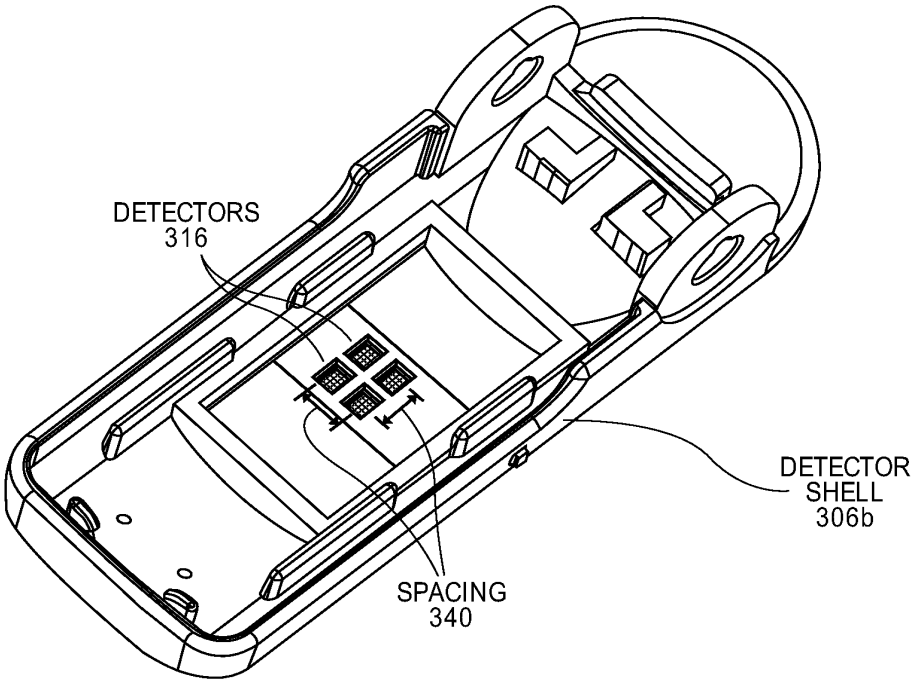


FIG. 3E

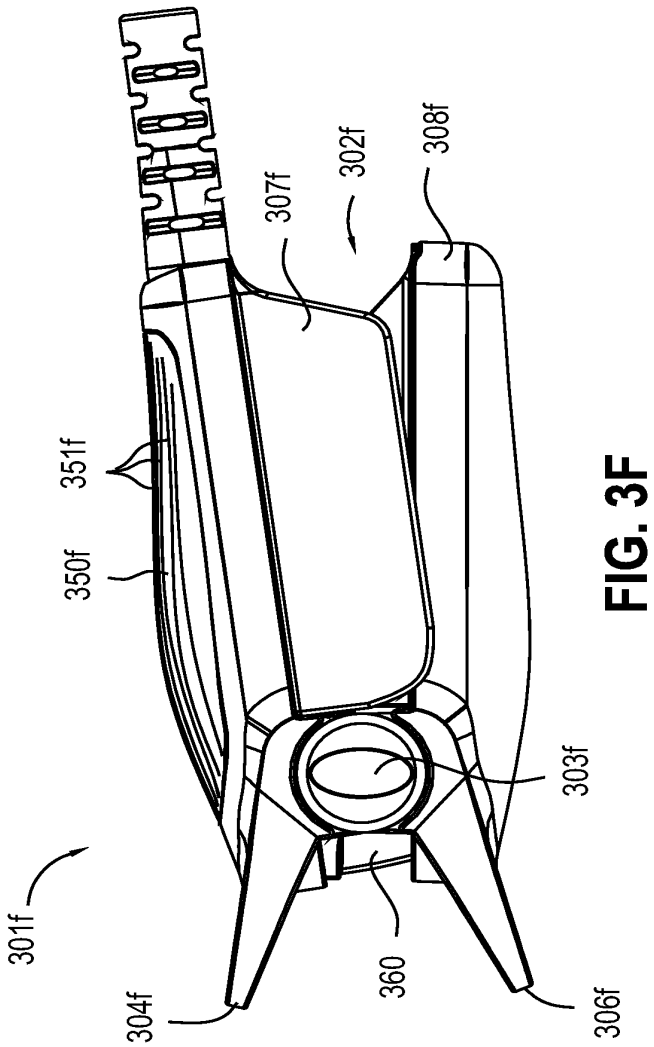


FIG. 3F

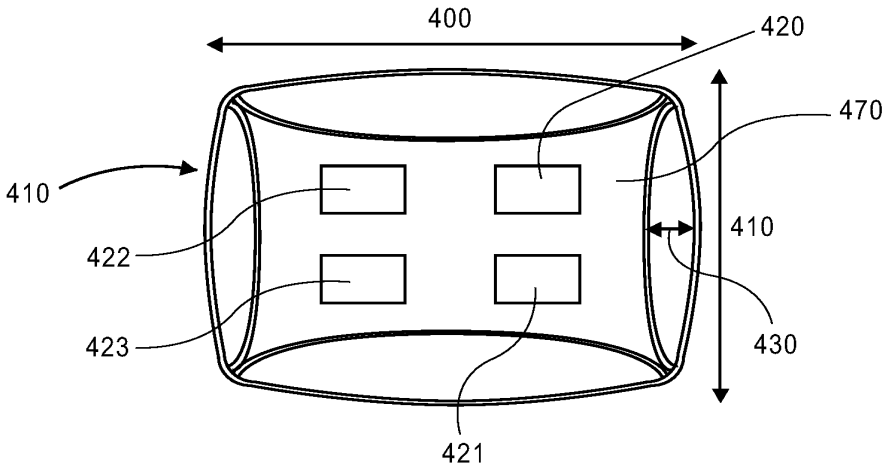


FIG. 4A

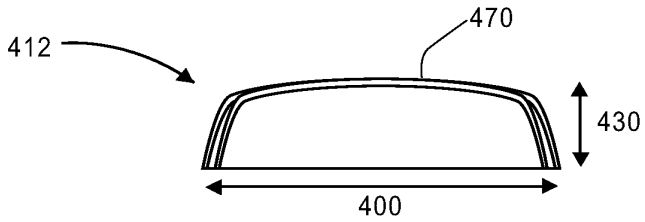


FIG. 4B

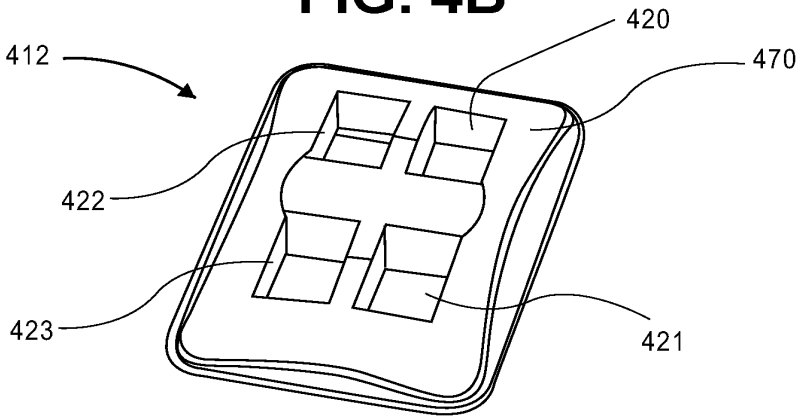


FIG. 4C

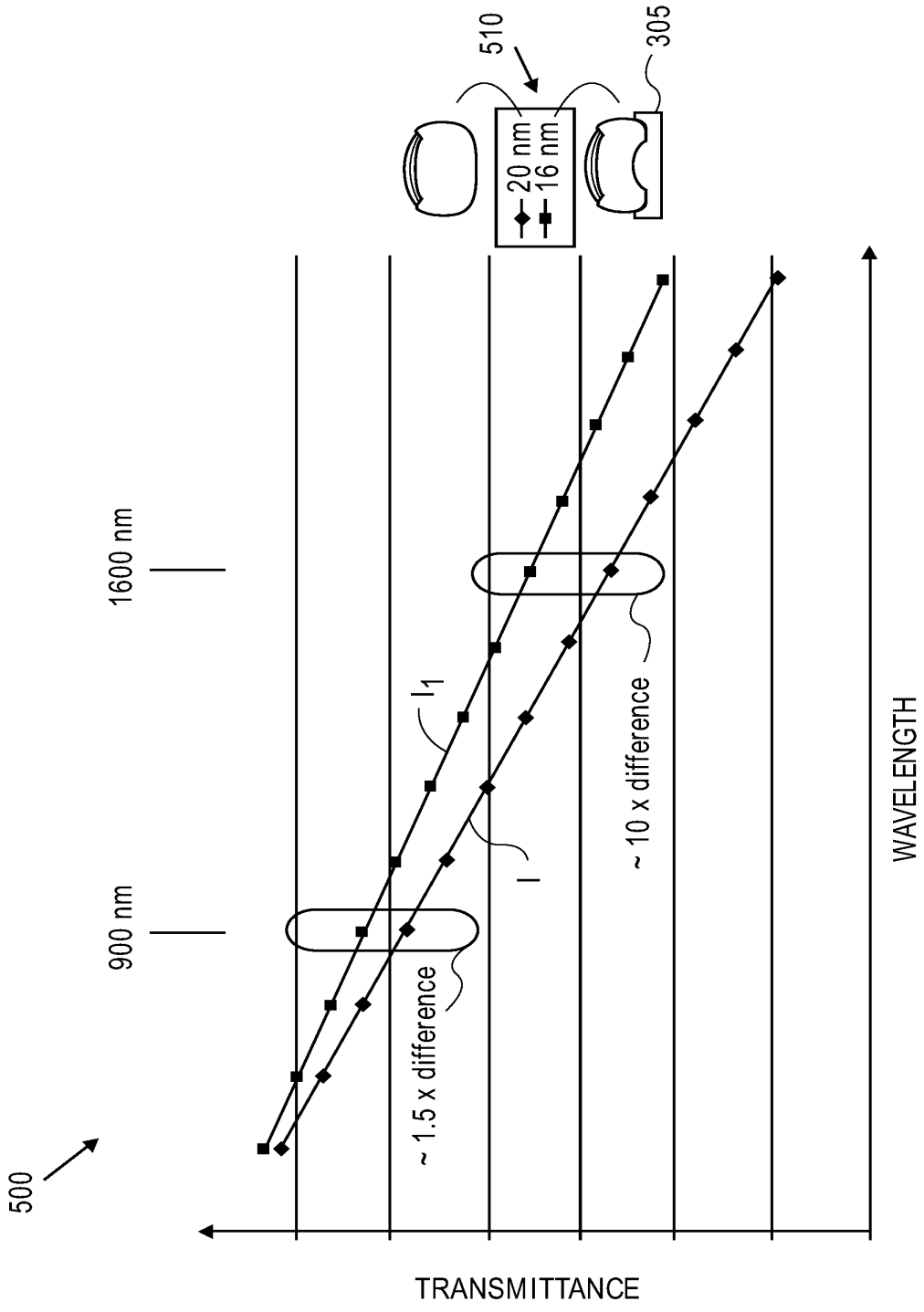

500
510
305
20 nm
16 nm
1600 nm
900 nm
~ 1.5 x difference
~ 10 x difference
I1
I
WAVELENGTH
TRANSMITTANCE

FIG. 5

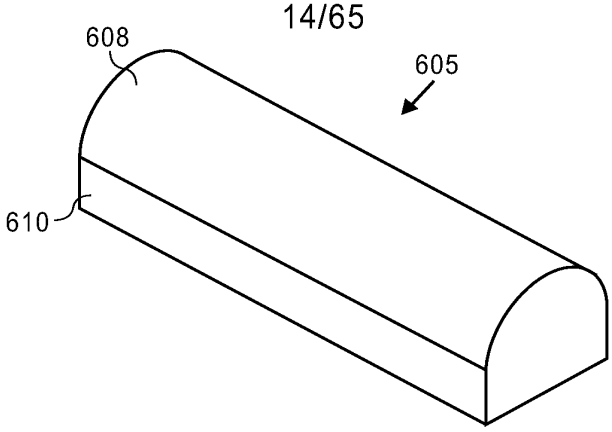


FIG. 6A

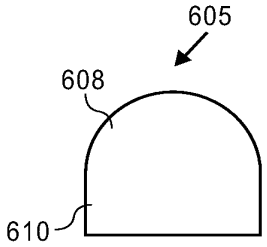


FIG. 6B

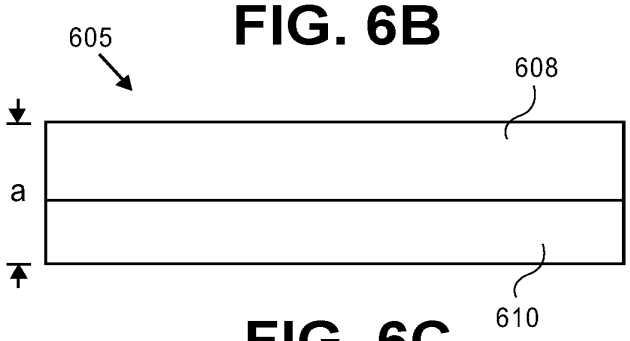


FIG. 6C

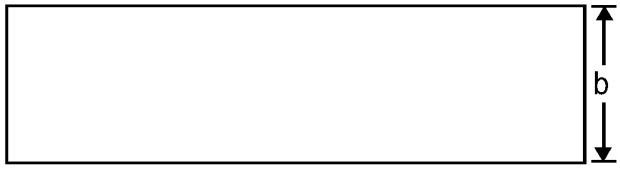


FIG. 6D

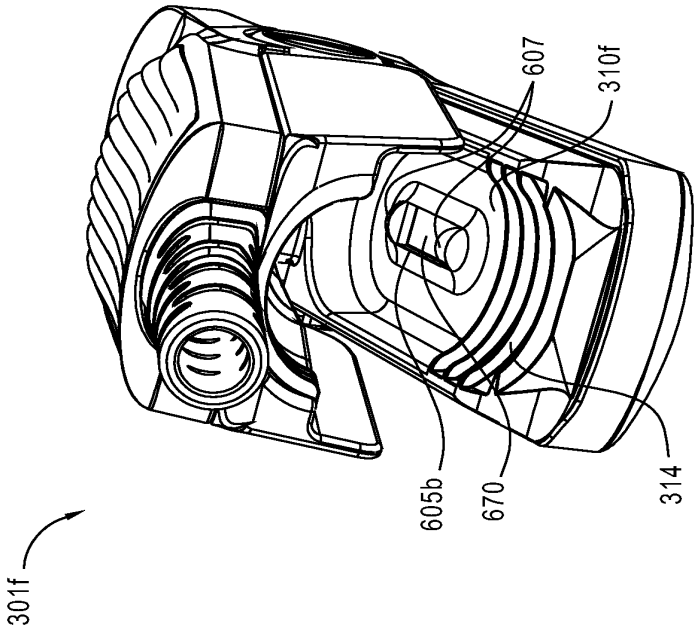


FIG. 6E

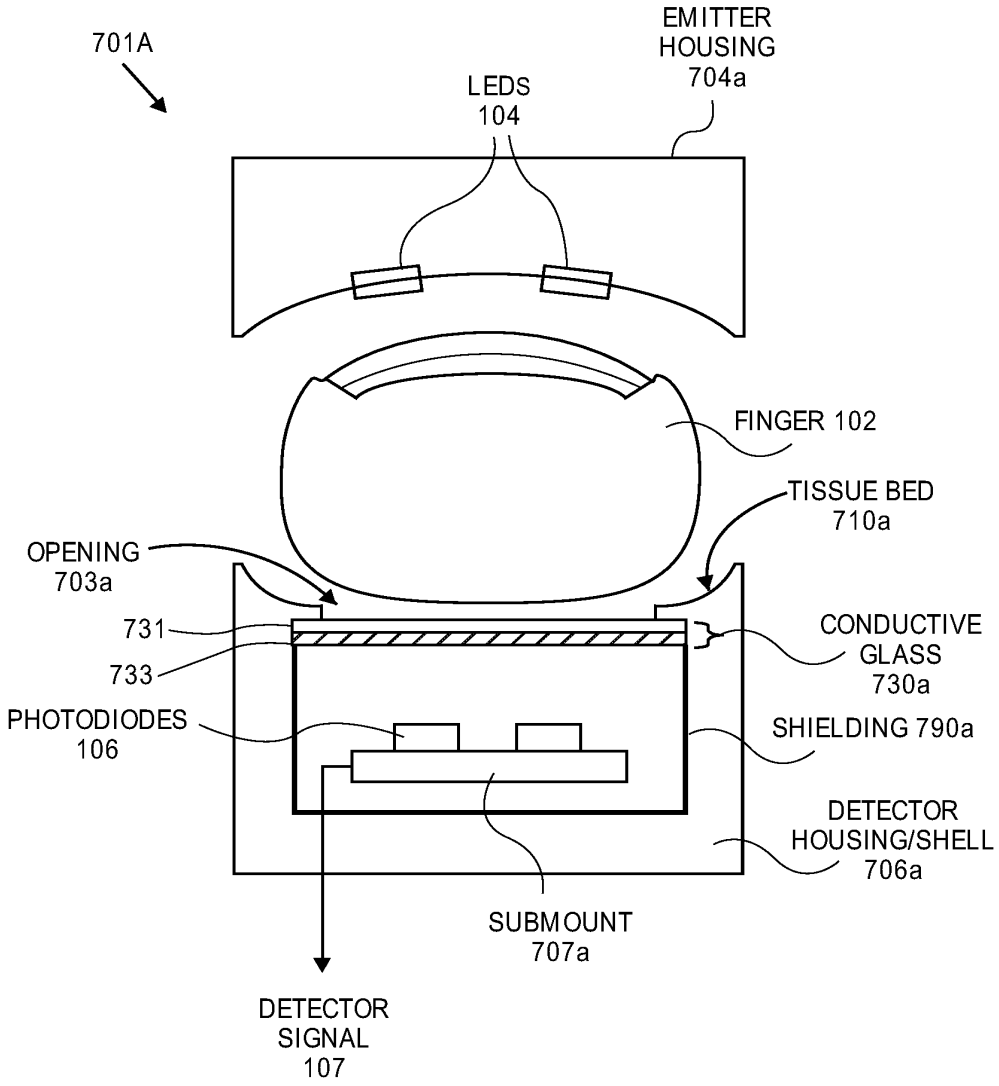

701A
EMITTER HOUSING 704a
LEDS 104
FINGER 102
TISSUE BED 710a
OPENING 703a
731
733
CONDUCTIVE GLASS 730a
PHOTODIODES 106
SHIELDING 790a
DETECTOR HOUSING/SHELL 706a
SUBMOUNT 707a
DETECTOR SIGNAL 107

FIG. 7A

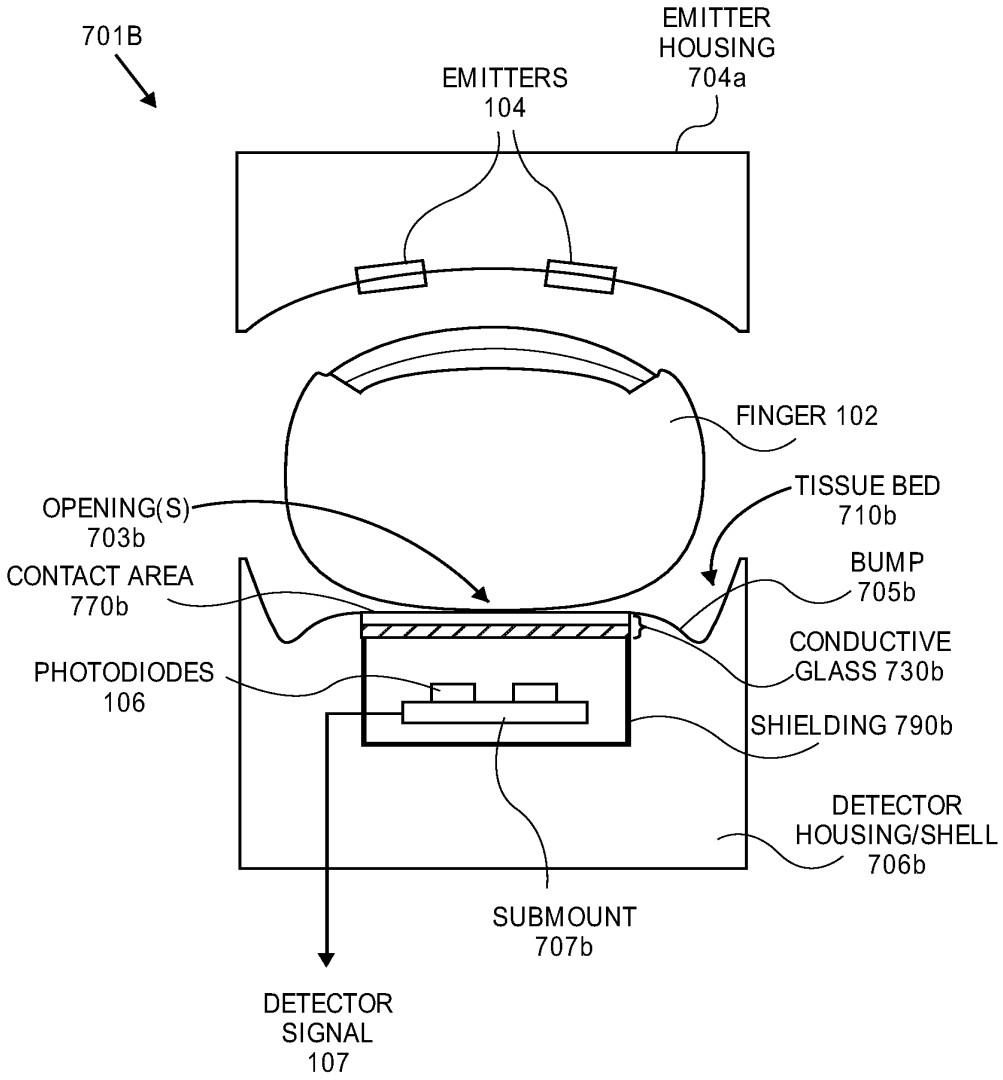

701B
EMITTER HOUSING 704a
EMITTERS 104
FINGER 102
TISSUE BED 710b
OPENING(S) 703b
BUMP 705b
CONTACT AREA 770b
CONDUCTIVE GLASS 730b
PHOTODIODES 106
SHIELDING 790b
DETECTOR HOUSING/SHELL 706b
SUBMOUNT 707b
DETECTOR SIGNAL 107

FIG. 7B

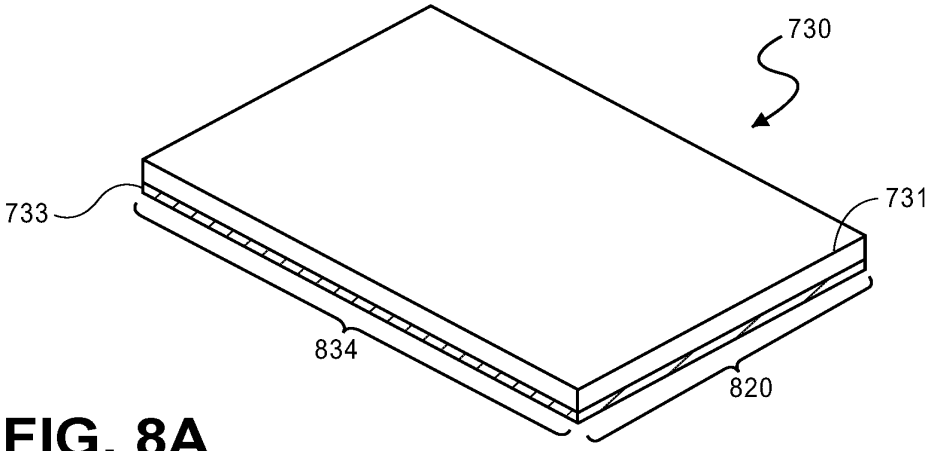


FIG. 8A

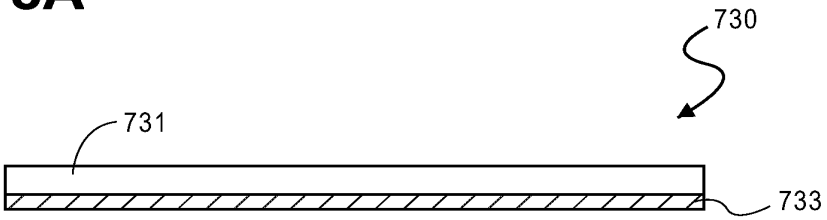


FIG. 8B

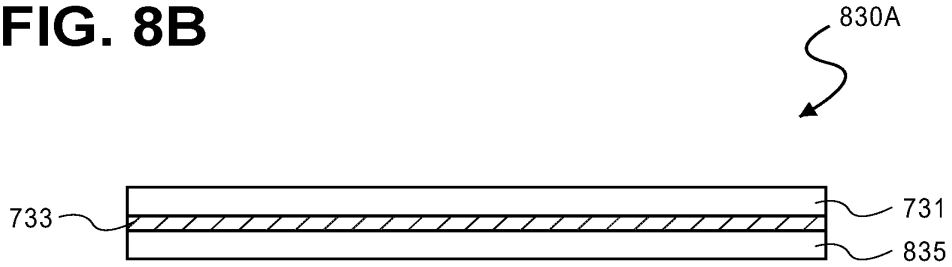


FIG. 8C

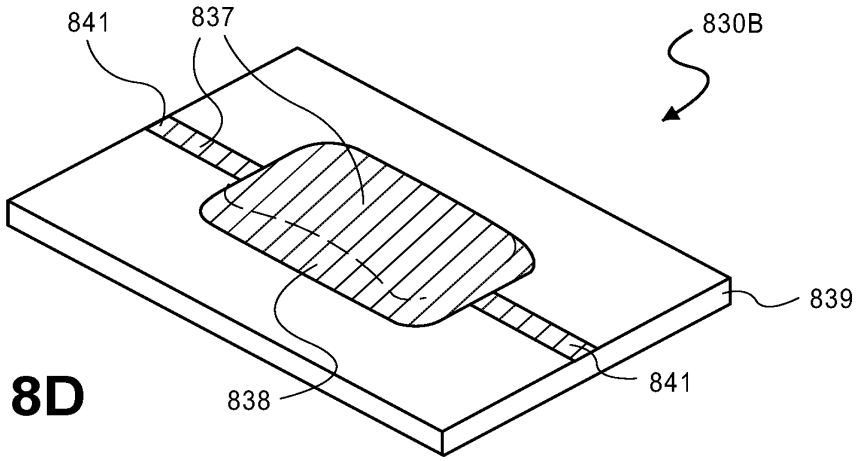


FIG. 8D

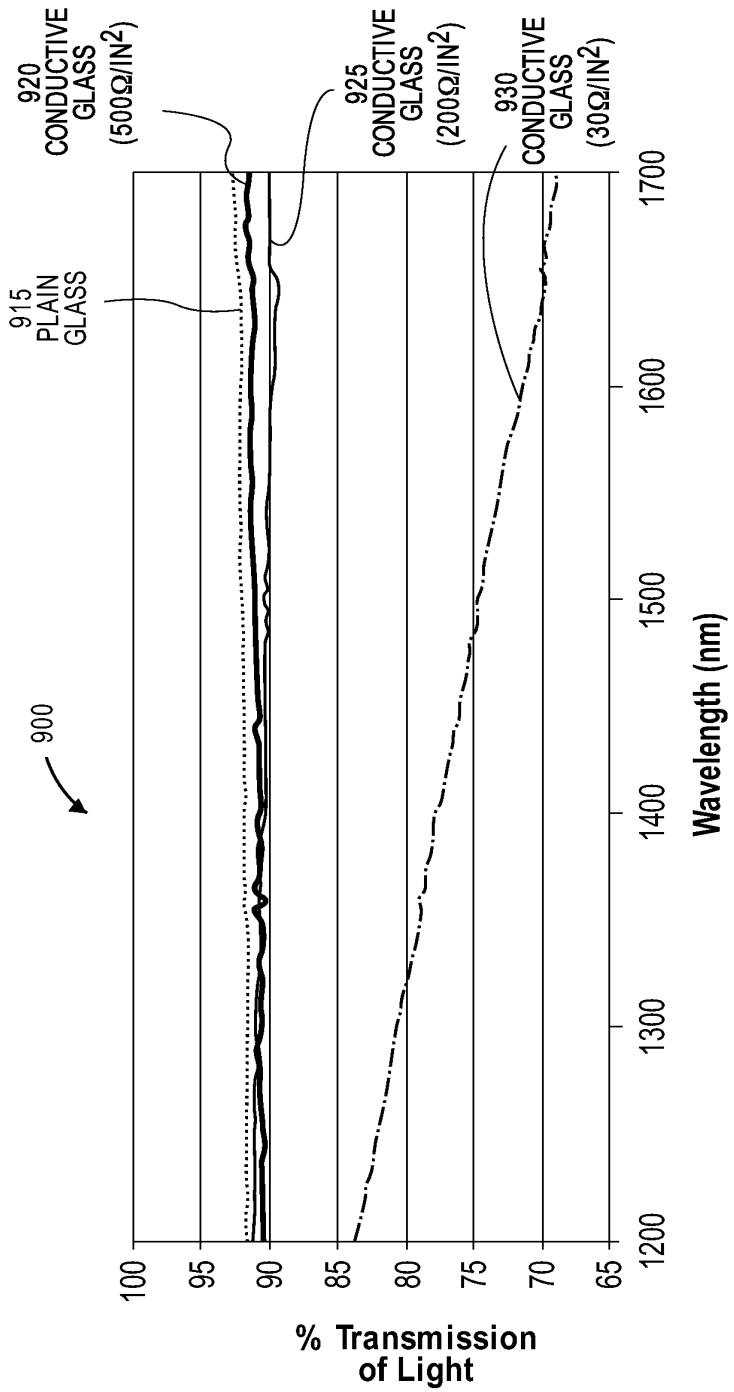

920
CONDUCTIVE
GLASS
(500Ω/IN2)
925
CONDUCTIVE
GLASS
(200Ω/IN2)
930
CONDUCTIVE
GLASS
(30Ω/IN2)
915
PLAIN
GLASS
900
100
95
90
85
80
75
70
65
% Transmission
of Light
1200
1300
1400
1500
1600
1700
Wavelength (nm)

FIG. 9

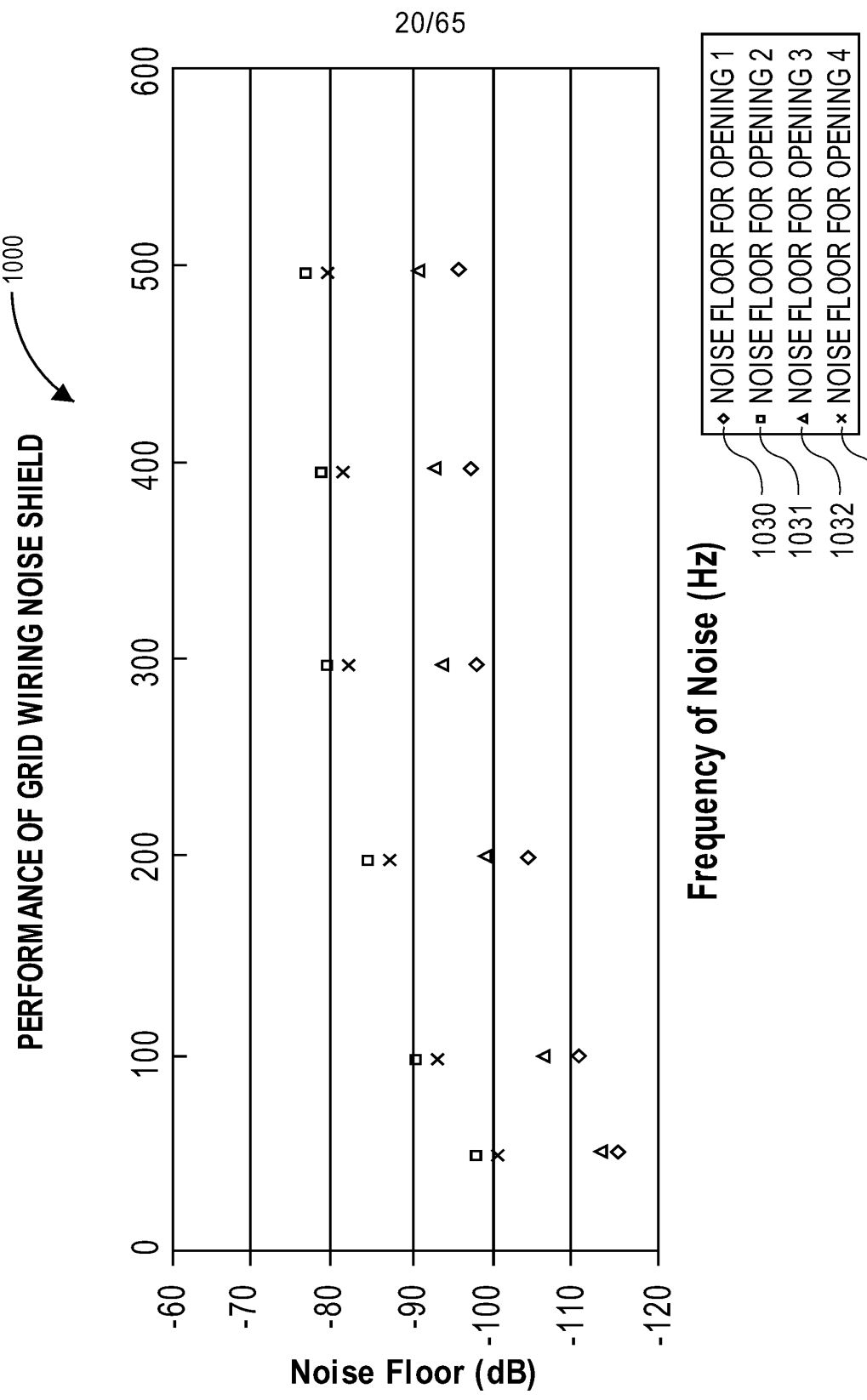

1000
PERFORMANCE OF GRID WIRING NOISE SHIELD
0
100
200
300
400
500
600
-60
-70
-80
-90
-100
-110
-120
Noise Floor (dB)
Frequency of Noise (Hz)
NOISE FLOOR FOR OPENING 1
NOISE FLOOR FOR OPENING 2
NOISE FLOOR FOR OPENING 3
NOISE FLOOR FOR OPENING 4
1030
1031
1032
1033

FIG. 10A

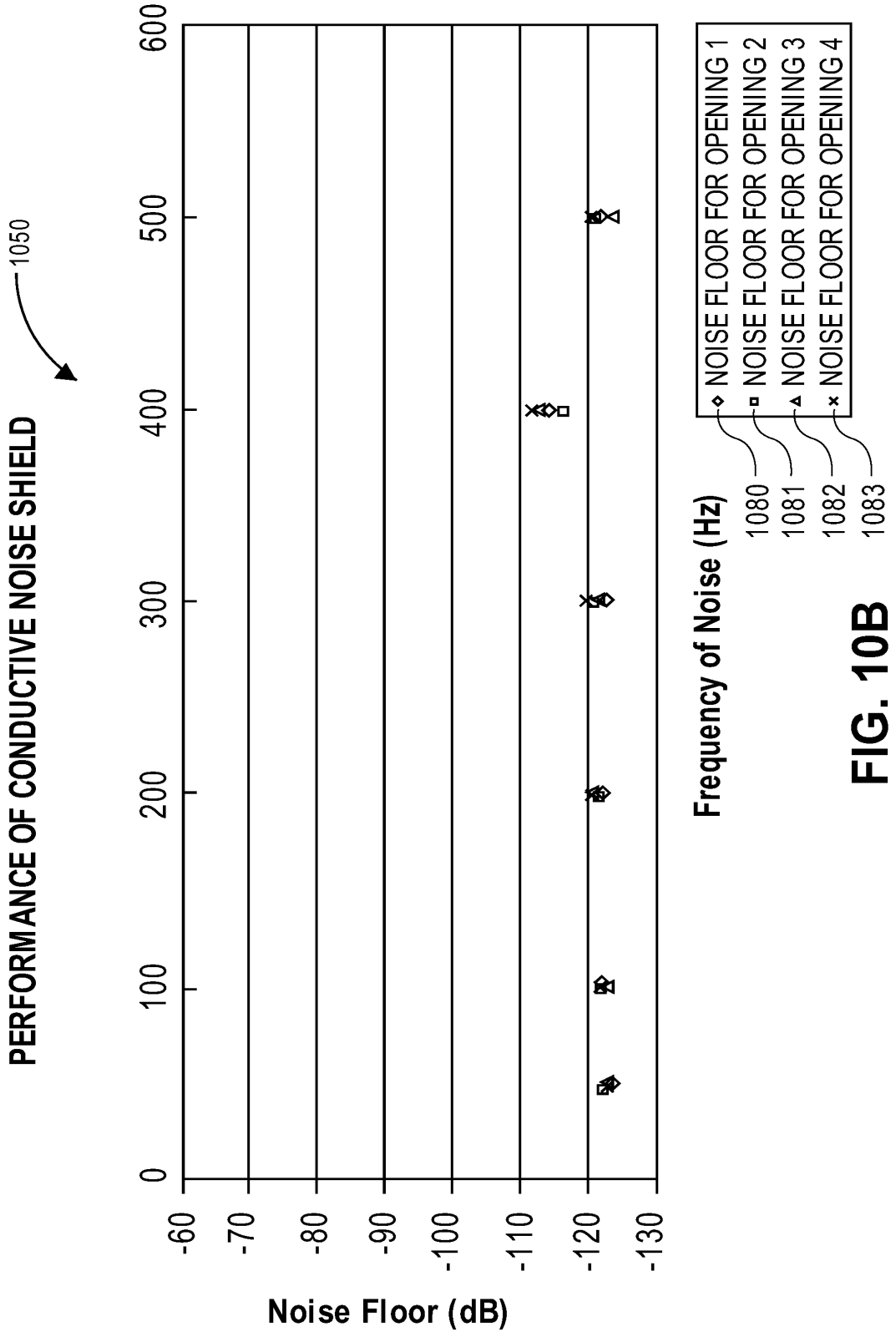

PERFORMANCE OF CONDUCTIVE NOISE SHIELD
1050
Noise Floor (dB)
-60
-70
-80
-90
-100
-110
-120
-130
Frequency of Noise (Hz)
0
100
200
300
400
500
600
NOISE FLOOR FOR OPENING 1
NOISE FLOOR FOR OPENING 2
NOISE FLOOR FOR OPENING 3
NOISE FLOOR FOR OPENING 4
1080
1081
1082
1083

FIG. 10B

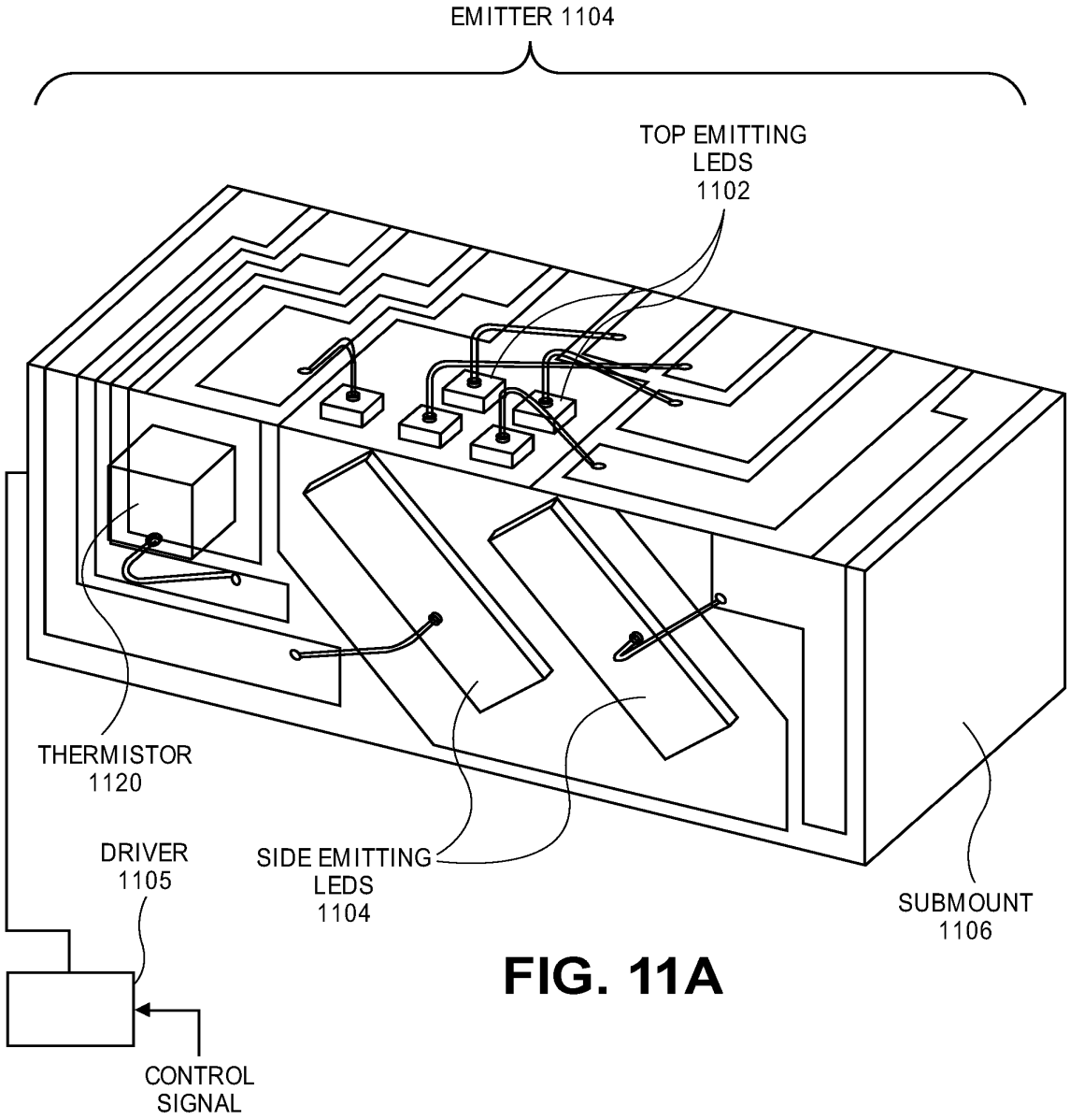

EMITTER 1104
TOP EMITTING LEDS 1102
THERMISTOR 1120
DRIVER 1105
SIDE EMITTING LEDS 1104
SUBMOUNT 1106
CONTROL SIGNAL

FIG. 11A

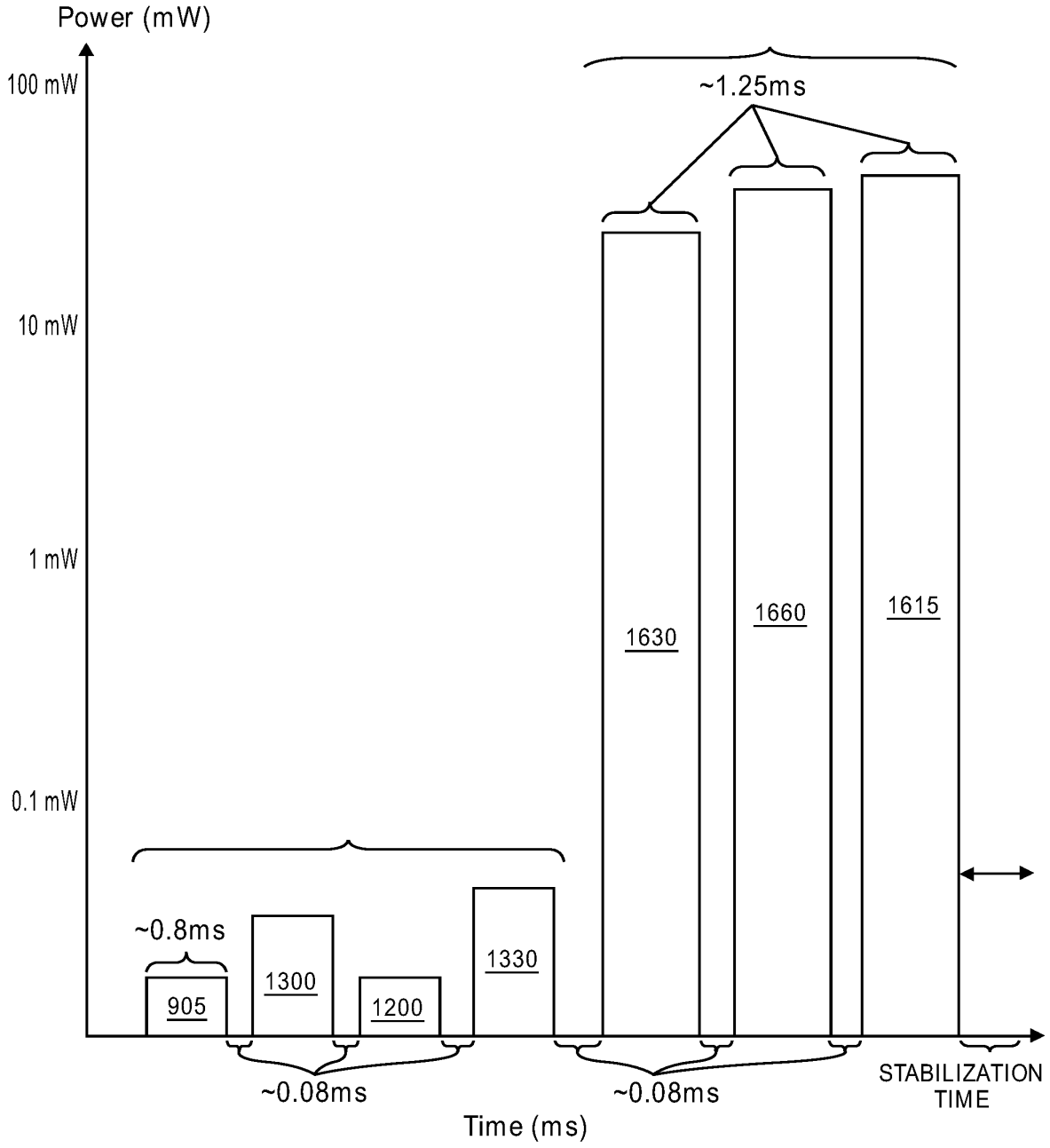

Power (mW)
100 mW
10 mW
1 mW
0.1 mW
~1.25ms
1630
1660
1615
~0.8ms
905
1300
1200
1330
~0.08ms
~0.08ms
STABILIZATION TIME
Time (ms)

FIG. 11B

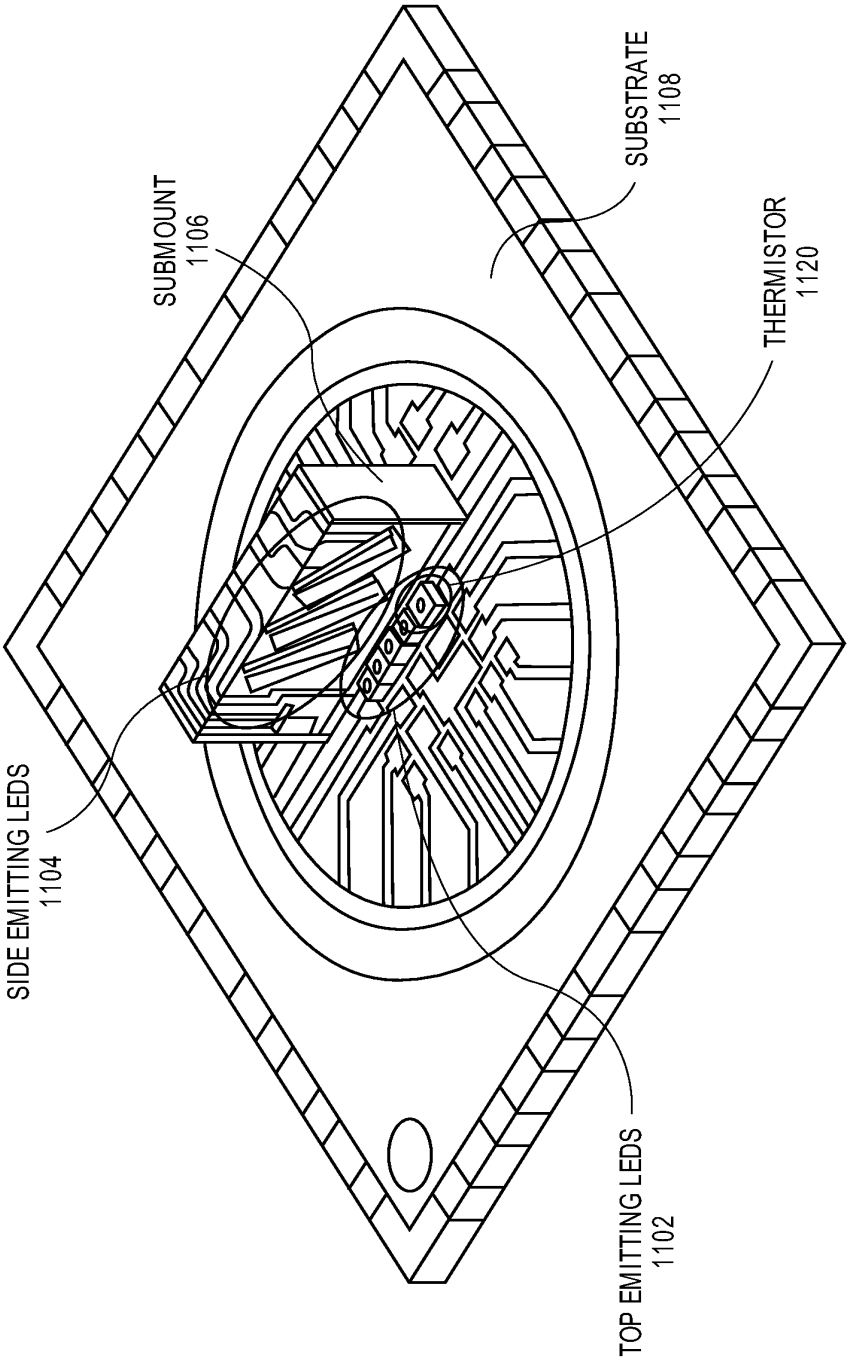

SUBMOUNT
1106
SUBSTRATE
1108
THERMISTOR
1120
SIDE EMITTING LEDS
1104
TOP EMITTING LEDS
1102

FIG. 11C

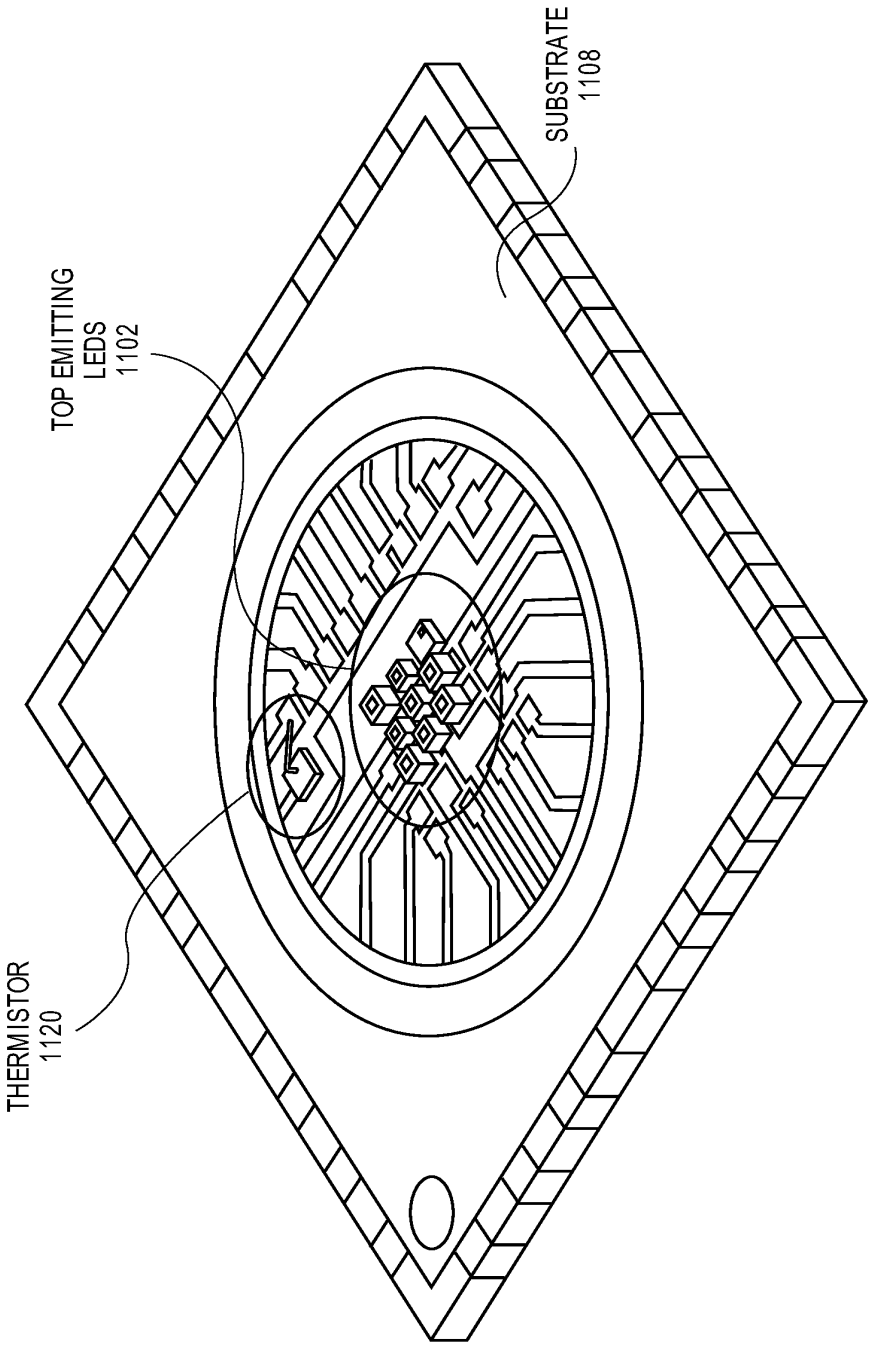


FIG. 11D

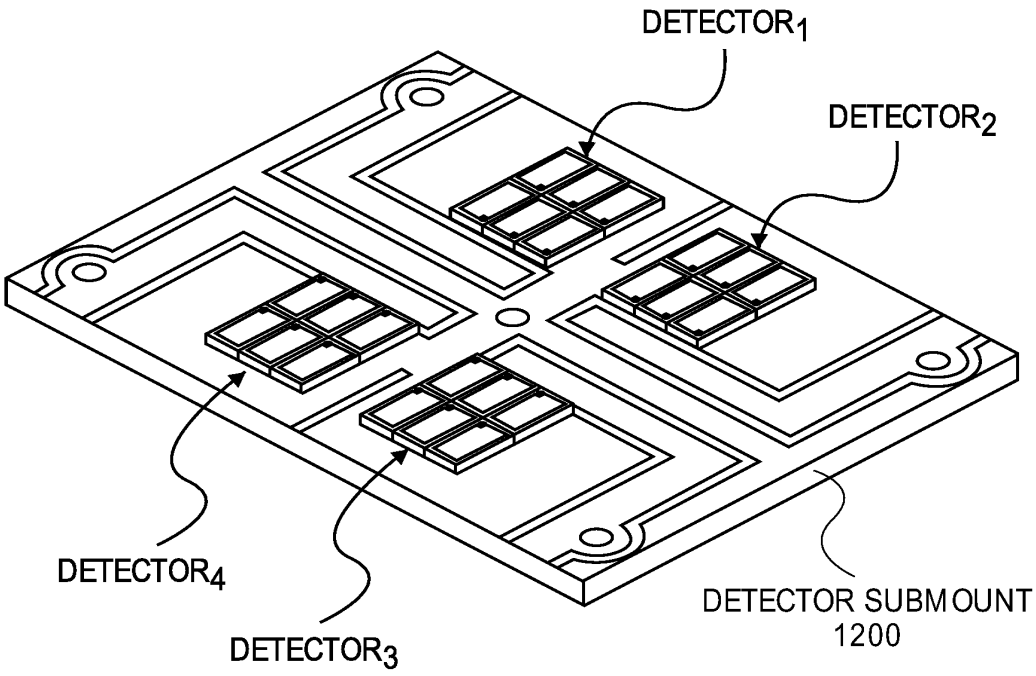

DETECTOR1
DETECTOR2
DETECTOR4
DETECTOR3
DETECTOR SUBMOUNT
1200

FIG. 12A

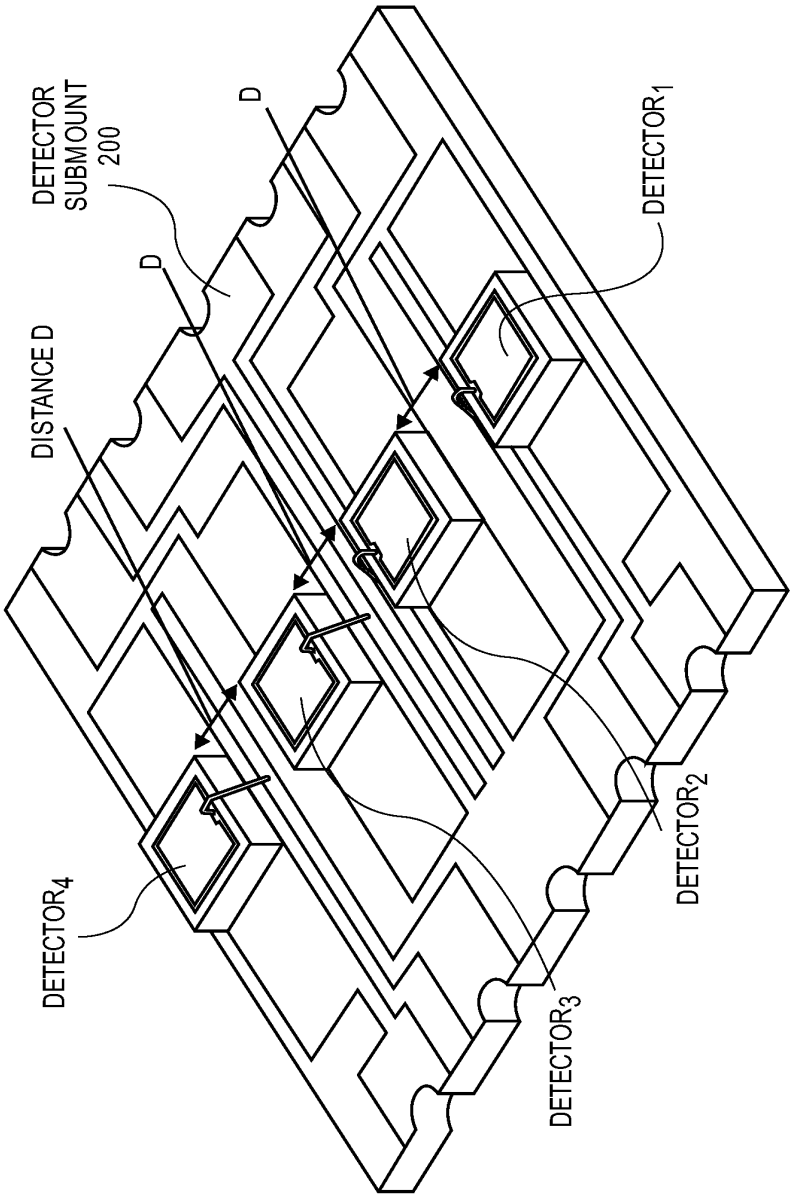

DETECTOR SUBMOUNT 200
D
D
DISTANCE D
DETECTOR$_1$
DETECTOR$_2$
DETECTOR$_3$
DETECTOR$_4$

FIG. 12B

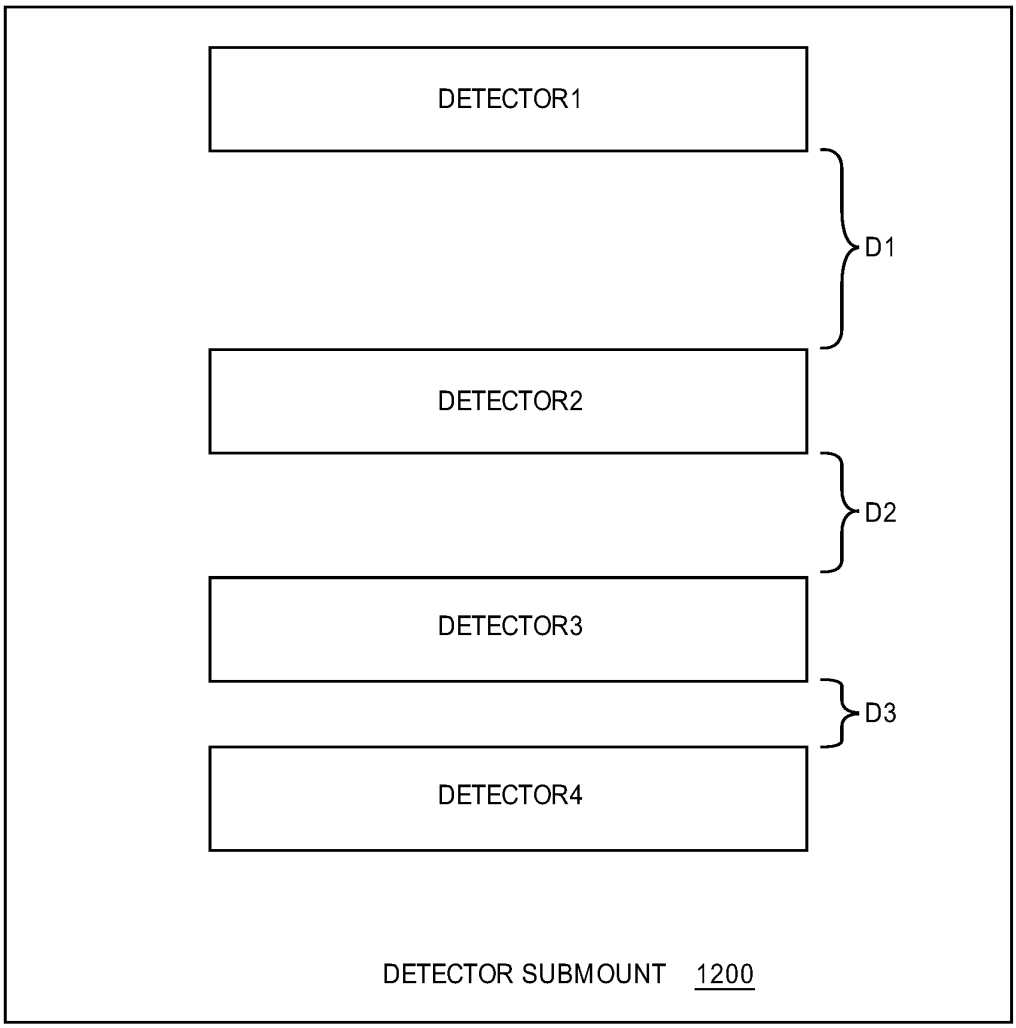

DETECTOR1
D1
DETECTOR2
D2
DETECTOR3
D3
DETECTOR4
DETECTOR SUBMOUNT 1200

FIG. 12C

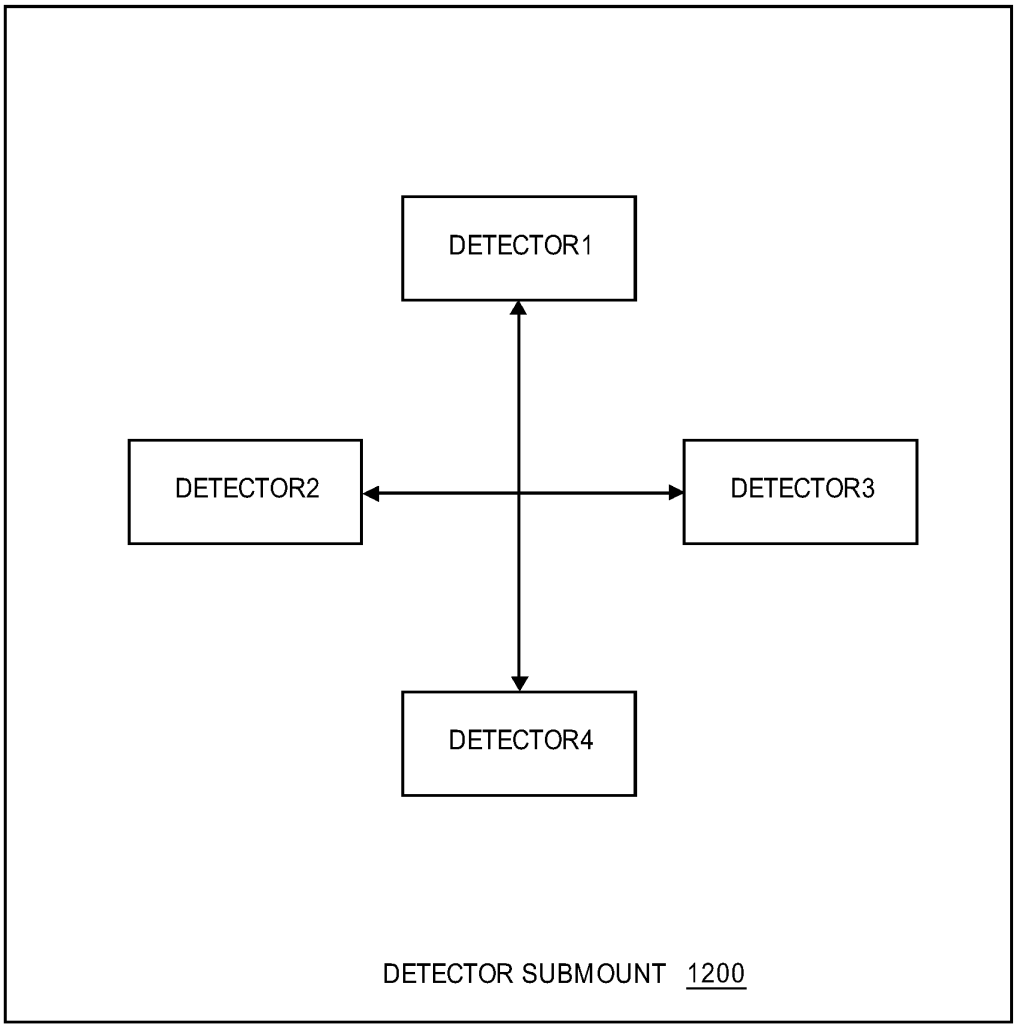

DETECTOR1
DETECTOR2
DETECTOR3
DETECTOR4
DETECTOR SUBMOUNT 1200

FIG. 12D

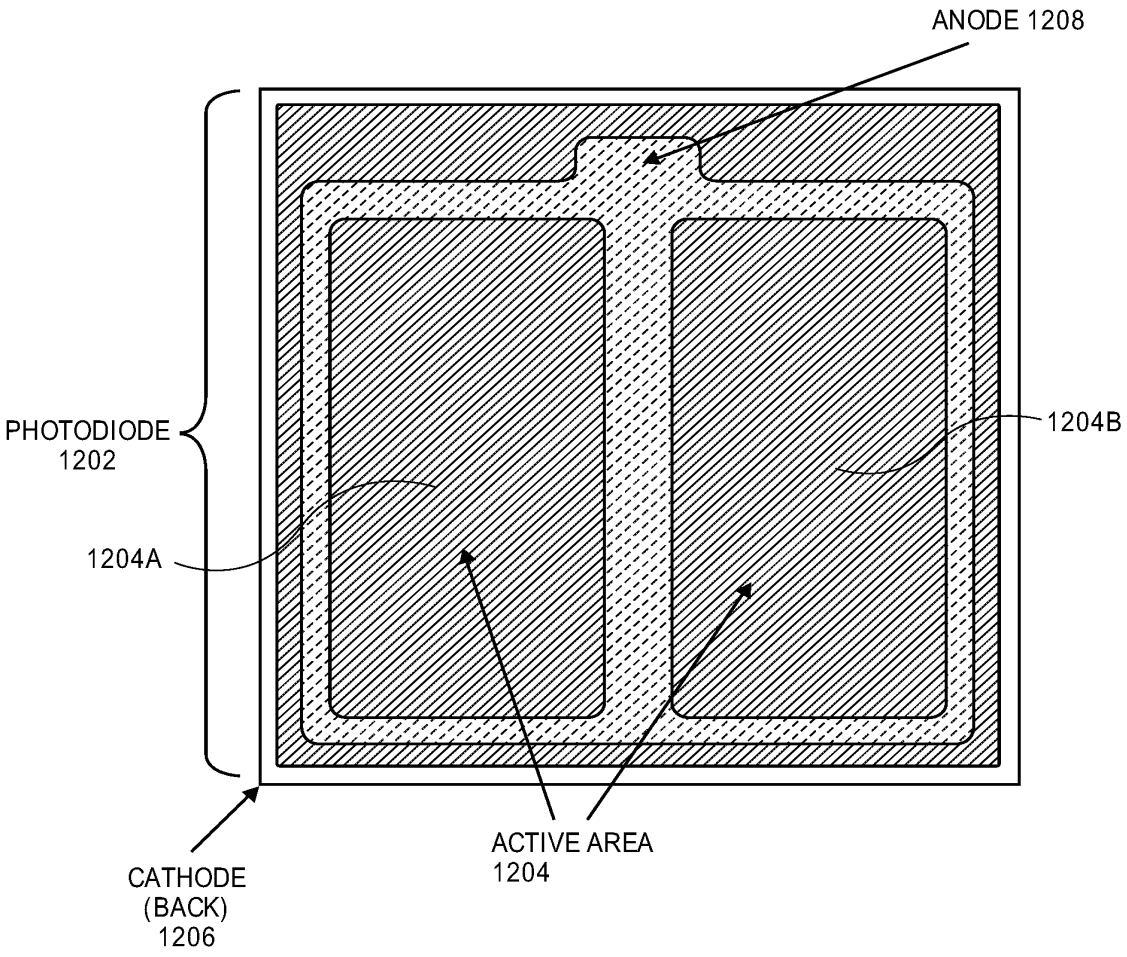

ANODE 1208
PHOTODIODE
1202
1204A
1204B
ACTIVE AREA
1204
CATHODE
(BACK)
1206

FIG. 12E

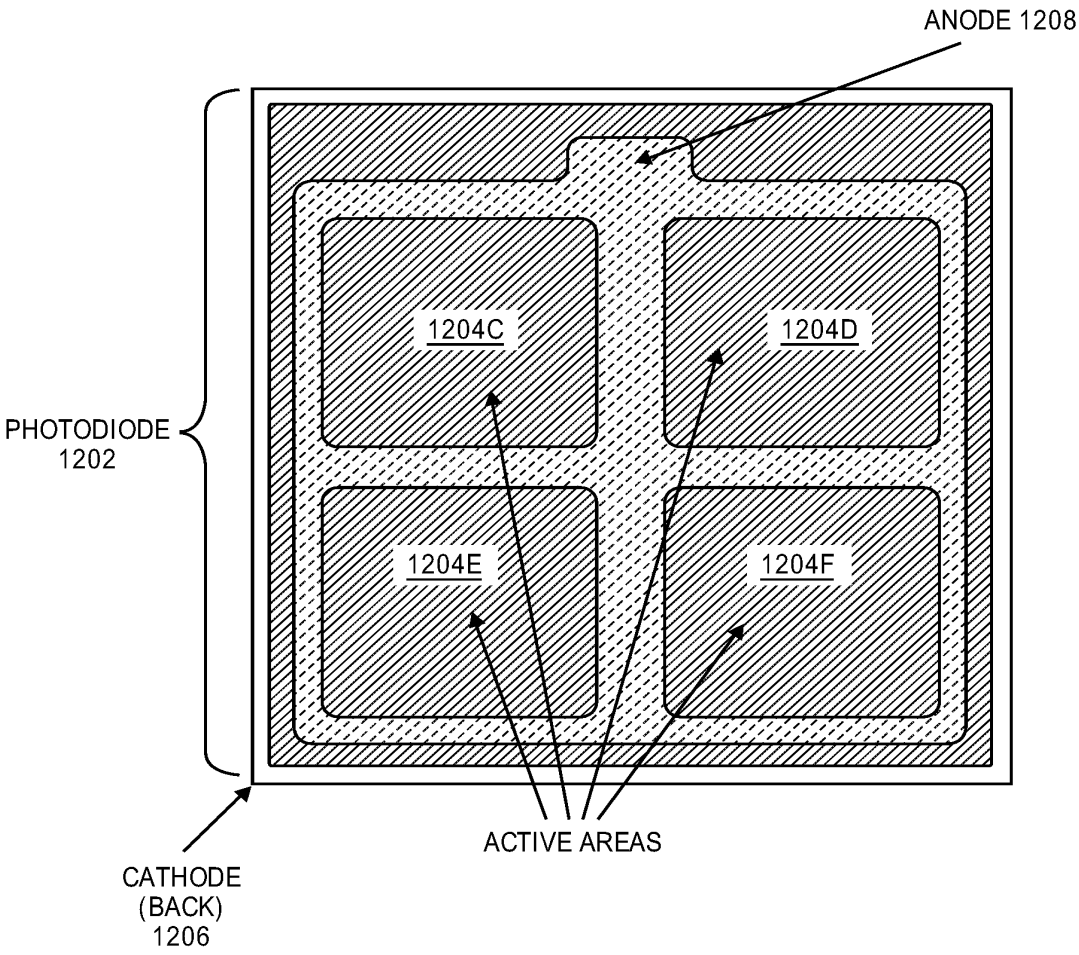

ANODE 1208
1204C
1204D
1204E
1204F
PHOTODIODE
1202
ACTIVE AREAS
CATHODE
(BACK)
1206

FIG. 12F

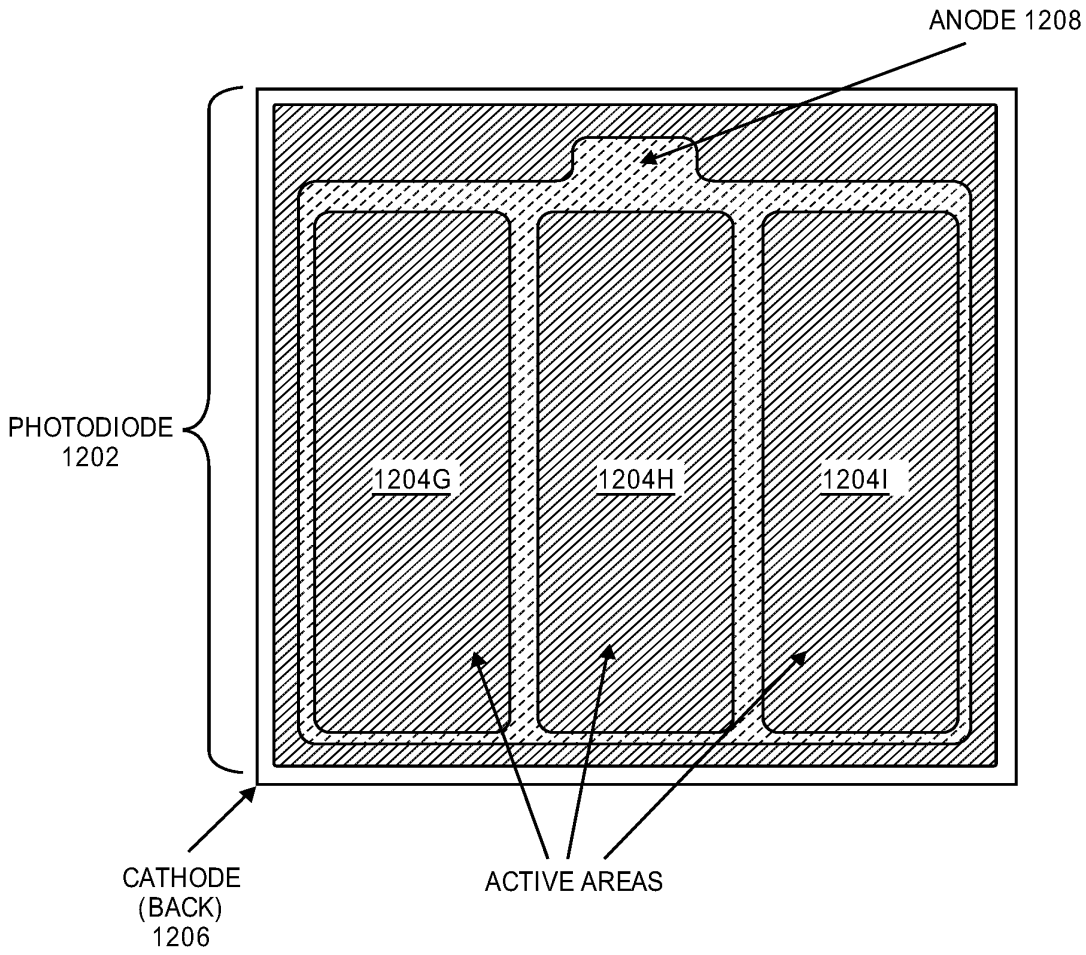

ANODE 1208
PHOTODIODE
1202
1204G
1204H
1204I
CATHODE
(BACK)
1206
ACTIVE AREAS

FIG. 12G

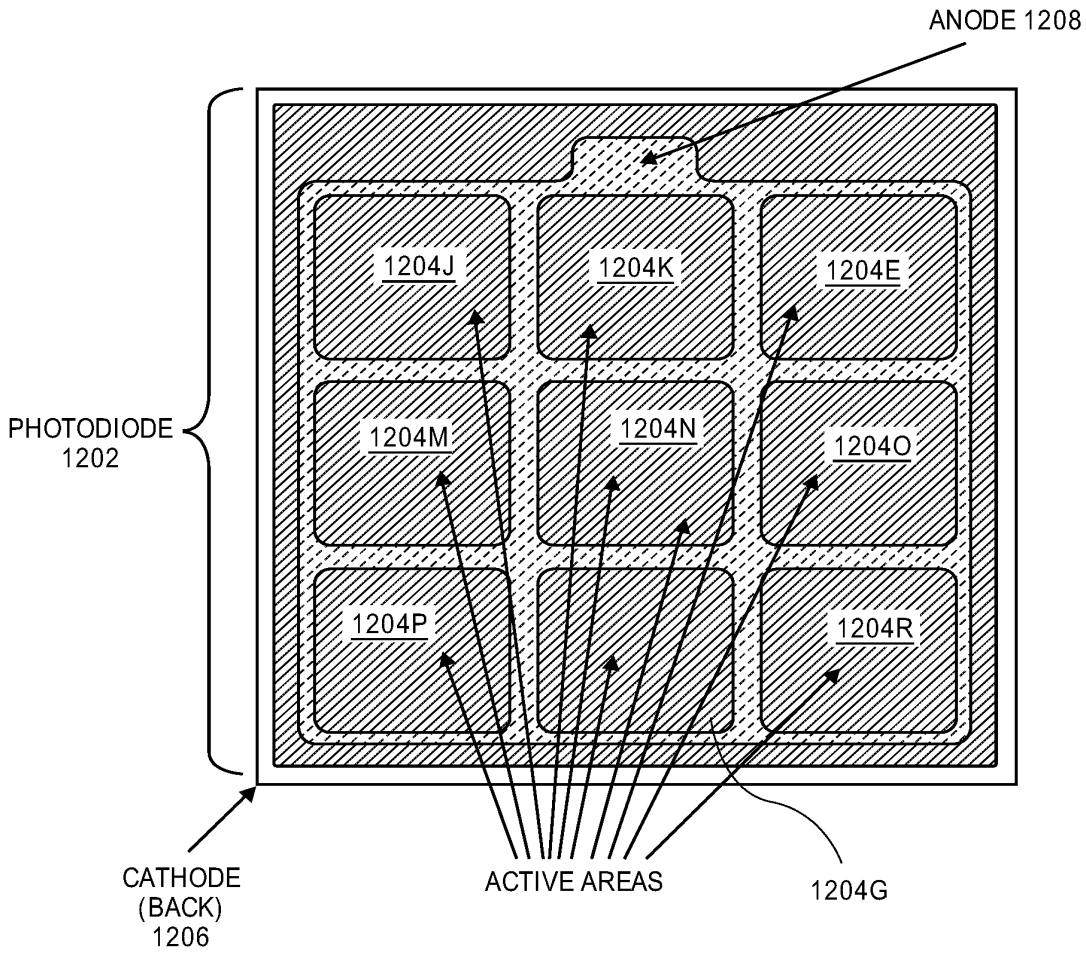

ANODE 1208
1204J
1204K
1204E
1204M
1204N
1204O
1204P
1204R
PHOTODIODE
1202
CATHODE
(BACK)
1206
ACTIVE AREAS
1204G

FIG. 12H

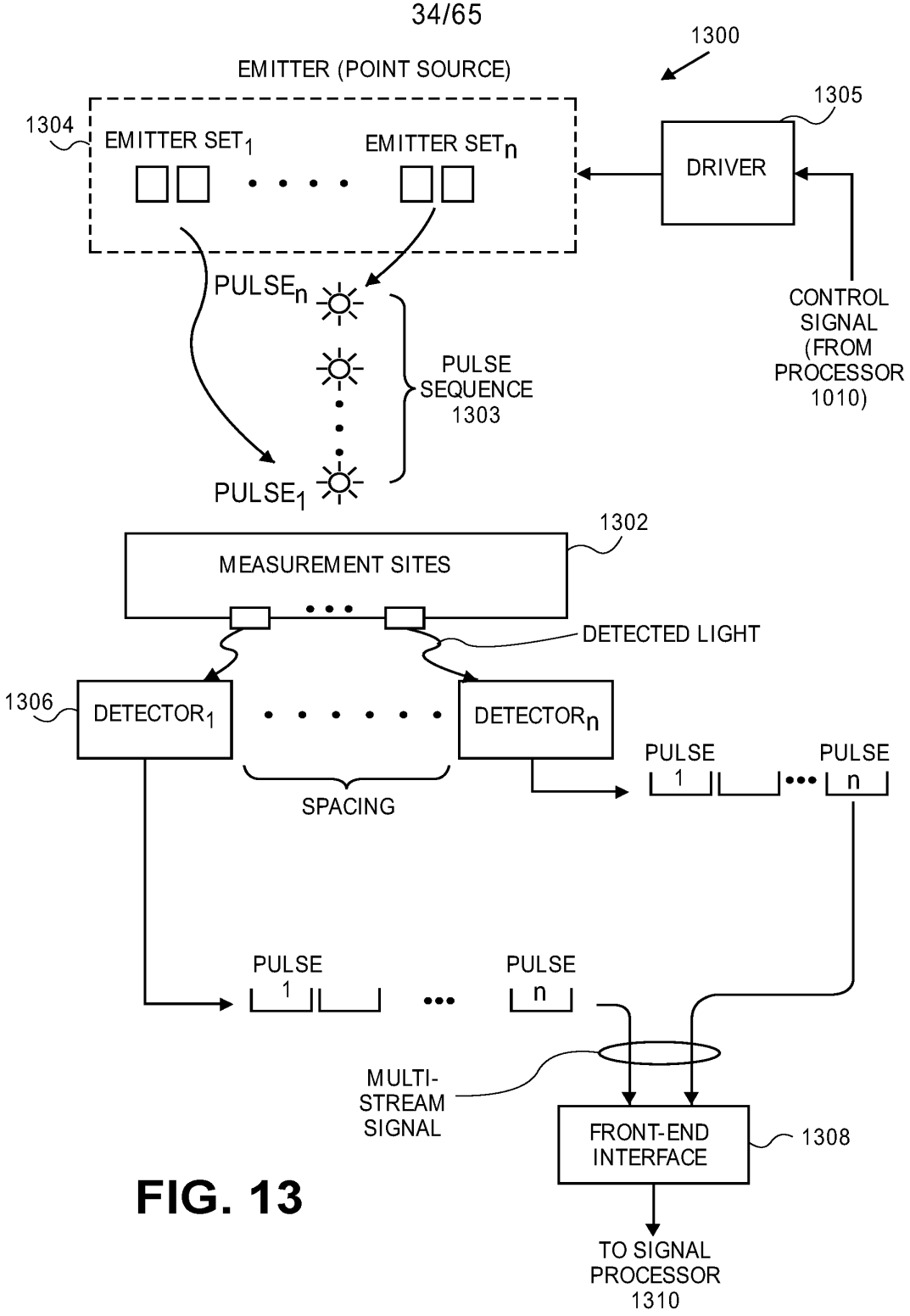

1300
EMITTER (POINT SOURCE)
1305
1304
EMITTER SET1
EMITTER SETn
DRIVER
PULSEn
PULSE SEQUENCE 1303
CONTROL SIGNAL (FROM PROCESSOR 1010)
PULSE1
1302
MEASUREMENT SITES
DETECTED LIGHT
1306
DETECTOR1
DETECTORn
PULSE 1
PULSE n
SPACING
PULSE 1
PULSE n
MULTI-STREAM SIGNAL
FRONT-END INTERFACE
1308
TO SIGNAL PROCESSOR 1310

FIG. 13

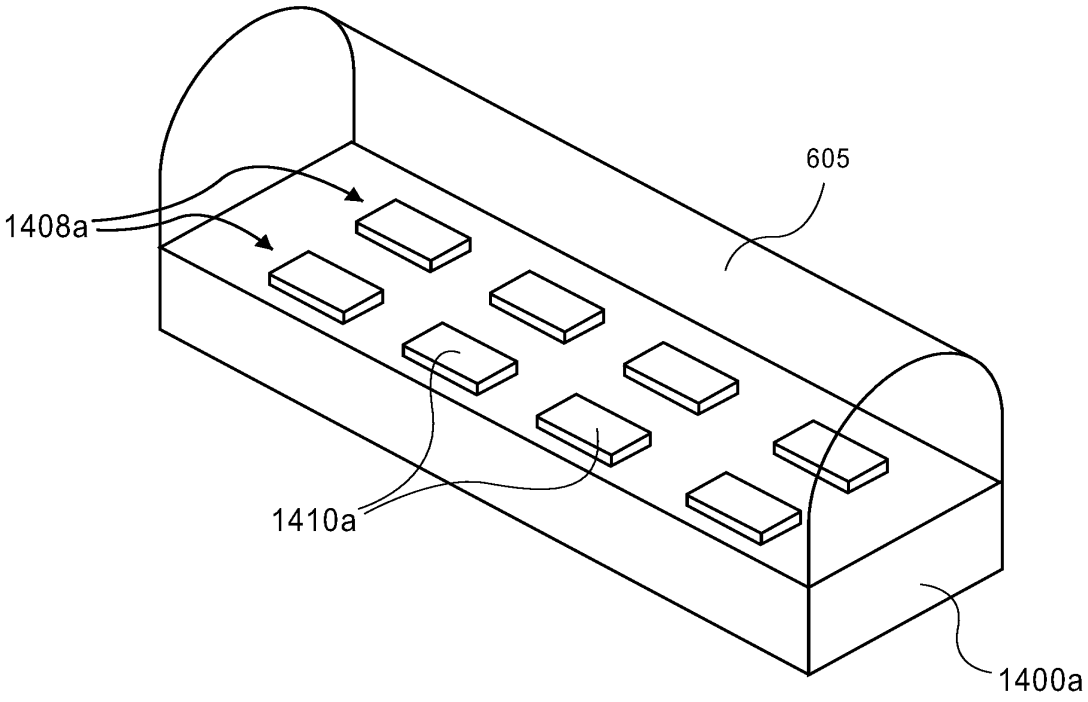


FIG. 14A

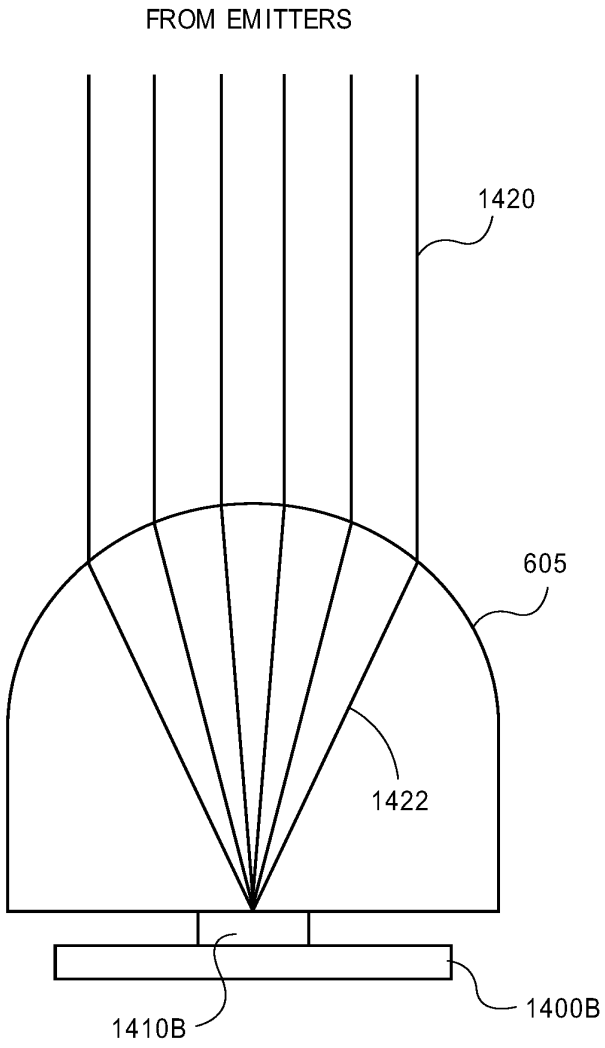


FIG. 14B

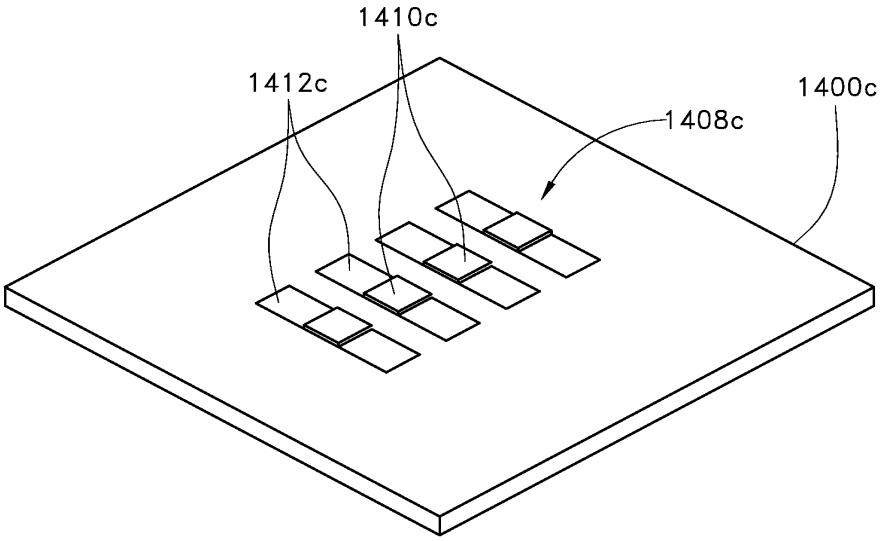


FIG. 14C

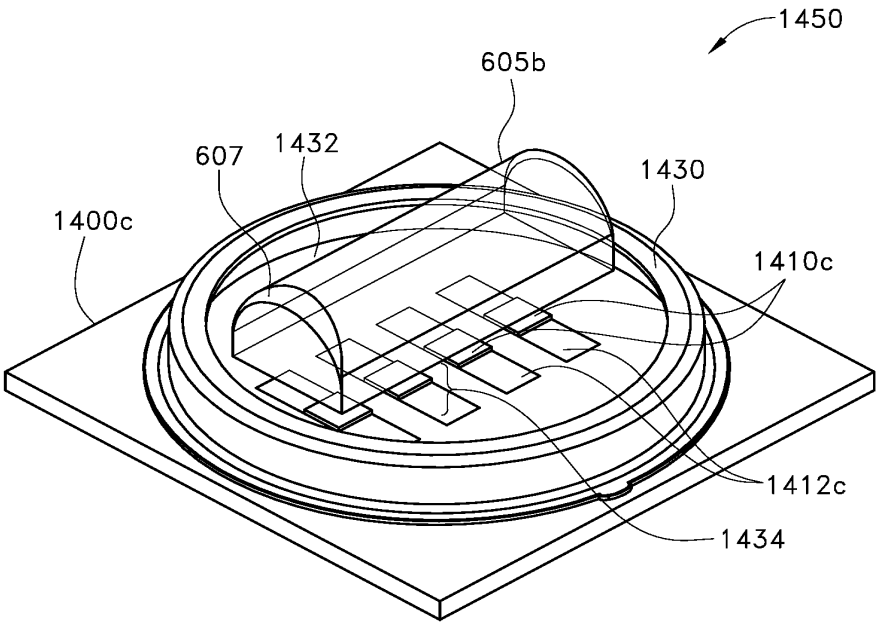


FIG. 14D

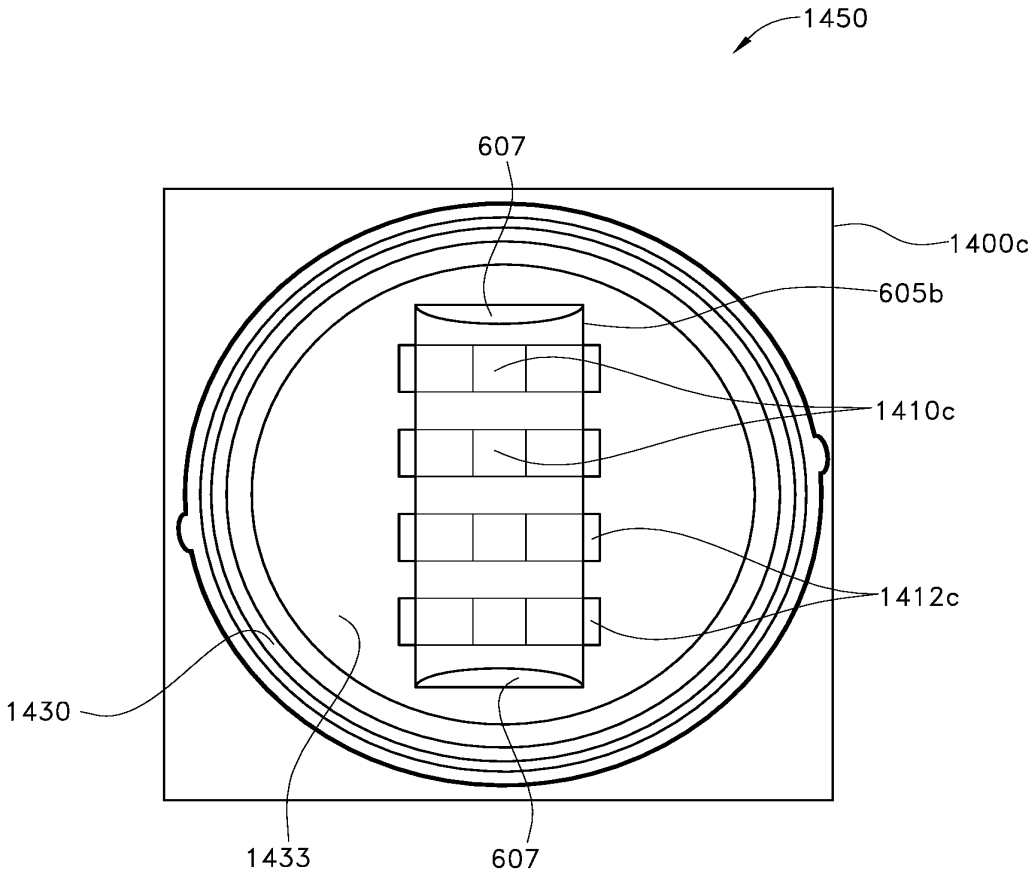


FIG. 14E

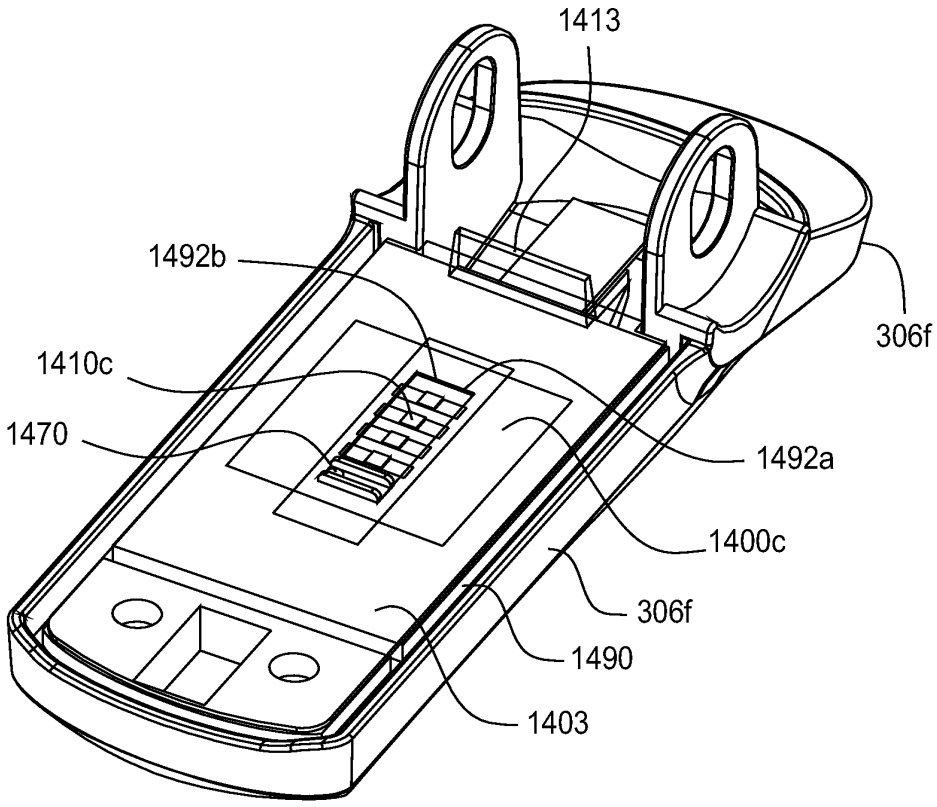


FIG. 14F

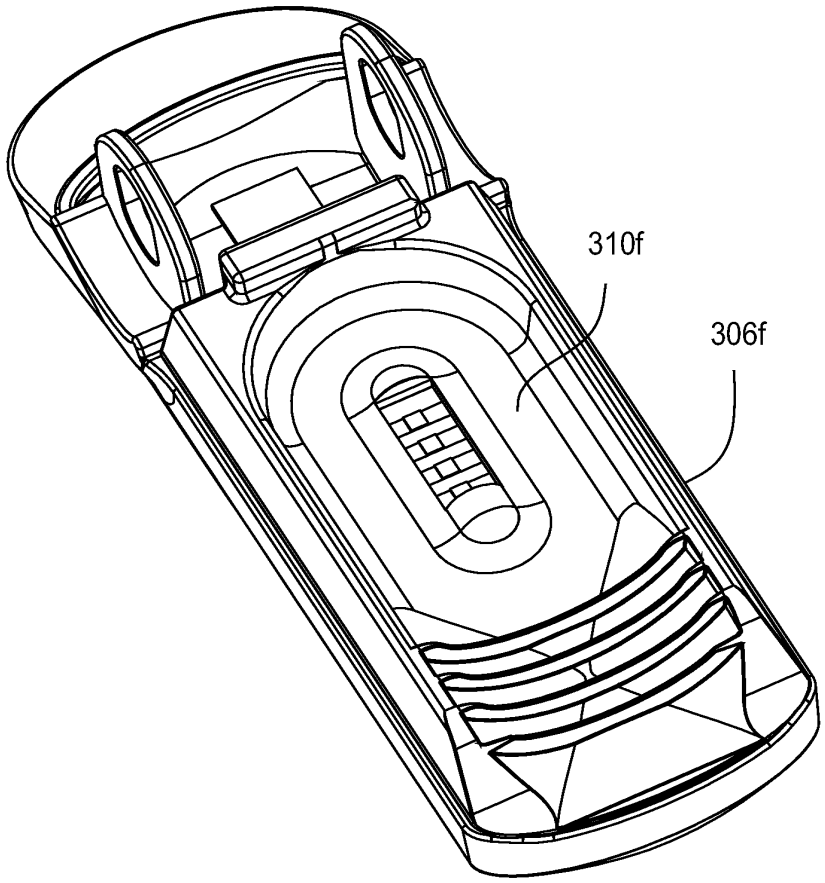


FIG. 14G

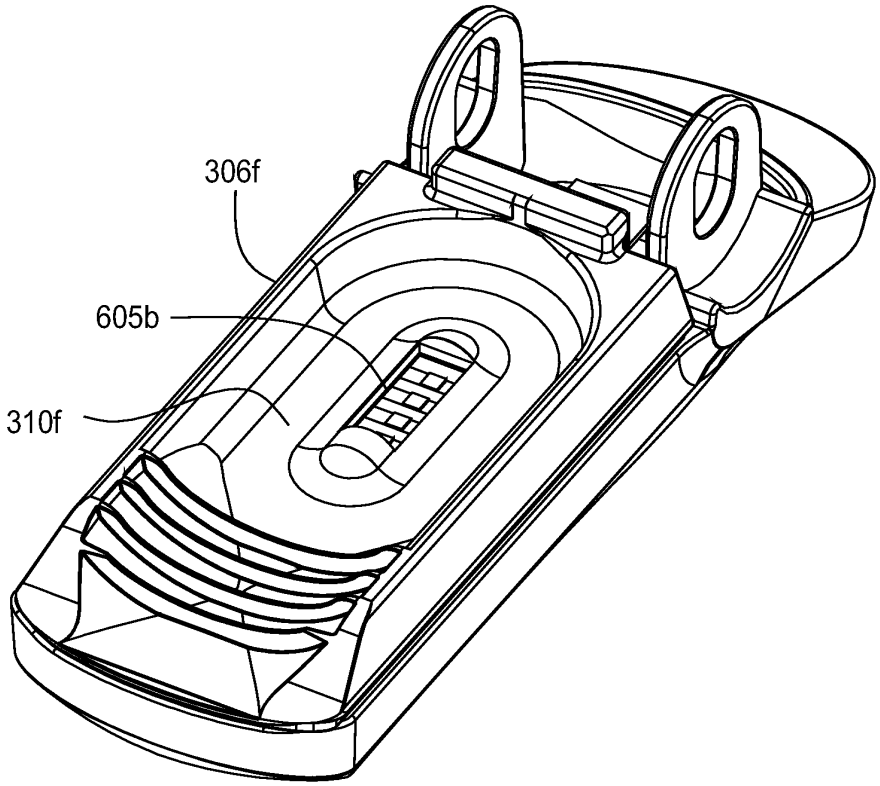


FIG. 14H

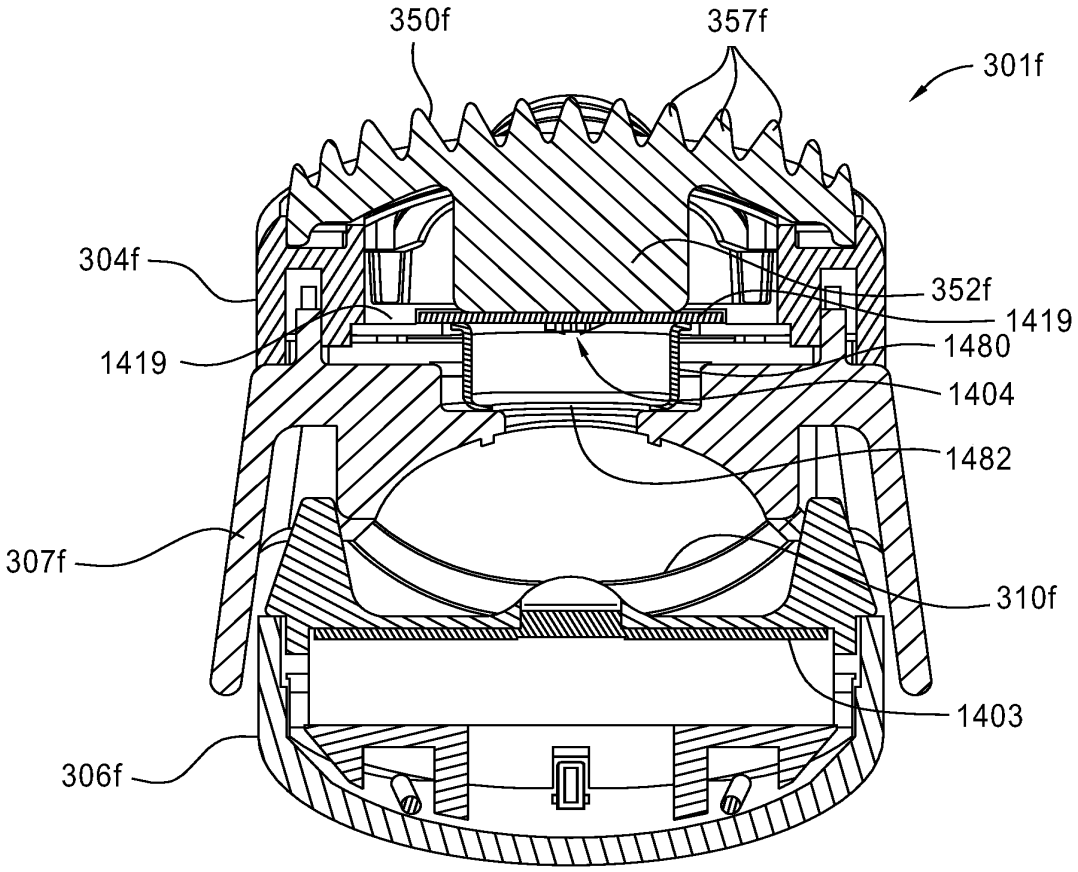

350f
357f
301f
304f
352f
1419
1480
1419
1404
1482
307f
310f
1403
306f

FIG. 14I

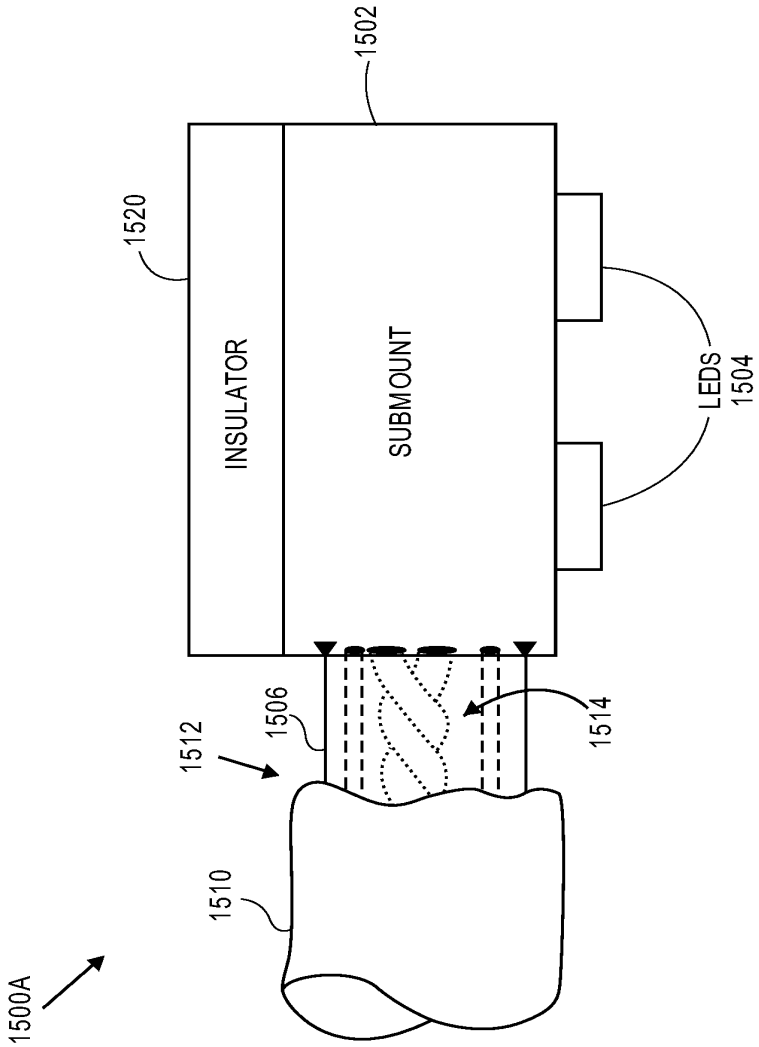

1502
1520
INSULATOR
SUBMOUNT
LEDs
1504
1506
1512
1514
1510
1500A

FIG. 15A

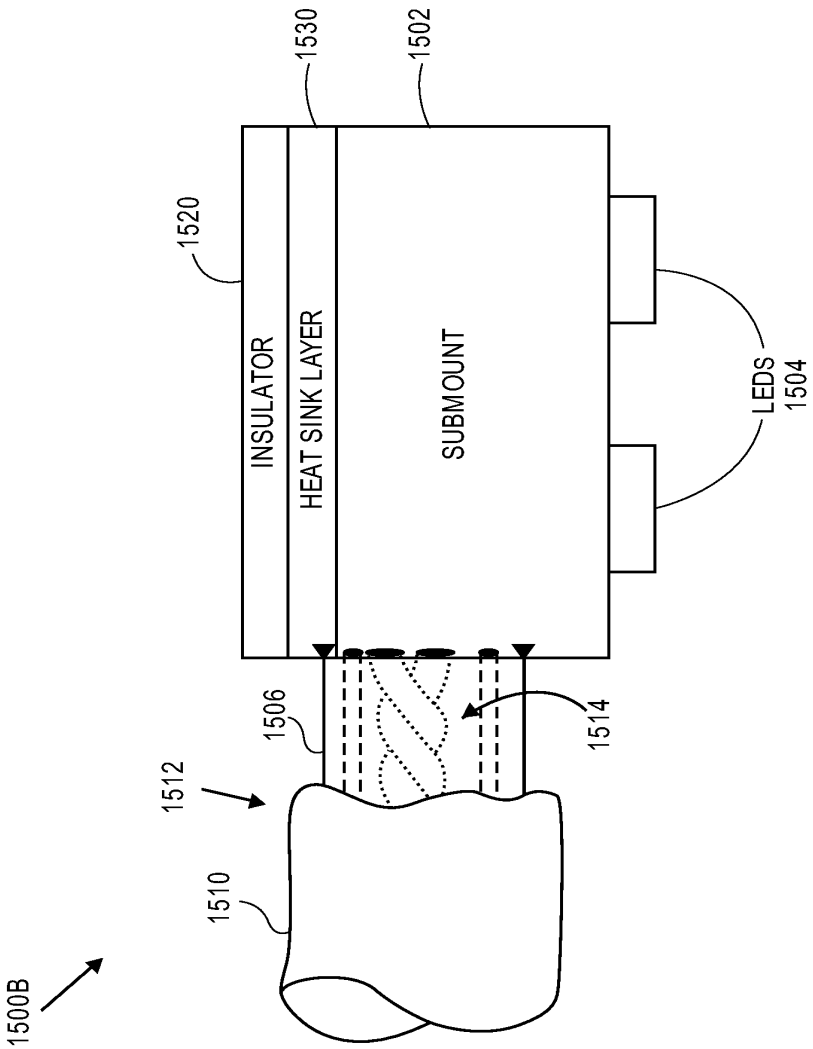

1530
1502
1520
INSULATOR
HEAT SINK LAYER
SUBMOUNT
LEDs
1504
1506
1514
1512
1510
1500B

FIG. 15B

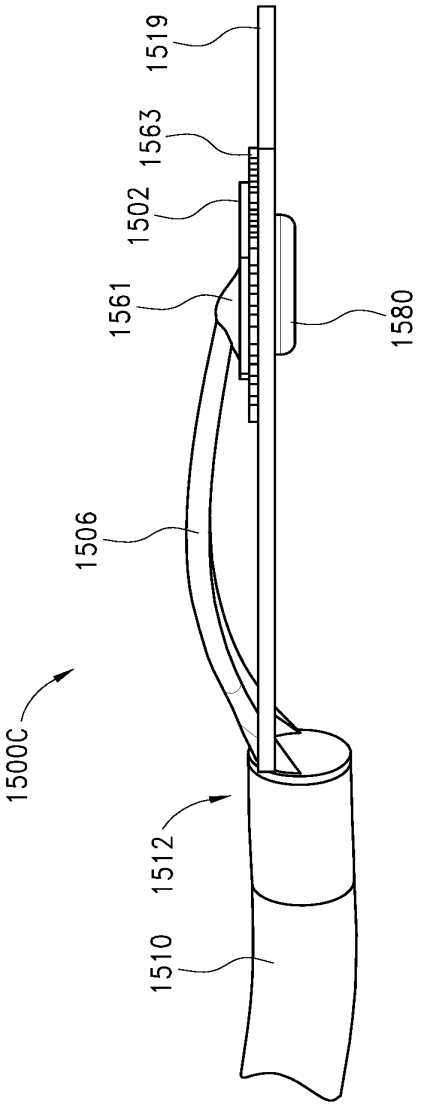


FIG. 15C

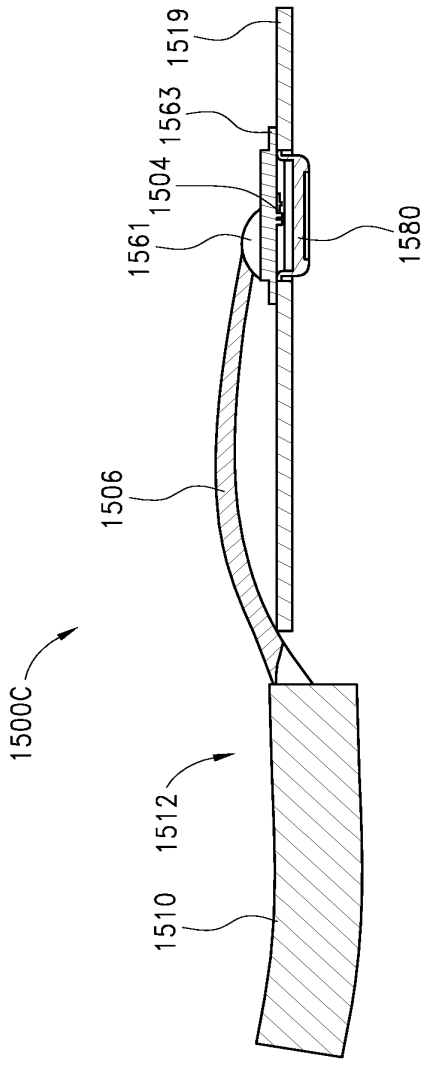


FIG. 15D

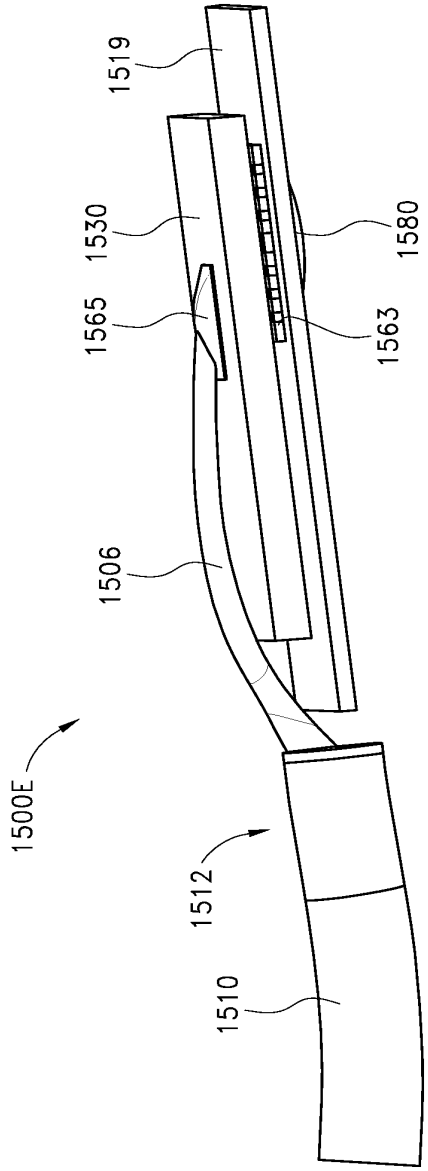


FIG. 15E

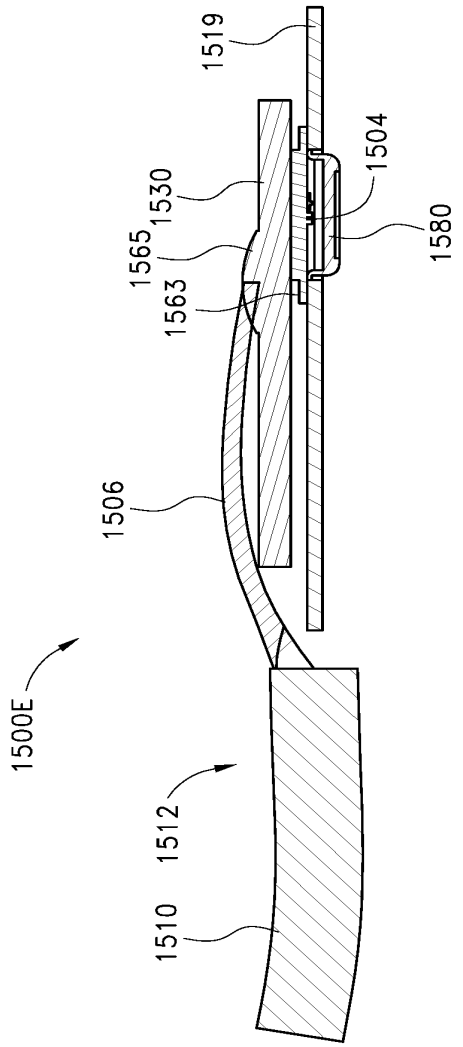


FIG. 15F

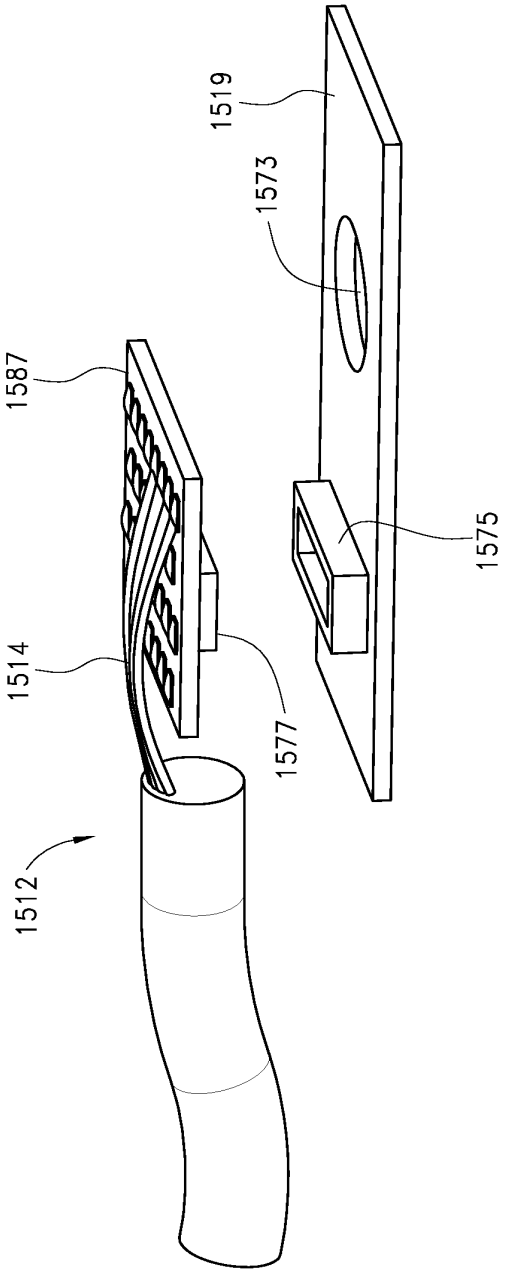


FIG. 15G

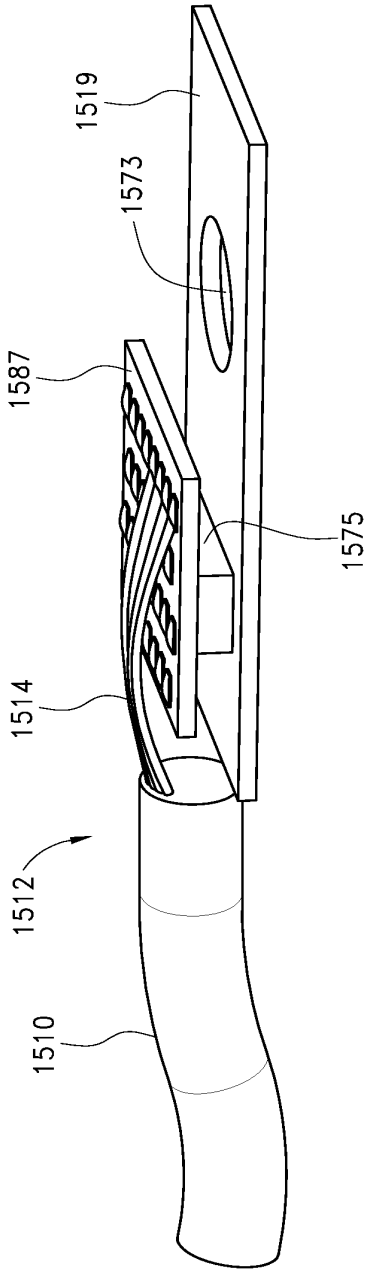


FIG. 15H

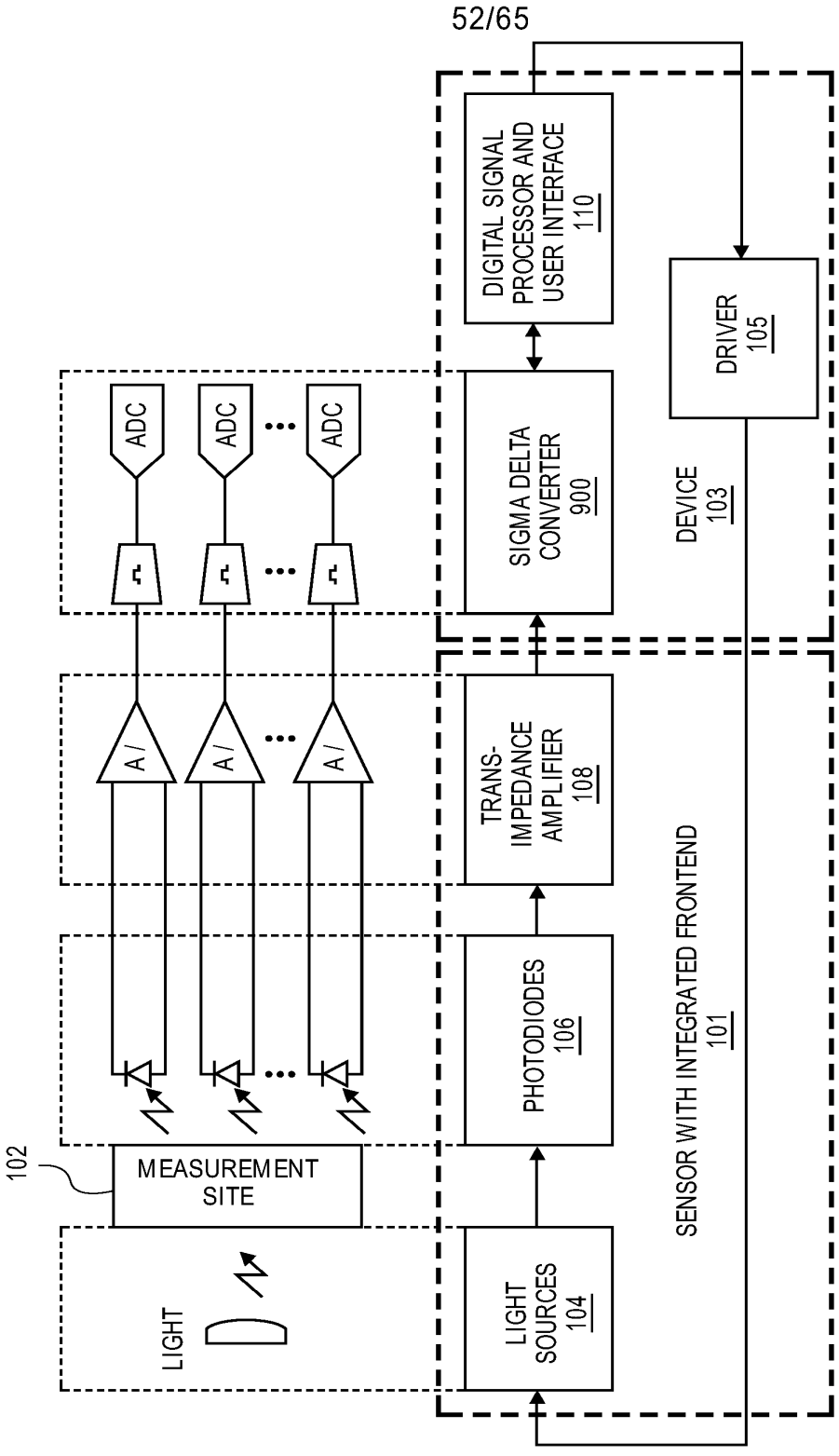

DIGITAL SIGNAL PROCESSOR AND USER INTERFACE 110
DRIVER 105
SIGMA DELTA CONVERTER 900
DEVICE 103
TRANS-IMPEDANCE AMPLIFIER 108
PHOTODIODES 106
LIGHT SOURCES 104
SENSOR WITH INTEGRATED FRONTEND 101
ADC
ADC
ADC
A /
A /
A /
102
MEASUREMENT SITE
LIGHT

FIG. 15I

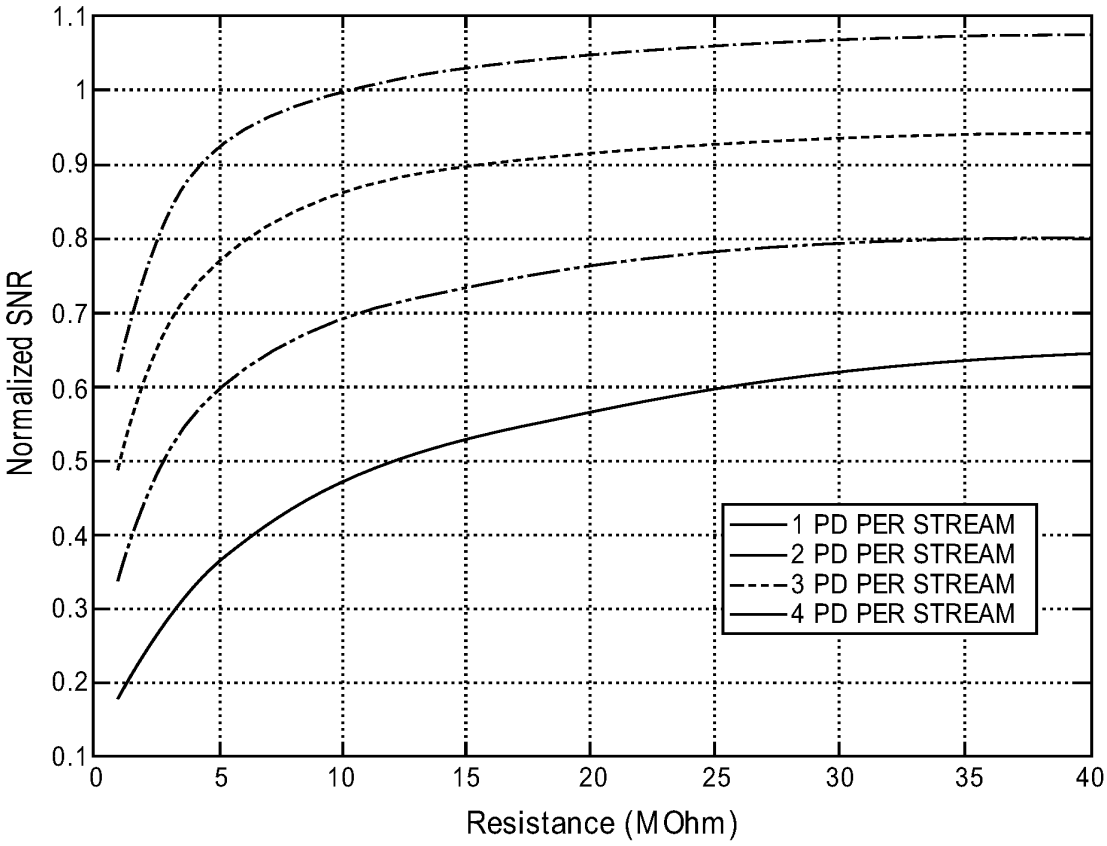

1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Normalized SNR
0
5
10
15
20
25
30
35
40
Resistance (MOhm)
1 PD PER STREAM
2 PD PER STREAM
3 PD PER STREAM
4 PD PER STREAM

FIG. 15J

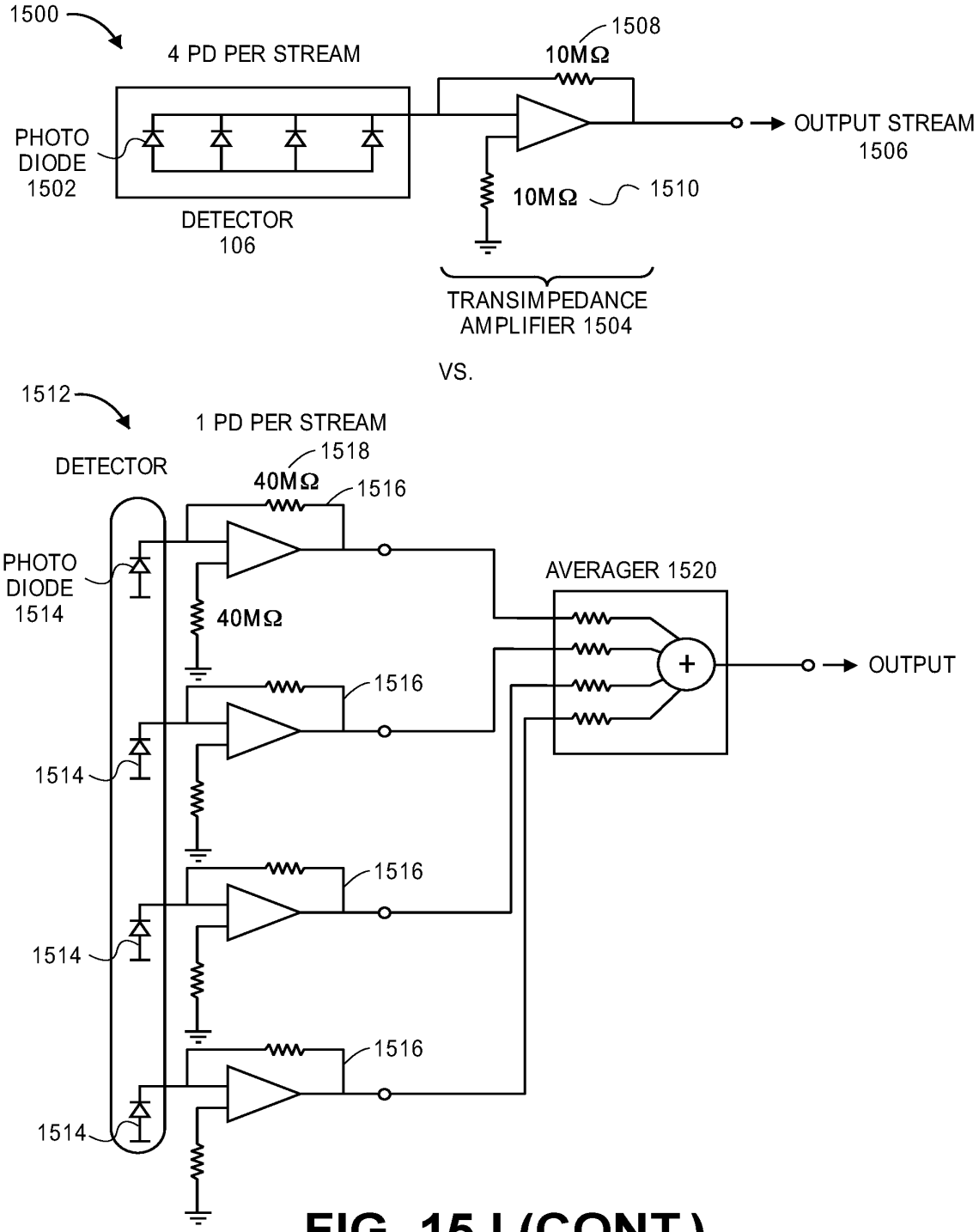
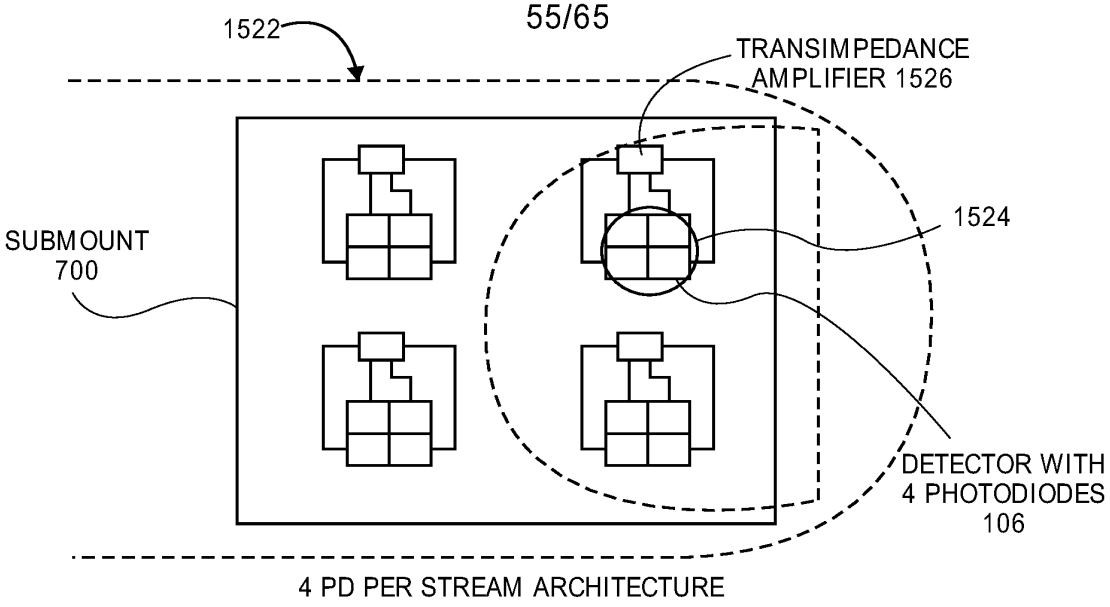

1500
4 PD PER STREAM
1508
10MΩ
PHOTO DIODE 1502
OUTPUT STREAM 1506
10MΩ
1510
DETECTOR 106
TRANSIMPEDANCE AMPLIFIER 1504
VS.
1512
1 PD PER STREAM
DETECTOR
1518
40MΩ
1516
PHOTO DIODE 1514
AVERAGER 1520
40MΩ
OUTPUT
1514
1516
1514
1516
1514
1516

FIG. 15J (CONT.)


1522
TRANSIMPEDANCE AMPLIFIER 1526
1524
SUBMOUNT 700
DETECTOR WITH 4 PHOTODIODES 106
4 PD PER STREAM ARCHITECTURE

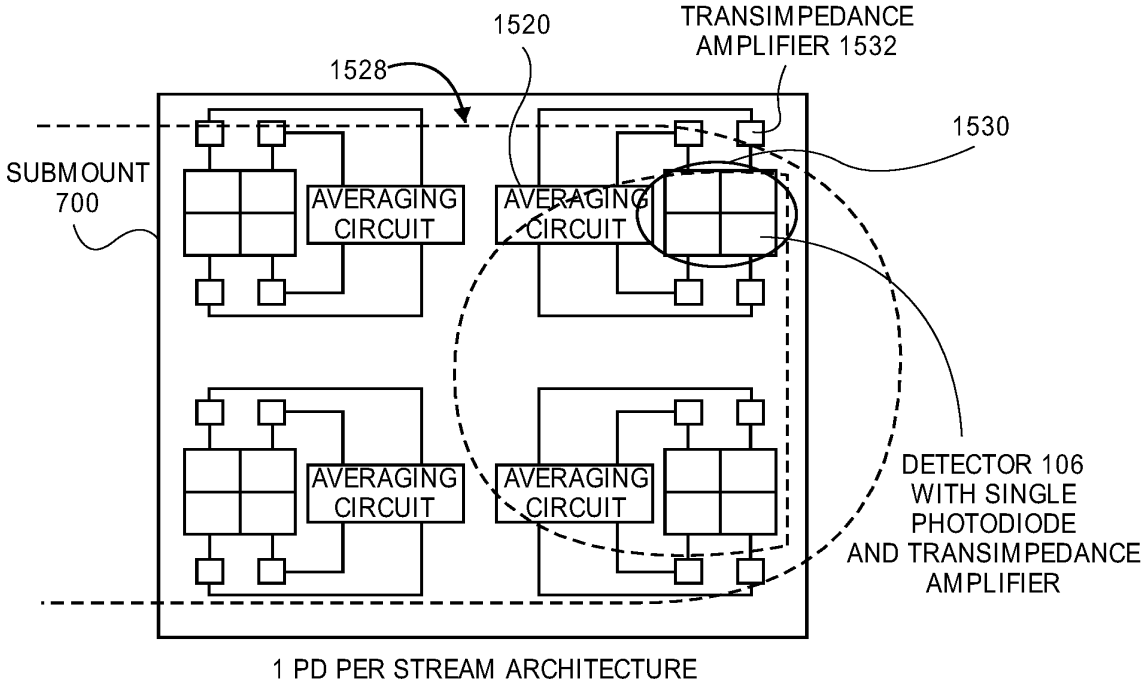

1520
TRANSIMPEDANCE AMPLIFIER 1532
1528
1530
SUBMOUNT 700
AVERAGING CIRCUIT
AVERAGING CIRCUIT
AVERAGING CIRCUIT
AVERAGING CIRCUIT
DETECTOR 106 WITH SINGLE PHOTODIODE AND TRANSIMPEDANCE AMPLIFIER
1 PD PER STREAM ARCHITECTURE

FIG. 15K

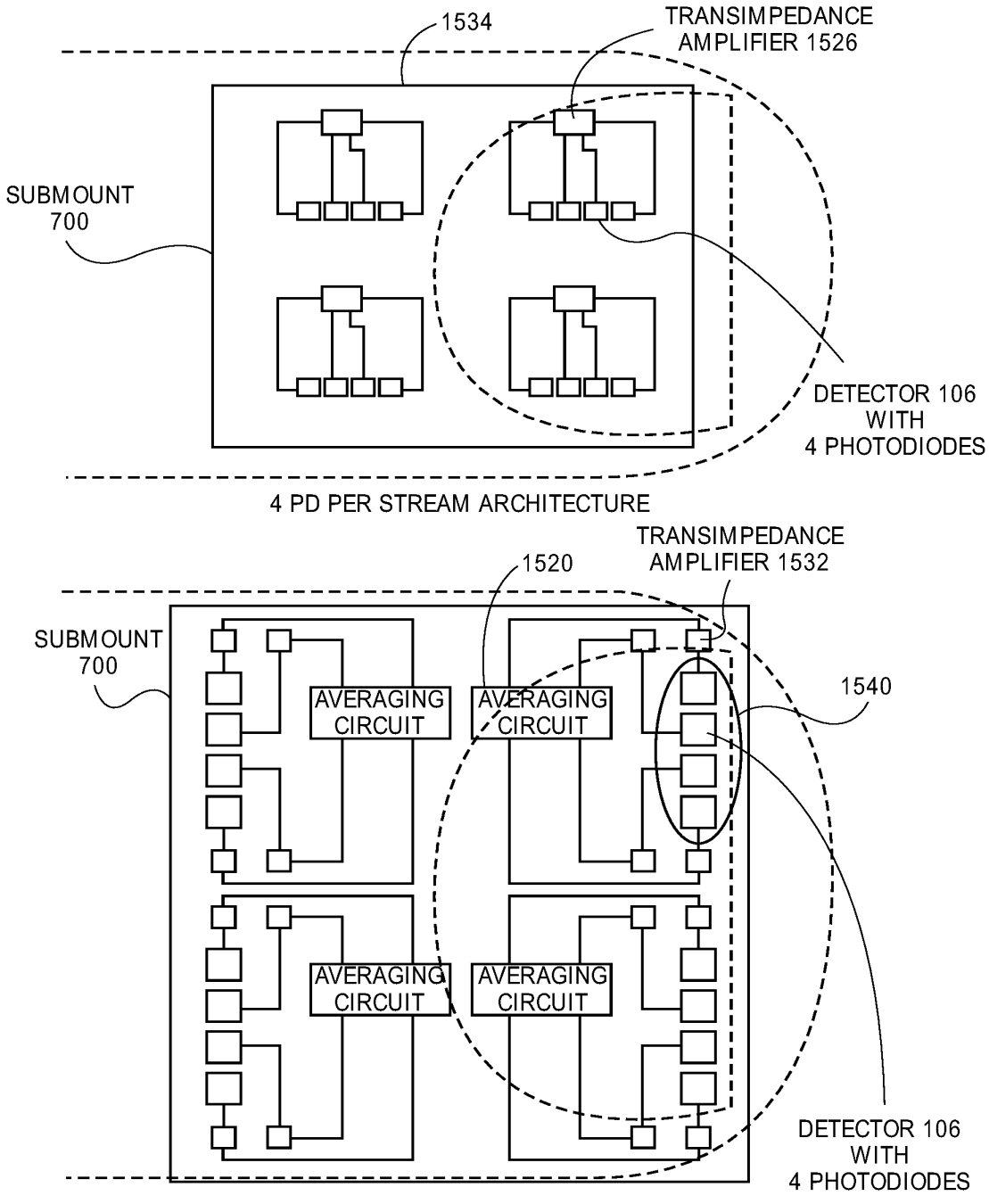

1534
TRANSIMPEDANCE AMPLIFIER 1526
SUBMOUNT 700
DETECTOR 106 WITH 4 PHOTODIODES
4 PD PER STREAM ARCHITECTURE
TRANSIMPEDANCE AMPLIFIER 1532
1520
SUBMOUNT 700
AVERAGING CIRCUIT
AVERAGING CIRCUIT
AVERAGING CIRCUIT
AVERAGING CIRCUIT
1540
DETECTOR 106 WITH 4 PHOTODIODES
1 PD PER STREAM ARCHITECTURE

FIG. 15K (CONT.)

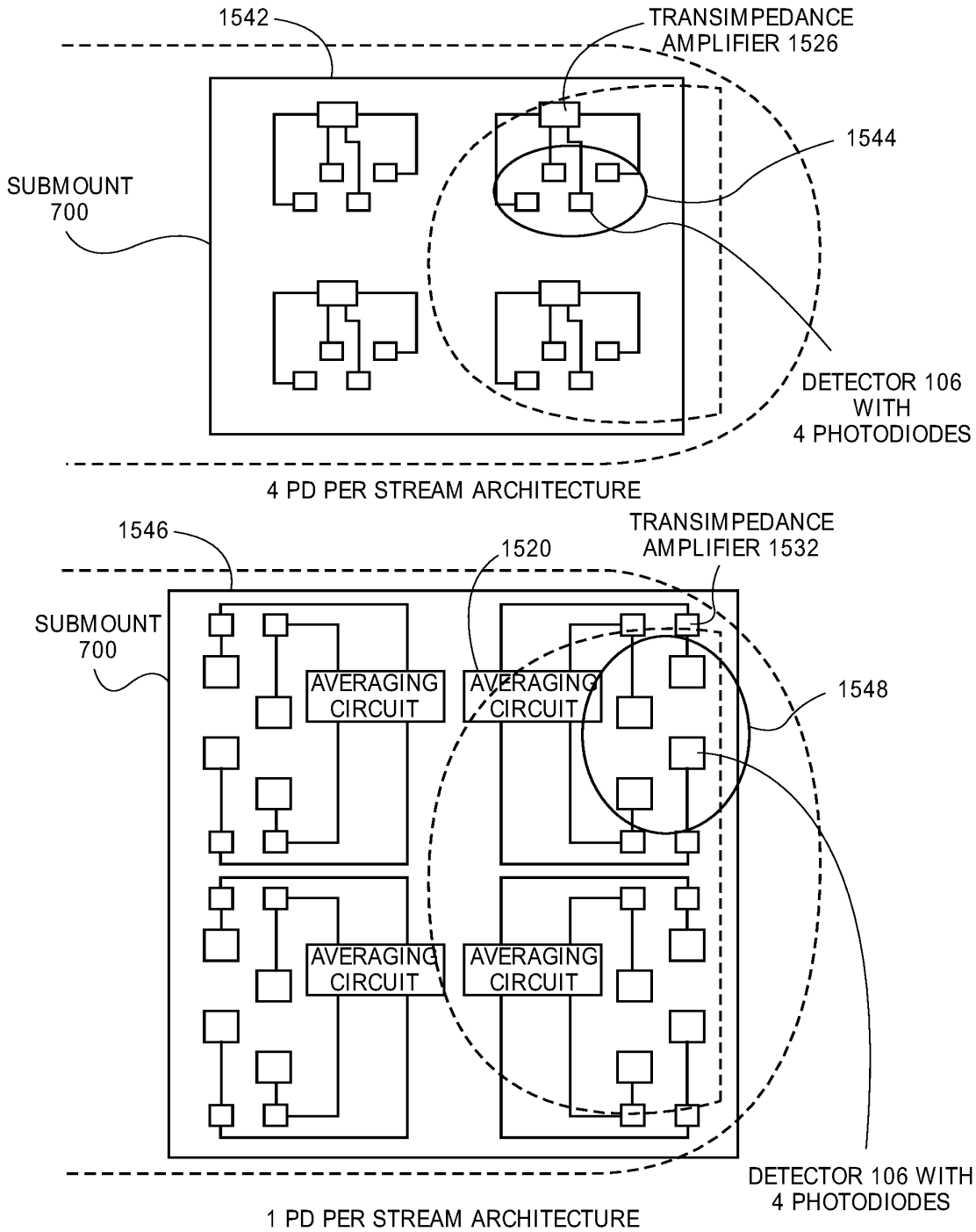

1542
TRANSIMPEDANCE AMPLIFIER 1526
1544
SUBMOUNT 700
DETECTOR 106 WITH 4 PHOTODIODES
4 PD PER STREAM ARCHITECTURE
1546
1520
TRANSIMPEDANCE AMPLIFIER 1532
SUBMOUNT 700
AVERAGING CIRCUIT
AVERAGING CIRCUIT
1548
AVERAGING CIRCUIT
AVERAGING CIRCUIT
DETECTOR 106 WITH 4 PHOTODIODES
1 PD PER STREAM ARCHITECTURE

FIG. 15K (CONT.)

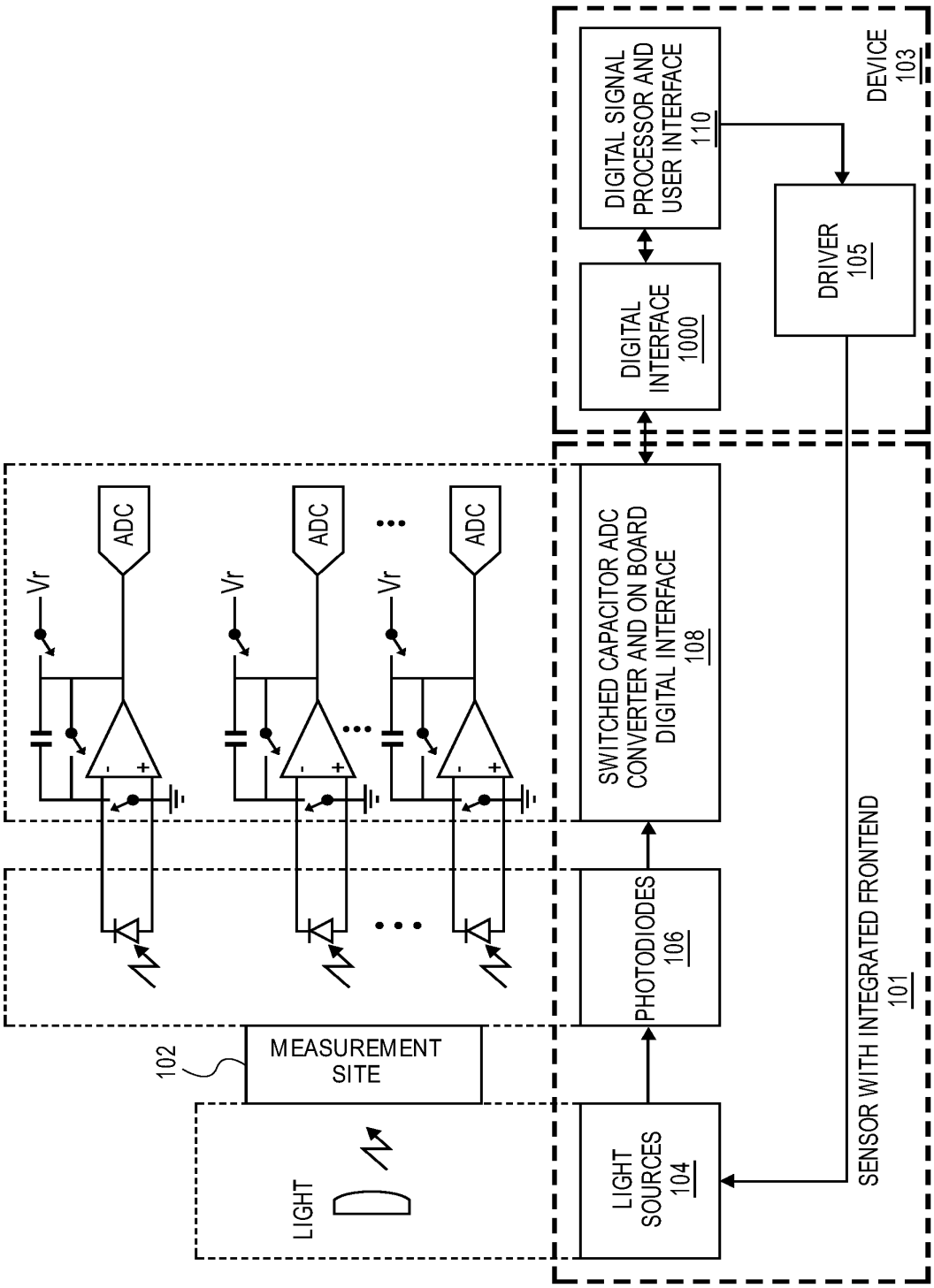

DEVICE
103
DIGITAL SIGNAL PROCESSOR AND USER INTERFACE
110
DRIVER
105
DIGITAL INTERFACE
1000
SWITCHED CAPACITOR ADC CONVERTER AND ON BOARD DIGITAL INTERFACE
108
PHOTODIODES
106
LIGHT SOURCES
104
SENSOR WITH INTEGRATED FRONTEND
101
MEASUREMENT SITE
102
LIGHT
ADC
Vr

FIG. 15L

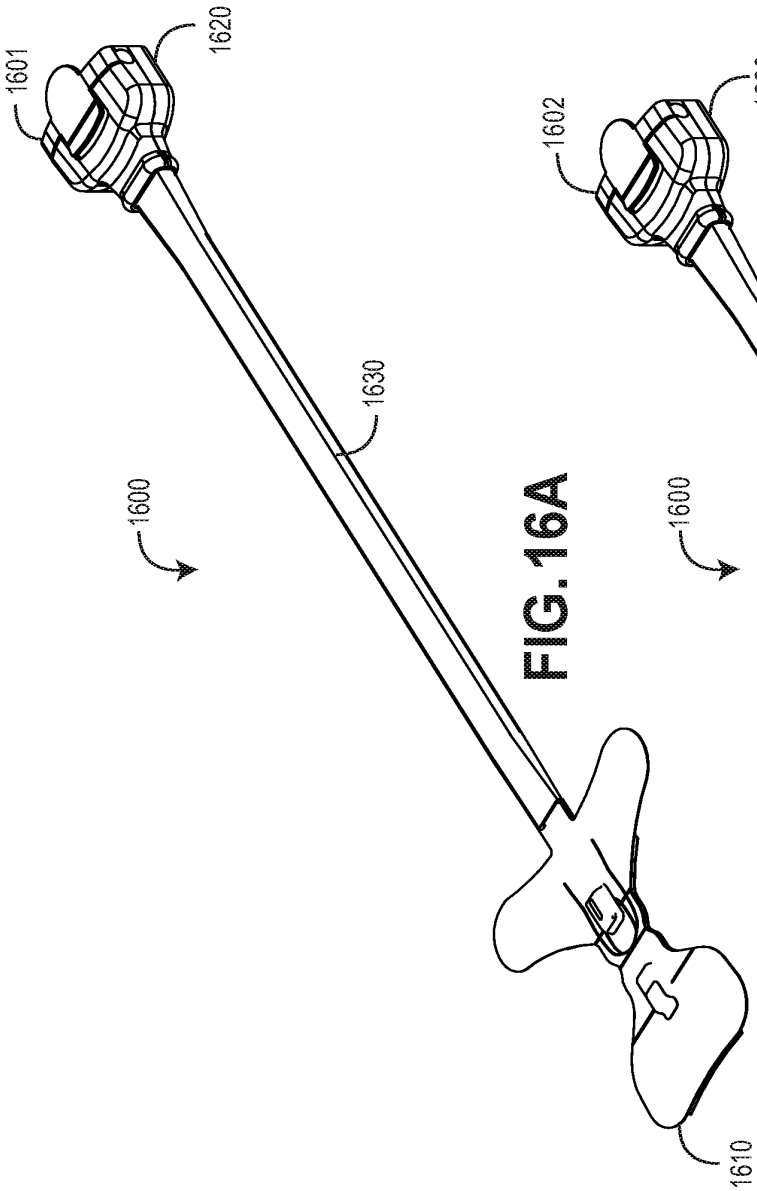


FIG.16A

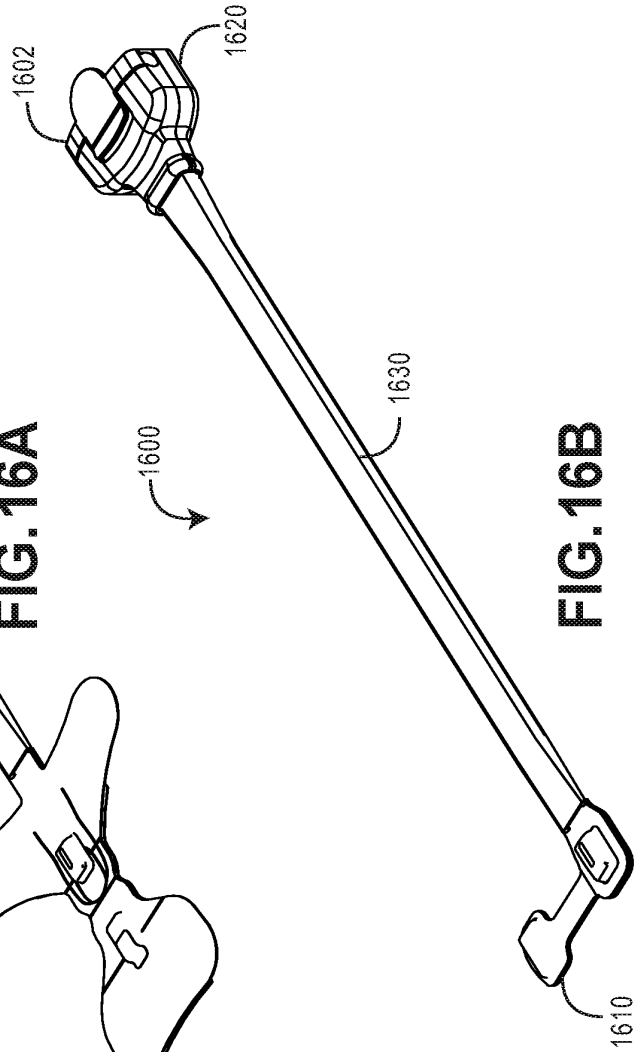


FIG.16B

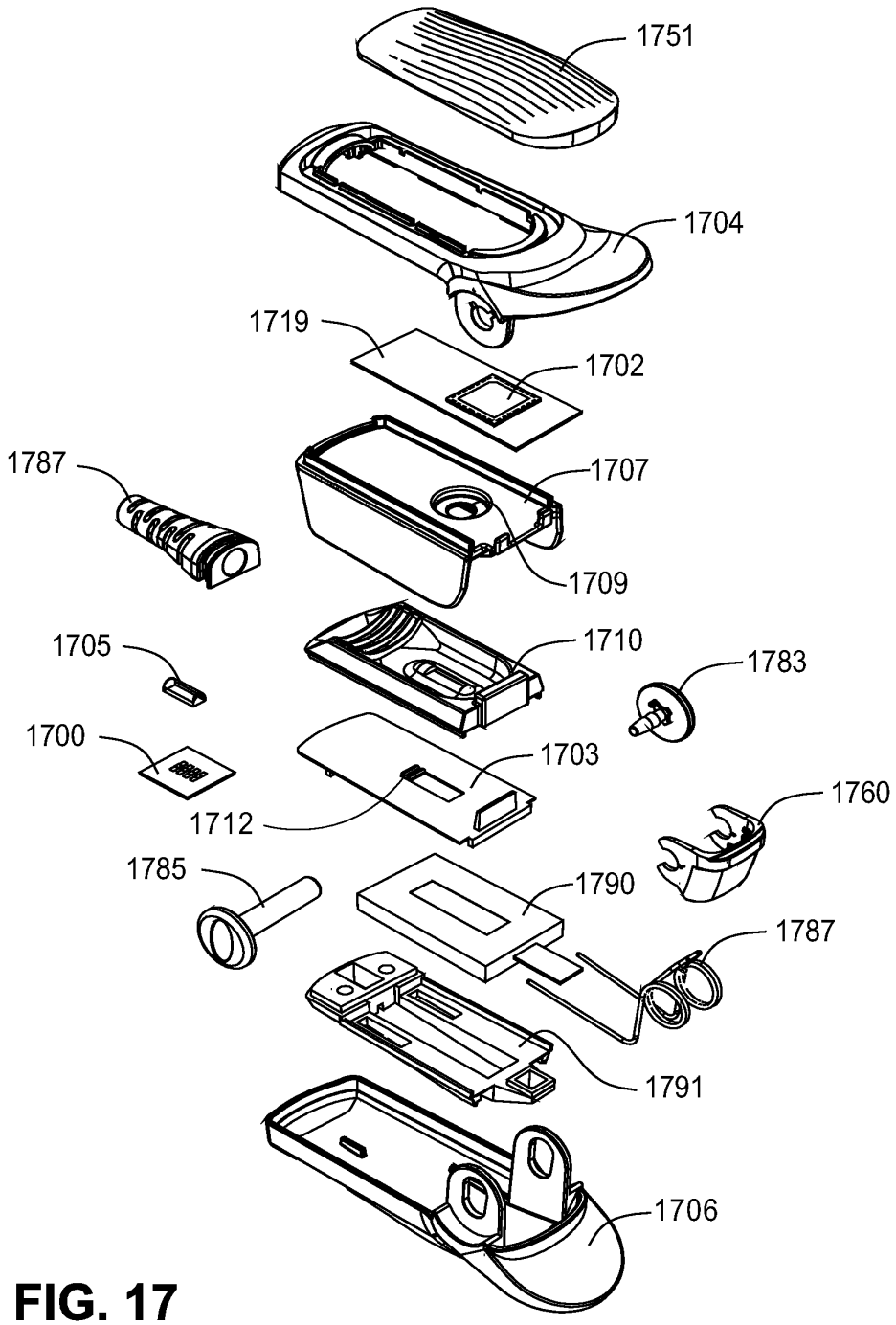

1751
1704
1719
1702
1787
1707
1709
1705
1710
1783
1700
1703
1760
1712
1785
1790
1787
1791
1706

FIG. 17

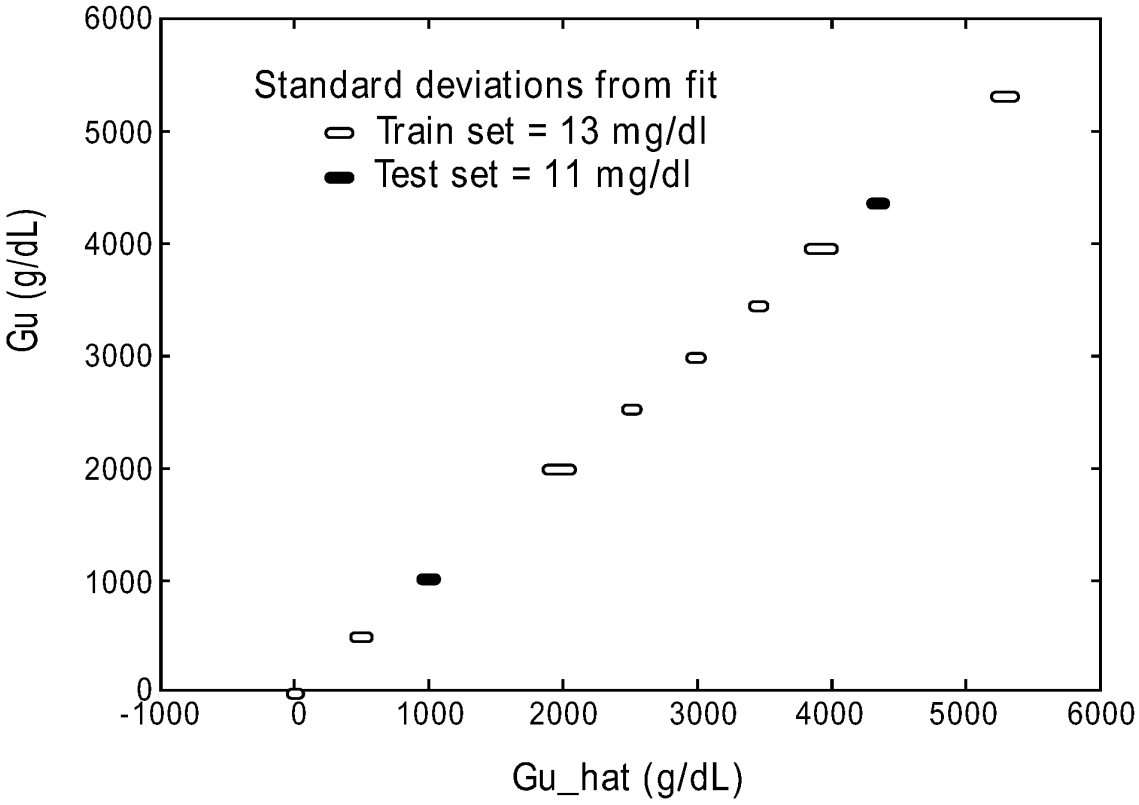

Standard deviations from fit
Train set = 13 mg/dl
Test set = 11 mg/dl
Gu (g/dL)
Gu_hat (g/dL)
6000
5000
4000
3000
2000
1000
0
-1000
0
1000
2000
3000
4000
5000
6000

FIG. 18

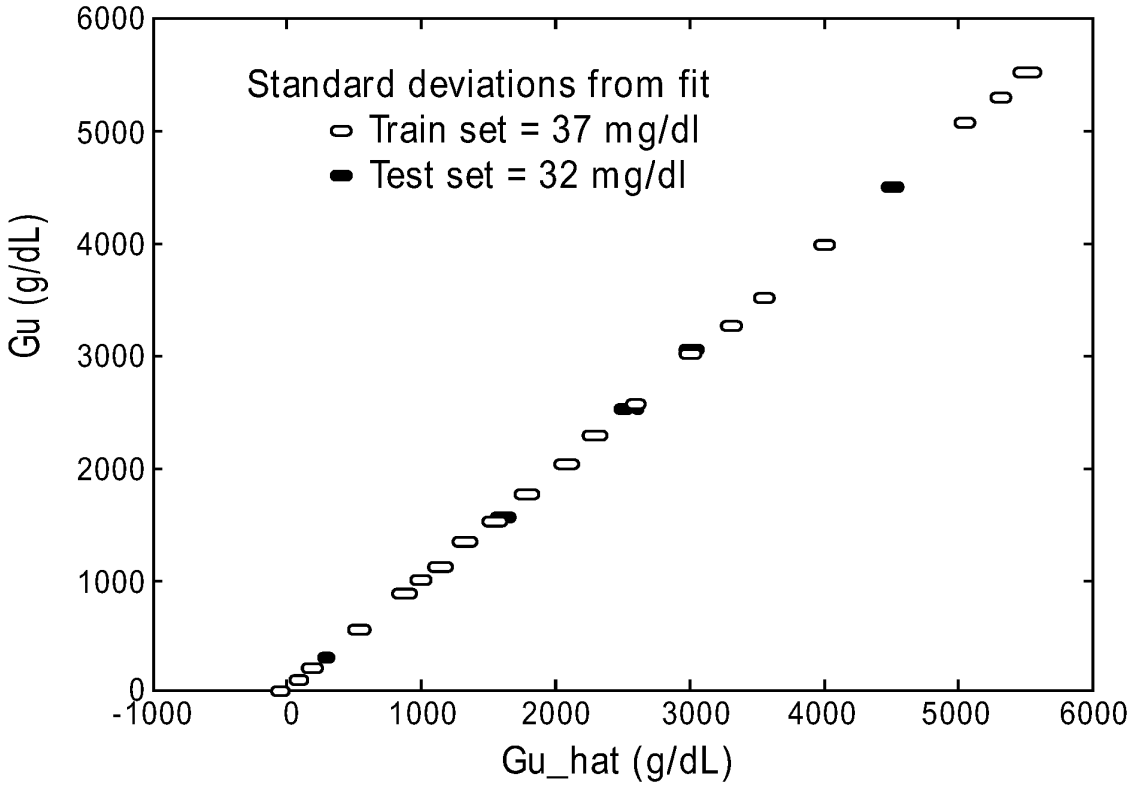

Standard deviations from fit
Train set = 37 mg/dl
Test set = 32 mg/dl
Gu (g/dL)
Gu_hat (g/dL)
6000
5000
4000
3000
2000
1000
0
-1000
0
1000
2000
3000
4000
5000
6000

FIG. 19

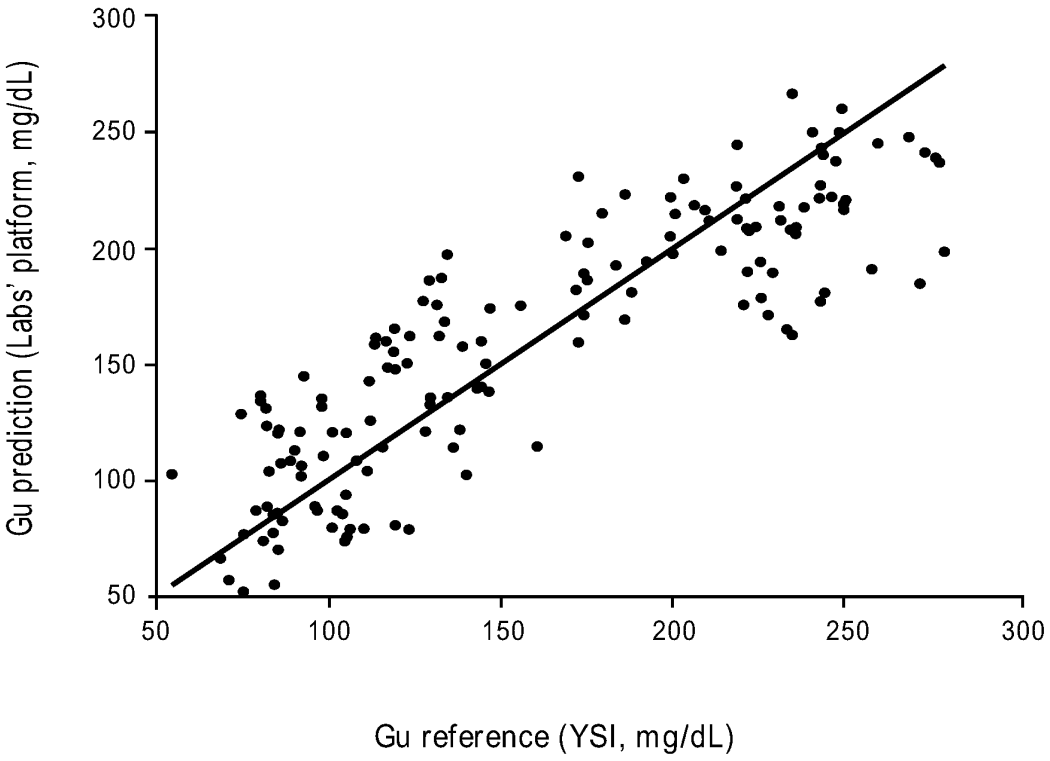

Gu prediction (Labs' platform, mg/dL)
300
250
200
150
100
50
50
100
150
200
250
300
Gu reference (YSI, mg/dL)

FIG. 20

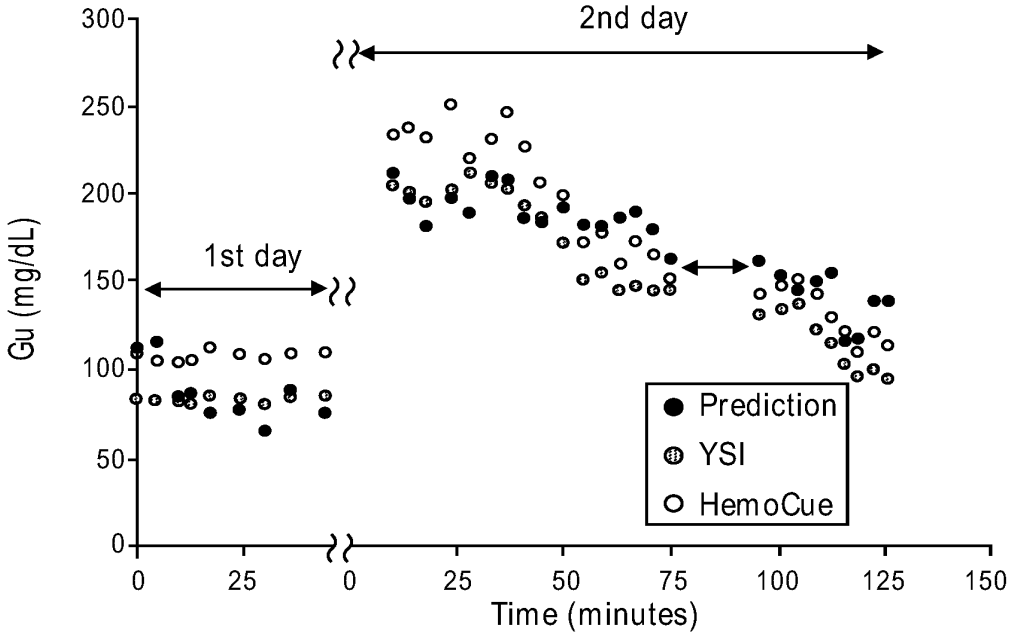

300
250
200
150
100
50
0
Gu (mg/dL)
1st day
2nd day
Prediction
YSI
HemoCue
0
25
0
25
50
75
100
125
150
Time (minutes)

FIG. 21

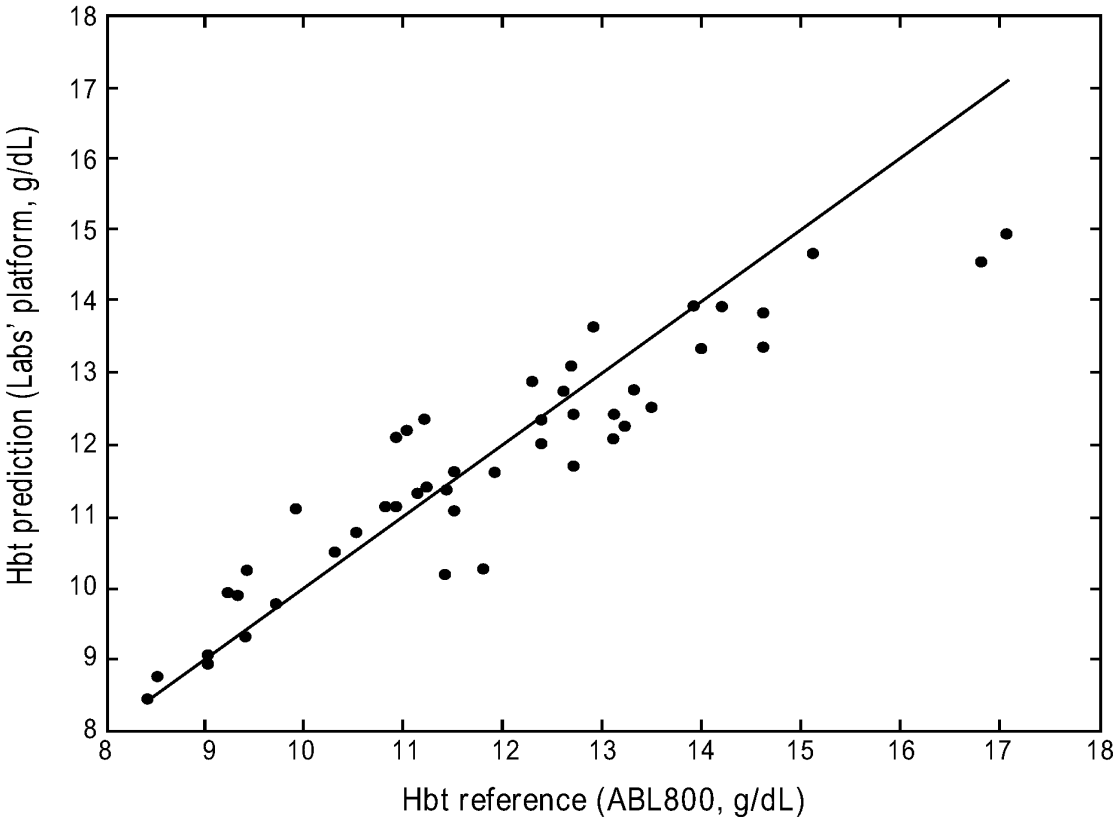

Hbt prediction (Labs' platform, g/dL)
Hbt reference (ABL800, g/dL)
8
9
10
11
12
13
14
15
16
17
18

FIG. 22

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: MASCER.002C4

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Jeroen Poeze

Declaration

This Declaration is directed to U.S. or International Application No. **16/212537**, filed December 6, 2018 and incorporating any amendments made thereto prior to the signature date of this Declaration.

As a named inventor, I declare that:

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 USC 1001 by fine or imprisonment of not more than five (5) years, or both.

I have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

Confirmation of Assignment from Inventors

WHEREAS, **above-identified inventors** (individual(s) hereinafter "ASSIGNOR") invented certain new and useful improvements, technology, inventions, developments, ideas, ornamental designs, or discoveries, and hereby assign as the ASSIGNOR may possess or are under an obligation to assign to the below identified Assignee the above-titled application (collectively hereinafter referred to as the "Work") for which an application for Letters Patent in the United States (identified above) has been prepared for filing with the United States Patent and Trademark Office (hereinafter the "Application").

AND WHEREAS, **Cercacor Laboratories, Inc.,** with its principal place of business at 40 Parker, Irvine, CA 92618 (hereinafter the "ASSIGNEE"), desires to acquire the entire right, title, and interest in and to the Application and the Work.

NOW, THEREFORE, for good and valuable consideration of which receipt is hereby acknowledged, ASSIGNOR hereby acknowledges and confirms that ASSIGNOR has sold, assigned, transferred and set over, and by these presents, to the extent not previously assigned, does hereby sell, assign, transfer and set over, unto said ASSIGNEE, its successors, legal representatives and assigns, the entire right, title, and interest throughout the world in the Application and the Work, including all Patent Properties filed or issued upon the Application and the Work; where "Patent Properties" include, but are not limited to:

all provisional applications relating thereto;

all nonprovisional applications claiming priority to aforementioned provisional(s) and/or the present Application, including, all divisions, continuations, continuations-in-part, reissues, and reexaminations thereof;

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 any related Letters Patent which may hereafter be granted or filed in any country or countries foreign to the United States, all extensions, renewals and reissues thereof.

ASSIGNOR hereby acknowledges the ASSIGNEE as the Applicant for all aforementioned Patent Properties, and authorizes and requests 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 related Letters Patent to the ASSIGNEE, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

AND ASSIGNOR DOES HEREBY sell, assign, transfer, and convey to ASSIGNEE, its successors, legal representatives, and assigns all claims for damages and all remedies arising out of any violation of the rights assigned hereby that may have accrued prior to the date of assignment to ASSIGNEE, or may accrue hereafter, including, but not limited to, the right to sue for, collect, and retain damages for past infringements of said Letters Patent before or after issuance.

AND ASSIGNOR DOES HEREBY covenant and agree that ASSIGNOR will communicate to said ASSIGNEE, its successors, legal representatives and assigns, any facts known to ASSIGNOR respecting the Work, and testify in any legal proceeding, assist in the preparation of any other Patent Property relating to the Application and the Work or any improvements made thereto, sign/execute all lawful papers, authorize the filing of and execute and make all rightful oaths and/or declarations in connection with the Application and the Work including any improvements made thereto, any patent applications filed therefrom, and any continuing application filed from any of the aforementioned applications, and generally do everything possible to aid the ASSIGNEE, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for the Work in all countries.

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: MASCER.002C4

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Jeroen Poeze

Legal Name of inventor: Jeroen Poeze

IN TESTIMONY WHEREOF, I hereunto set my hand and seal this 17 day of July, 20 19.

Signature: 

A NOTARY PUBLIC OR OTHER OFFICER COMPLETING THIS CERTIFICATE VERIFIES ONLY THE IDENTITY OF THE INDIVIDUAL WHO SIGNED THE DOCUMENT TO WHICH THIS CERTIFICATE IS ATTACHED, AND NOT THE TRUTHFULNESS, ACCURACY, OR VALIDITY OF THAT DOCUMENT.

STATE OF CALIFORNIA

COUNTY OF ORANGE } ss.

On 17 Jul 2019, before me, ELISA M. MULET, notary public, personally appeared Jeroen Poeze who 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 he/~~she/they~~ executed the same in his/~~her/their~~ authorized capacity~~(ies)~~, and that by his/~~her/their~~ signature~~(s)~~ on the instrument the person~~(s)~~, or the entity upon behalf of which the person~~(s)~~ acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Notary Signature

[SEAL]

ELISA M. MULET
Notary Public - California
Orange County
Commission # 2173718
My Comm. Expires Dec 23, 2020

29717198

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: MASCER.002C4

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Sean Merritt

Declaration

This Declaration is directed to U.S. or International Application No. **16/212537**, filed December 6, 2018 and incorporating any amendments made thereto prior to the signature date of this Declaration.

As a named inventor, I declare that:

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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all nonprovisional applications claiming priority to aforementioned provisional(s) and/or the present Application, including, all divisions, continuations, continuations-in-part, reissues, and reexaminations thereof;

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 any related Letters Patent which may hereafter be granted or filed in any country or countries foreign to the United States, all extensions, renewals and reissues thereof.

ASSIGNOR hereby acknowledges the ASSIGNEE as the Applicant for all aforementioned Patent Properties, and authorizes and requests 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 related Letters Patent to the ASSIGNEE, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

AND ASSIGNOR DOES HEREBY sell, assign, transfer, and convey to ASSIGNEE, its successors, legal representatives, and assigns all claims for damages and all remedies arising out of any violation of the rights assigned hereby that may have accrued prior to the date of assignment to ASSIGNEE, or may accrue hereafter, including, but not limited to, the right to sue for, collect, and retain damages for past infringements of said Letters Patent before or after issuance.

AND ASSIGNOR DOES HEREBY covenant and agree that ASSIGNOR will communicate to said ASSIGNEE, its successors, legal representatives and assigns, during mutually agreeable times according to ASSIGNOR'S availability which will not be unreasonably withheld, any facts known to ASSIGNOR respecting the Work, and testify in any legal proceeding, assist in the preparation of any other Patent Property relating to the Application and the Work or any improvements made thereto, sign/execute all lawful papers, authorize the filing of and execute and make all rightful oaths and/or declarations in connection with the Application and the Work including any improvements made thereto, any patent applications filed therefrom, and any continuing application filed from any of the aforementioned applications, and generally do everything possible to aid the ASSIGNEE, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for the Work in all countries. ASSIGNEE hereby further agrees to compensate ASSIGNOR for ASSIGNOR'S reasonable time spent assisting in the foregoing at a mutually agreeable hourly rate commensurate with current industry norms and when such norms are reasonably similar to ASSIGNOR'S normal hourly income or an hourly rate, at ASSIGNOR'S normal hourly rate.

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: MASCER.002C4

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Sean Merritt

Legal Name of Inventor: Sean Merritt

IN TESTIMONY WHEREOF, I hereunto set my hand and seal this 25 day of July, 20 19.

Signature: _____

A NOTARY PUBLIC OR OTHER OFFICER COMPLETING THIS CERTIFICATE VERIFIES ONLY THE IDENTITY OF THE INDIVIDUAL WHO SIGNED THE DOCUMENT TO WHICH THIS CERTIFICATE IS ATTACHED, AND NOT THE TRUTHFULNESS, ACCURACY, OR VALIDITY OF THAT DOCUMENT.

STATE OF CALIFORNIA
COUNTY OF Orange } ss.

On 7/25/19, before me, Shelley Orel, notary public, personally appeared Sean Merritt who 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 he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Notary Signature

[SEAL]

SHELLEY OREL
Notary Public - California
Orange County
Commission # 2191730
My Comm. Expires Apr 14, 2021

29717221

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Cristiano Dalvi

Declaration

This Declaration is directed to U.S. or International Application No. **16/212537**, filed December 6, 2018 and incorporating any amendments made thereto prior to the signature date of this Declaration.

As a named inventor, I declare that:

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 USC 1001 by fine or imprisonment of not more than five (5) years, or both.

I have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

Confirmation of Assignment from Inventors

WHEREAS, **above-identified inventors** (individual(s) hereinafter "ASSIGNOR") invented certain new and useful improvements, technology, inventions, developments, ideas, ornamental designs, or discoveries, and hereby assign as the ASSIGNOR may possess or are under an obligation to assign to the below identified Assignee the above-titled application (collectively hereinafter referred to as the "Work") for which an application for Letters Patent in the United States (identified above) has been prepared for filing with the United States Patent and Trademark Office (hereinafter the "Application").

AND WHEREAS, **Cercacor Laboratories, Inc.,** with its principal place of business at 40 Parker, Irvine, CA 92618 (hereinafter the "ASSIGNEE"), desires to acquire the entire right, title, and interest in and to the Application and the Work.

NOW, THEREFORE, for good and valuable consideration of which receipt is hereby acknowledged, ASSIGNOR hereby acknowledges and confirms that ASSIGNOR has sold, assigned, transferred and set over, and by these presents, to the extent not previously assigned, does hereby sell, assign, transfer and set over, unto said ASSIGNEE, its successors, legal representatives and assigns, the entire right, title, and interest throughout the world in the Application and the Work, including all Patent Properties filed or issued upon the Application and the Work; where "Patent Properties" include, but are not limited to:

all provisional applications relating thereto;

all nonprovisional applications claiming priority to aforementioned provisional(s) and/or the present Application, including, all divisions, continuations, continuations-in-part, reissues, and reexaminations thereof;

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 any related Letters Patent which may hereafter be granted or filed in any country or countries foreign to the United States, all extensions, renewals and reissues thereof.

ASSIGNOR hereby acknowledges the ASSIGNEE as the Applicant for all aforementioned Patent Properties, and authorizes and requests 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 related Letters Patent to the ASSIGNEE, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

AND ASSIGNOR DOES HEREBY sell, assign, transfer, and convey to ASSIGNEE, its successors, legal representatives, and assigns all claims for damages and all remedies arising out of any violation of the rights assigned hereby that may have accrued prior to the date of assignment to ASSIGNEE, or may accrue hereafter, including, but not limited to, the right to sue for, collect, and retain damages for past infringements of said Letters Patent before or after issuance.

AND ASSIGNOR DOES HEREBY covenant and agree that ASSIGNOR will communicate to said ASSIGNEE, its successors, legal representatives and assigns, any facts known to ASSIGNOR respecting the Work, and testify in any legal proceeding, assist in the preparation of any other Patent Property relating to the Application and the Work or any improvements made thereto, sign/execute all lawful papers, authorize the filing of and execute and make all rightful oaths and/or declarations in connection with the Application and the Work including any improvements made thereto, any patent applications filed therefrom, and any continuing application filed from any of the aforementioned applications, and generally do everything possible to aid the ASSIGNEE, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for the Work in all countries.

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: MASCER.002C4 Page 3 of 3

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Cristiano Dalvi

Legal Name of inventor: Cristiano Dalvi

IN TESTIMONY WHEREOF, I hereunto set my hand and seal this 17th day of July, 20 19.

Signature: C. Dalvi

A NOTARY PUBLIC OR OTHER OFFICER COMPLETING THIS CERTIFICATE VERIFIES ONLY THE IDENTITY OF THE INDIVIDUAL WHO SIGNED THE DOCUMENT TO WHICH THIS CERTIFICATE IS ATTACHED, AND NOT THE TRUTHFULNESS, ACCURACY, OR VALIDITY OF THAT DOCUMENT.

STATE OF CALIFORNIA }
} ss.
COUNTY OF ORANGE }

On 17JUL2019, before me, ELISA M MULET, notary public, personally appeared Cristiano Dalvi who 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 he/~~she/they~~ executed the same in his/~~her/their~~ authorized capacity~~(ies)~~, and that by his/~~her/their~~ signature~~(s)~~ on the instrument the person~~(s)~~, or the entity upon behalf of which the person~~(s)~~ acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

E. M. Mulet
Notary Signature

[SEAL]

ELISA M. MULET
Notary Public - California
Orange County
Commission # 2173718
My Comm. Expires Dec 23, 2020

29717321

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: MASCER.002C4 Page 1 of 3

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Hung Vo

Declaration

This Declaration is directed to U.S. or International Application No. **16/212537**, filed December 6, 2018 and incorporating any amendments made thereto prior to the signature date of this Declaration.

As a named inventor, I declare that:

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 USC 1001 by fine or imprisonment of not more than five (5) years, or both.

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Confirmation of Assignment from Inventors

WHEREAS, **above-identified inventors** (individual(s) hereinafter "ASSIGNOR") invented certain new and useful improvements, technology, inventions, developments, ideas, ornamental designs, or discoveries, and hereby assign as the ASSIGNOR may possess or are under an obligation to assign to the below identified Assignee the above-titled application (collectively hereinafter referred to as the "Work") for which an application for Letters Patent in the United States (identified above) has been prepared for filing with the United States Patent and Trademark Office (hereinafter the "Application").

AND WHEREAS, **Cercacor Laboratories, Inc.,** with its principal place of business at 40 Parker, Irvine, CA 92618 (hereinafter the "ASSIGNEE"), desires to acquire the entire right, title, and interest in and to the Application and the Work.

NOW, THEREFORE, for good and valuable consideration of which receipt is hereby acknowledged, ASSIGNOR hereby acknowledges and confirms that ASSIGNOR has sold, assigned, transferred and set over, and by these presents, to the extent not previously assigned, does hereby sell, assign, transfer and set over, unto said ASSIGNEE, its successors, legal representatives and assigns, the entire right, title, and interest throughout the world in the Application and the Work, including all Patent Properties filed or issued upon the Application and the Work; where "Patent Properties" include, but are not limited to:

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ASSIGNOR hereby acknowledges the ASSIGNEE as the Applicant for all aforementioned Patent Properties, and authorizes and requests 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 related Letters Patent to the ASSIGNEE, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

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AND ASSIGNOR DOES HEREBY covenant and agree that ASSIGNOR will communicate to said ASSIGNEE, its successors, legal representatives and assigns, any facts known to ASSIGNOR respecting the Work, and testify in any legal proceeding, assist in the preparation of any other Patent Property relating to the Application and the Work or any improvements made thereto, sign/execute all lawful papers, authorize the filing of and execute and make all rightful oaths and/or declarations in connection with the Application and the Work including any improvements made thereto, any patent applications filed therefrom, and any continuing application filed from any of the aforementioned applications, and generally do everything possible to aid the ASSIGNEE, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for the Work in all countries.

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: MASCER.002C4 Page 3 of 3

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Hung Vo

Legal Name of inventor: Hung Vo

IN TESTIMONY WHEREOF, I hereunto set my hand and seal this 17 day of July, 20 19.

Signature: _____

A NOTARY PUBLIC OR OTHER OFFICER COMPLETING THIS CERTIFICATE VERIFIES ONLY THE IDENTITY OF THE INDIVIDUAL WHO SIGNED THE DOCUMENT TO WHICH THIS CERTIFICATE IS ATTACHED, AND NOT THE TRUTHFULNESS, ACCURACY, OR VALIDITY OF THAT DOCUMENT.

STATE OF CALIFORNIA
} ss.
COUNTY OF ORANGE

On 17 JUL 2019, before me, ELISA M. MULET, notary public, personally appeared Hung Vo who 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 he/~~she/they~~ executed the same in his/~~her/their~~ authorized capacity~~(ies)~~, and that by his/~~her/their~~ signature~~(s)~~ on the instrument the person~~(s)~~, or the entity upon behalf of which the person~~(s)~~ acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Notary Signature

[SEAL]

ELISA M. MULET
Notary Public - California
Orange County
Commission # 2173718
My Comm. Expires Dec 23, 2020

29717661

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Johannes Bruinsma

Declaration

This Declaration is directed to U.S. or International Application No. **16/212537**, filed December 6, 2018 and incorporating any amendments made thereto prior to the signature date of this Declaration.

As a named inventor, I declare that:

The above-identified application was made or authorized to be made by me.

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ASSIGNOR hereby acknowledges the ASSIGNEE as the Applicant for all aforementioned Patent Properties, and authorizes and requests 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 related Letters Patent to the ASSIGNEE, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

AND ASSIGNOR DOES HEREBY sell, assign, transfer, and convey to ASSIGNEE, its successors, legal representatives, and assigns all claims for damages and all remedies arising out of any violation of the rights assigned hereby that may have accrued prior to the date of assignment to ASSIGNEE, or may accrue hereafter, including, but not limited to, the right to sue for, collect, and retain damages for past infringements of said Letters Patent before or after issuance.

AND ASSIGNOR DOES HEREBY covenant and agree that ASSIGNOR will communicate to said ASSIGNEE, its successors, legal representatives and assigns, any facts known to ASSIGNOR respecting the Work, and testify in any legal proceeding, assist in the preparation of any other Patent Property relating to the Application and the Work or any improvements made thereto, sign/execute all lawful papers, authorize the filing of and execute and make all rightful oaths and/or declarations in connection with the Application and the Work including any improvements made thereto, any patent applications filed therefrom, and any continuing application filed from any of the aforementioned applications, and generally do everything possible to aid the ASSIGNEE, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for the Work in all countries.

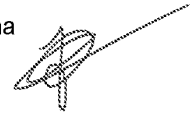
COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Johannes Bruinsma

Legal Name of inventor: Johannes Bruinsma

Signature:  Date: May - 2 - 2019

Witnessed by: 

Witness Name (printed): Marilza Bruinsma

29717764

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: MASCER.002C4

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Ferdyan Lesmana

Declaration

This Declaration is directed to U.S. or International Application No. **16/212537**, filed December 6, 2018 and incorporating any amendments made thereto prior to the signature date of this Declaration.

As a named inventor, I declare that:

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 USC 1001 by fine or imprisonment of not more than five (5) years, or both.

I have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

Confirmation of Assignment from Inventors

WHEREAS, **above-identified inventors** (individual(s) hereinafter "ASSIGNOR") invented certain new and useful improvements, technology, inventions, developments, ideas, ornamental designs, or discoveries, and hereby assign as the ASSIGNOR may possess or are under an obligation to assign to the below identified Assignee the above-titled application (collectively hereinafter referred to as the "Work") for which an application for Letters Patent in the United States (identified above) has been prepared for filing with the United States Patent and Trademark Office (hereinafter the "Application").

AND WHEREAS, **Cercacor Laboratories, Inc.,** with its principal place of business at 40 Parker, Irvine, CA 92618 (hereinafter the "ASSIGNEE"), desires to acquire the entire right, title, and interest in and to the Application and the Work.

NOW, THEREFORE, for good and valuable consideration of which receipt is hereby acknowledged, ASSIGNOR hereby acknowledges and confirms that ASSIGNOR has sold, assigned, transferred and set over, and by these presents, to the extent not previously assigned, does hereby sell, assign, transfer and set over, unto said ASSIGNEE, its successors, legal representatives and assigns, the entire right, title, and interest throughout the world in the Application and the Work, including all Patent Properties filed or issued upon the Application and the Work; where "Patent Properties" include, but are not limited to:

all provisional applications relating thereto;

all nonprovisional applications claiming priority to aforementioned provisional(s) and/or the present Application, including, all divisions, continuations, continuations-in-part, reissues, and reexaminations thereof;

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 any related Letters Patent which may hereafter be granted or filed in any country or countries foreign to the United States, all extensions, renewals and reissues thereof.

ASSIGNOR hereby acknowledges the ASSIGNEE as the Applicant for all aforementioned Patent Properties, and authorizes and requests 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 related Letters Patent to the ASSIGNEE, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

AND ASSIGNOR DOES HEREBY sell, assign, transfer, and convey to ASSIGNEE, its successors, legal representatives, and assigns all claims for damages and all remedies arising out of any violation of the rights assigned hereby that may have accrued prior to the date of assignment to ASSIGNEE, or may accrue hereafter, including, but not limited to, the right to sue for, collect, and retain damages for past infringements of said Letters Patent before or after issuance.

AND ASSIGNOR DOES HEREBY covenant and agree that ASSIGNOR will communicate to said ASSIGNEE, its successors, legal representatives and assigns, any facts known to ASSIGNOR respecting the Work, and testify in any legal proceeding, assist in the preparation of any other Patent Property relating to the Application and the Work or any improvements made thereto, sign/execute all lawful papers, authorize the filing of and execute and make all rightful oaths and/or declarations in connection with the Application and the Work including any improvements made thereto, any patent applications filed therefrom, and any continuing application filed from any of the aforementioned applications, and generally do everything possible to aid the ASSIGNEE, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for the Work in all countries.

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

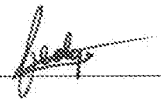
Docket No.: MASCER.002C4

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Ferdyan Lesmana

Legal Name of inventor: Ferdyan Lesmana

IN TESTIMONY WHEREOF, I hereunto set my hand and seal this 17 day of July, 2019.

Signature: 

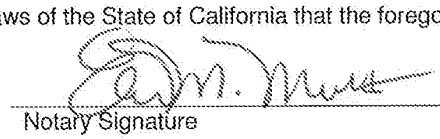
A NOTARY PUBLIC OR OTHER OFFICER COMPLETING THIS CERTIFICATE VERIFIES ONLY THE IDENTITY OF THE INDIVIDUAL WHO SIGNED THE DOCUMENT TO WHICH THIS CERTIFICATE IS ATTACHED, AND NOT THE TRUTHFULNESS, ACCURACY, OR VALIDITY OF THAT DOCUMENT.

STATE OF CALIFORNIA
COUNTY OF ORANGE } ss.

On 17 JUL 2019, before me, ELISA M MULET, notary public, personally appeared Ferdyan Lesmana who 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 he~~/she/they~~ executed the same in his~~/her/their~~ authorized capacity~~(ies)~~, and that by his~~/her/their~~ signature~~(s)~~ on the instrument the person~~(s)~~, or the entity upon behalf of which the person~~(s)~~ acted, executed the instrument.

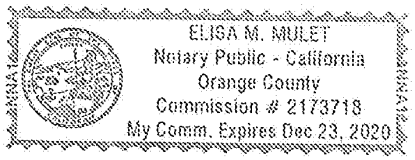
I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.



Notary Signature

[SEAL]



29717769

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Massi Joe E. Kiani

Declaration

This Declaration is directed to U.S. or International Application No. **16/212537**, filed December 6, 2018 and incorporating any amendments made thereto prior to the signature date of this Declaration.

As a named inventor, I declare that:

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 USC 1001 by fine or imprisonment of not more than five (5) years, or both.

I have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

Confirmation of Assignment from Inventors

WHEREAS, **above-identified inventors** (individual(s) hereinafter "ASSIGNOR") invented certain new and useful improvements, technology, inventions, developments, ideas, ornamental designs, or discoveries, and hereby assign as the ASSIGNOR may possess or are under an obligation to assign to the below identified Assignee the above-titled application (collectively hereinafter referred to as the "Work") for which an application for Letters Patent in the United States (identified above) has been prepared for filing with the United States Patent and Trademark Office (hereinafter the "Application").

AND WHEREAS, **Masimo Corporation,** with its principal place of business at 52 Discovery, Irvine, CA 92618 (hereinafter the "ASSIGNEE"), desires to acquire the entire right, title, and interest in and to the Application and the Work.

NOW, THEREFORE, for good and valuable consideration of which receipt is hereby acknowledged, ASSIGNOR hereby acknowledges and confirms that ASSIGNOR has sold, assigned, transferred and set over, and by these presents, to the extent not previously assigned, does hereby sell, assign, transfer and set over, unto said ASSIGNEE, its successors, legal representatives and assigns, the entire right, title, and interest throughout the world in the Application and the Work, including all Patent Properties filed or issued upon the Application and the Work; where "Patent Properties" include, but are not limited to:

all provisional applications relating thereto;

all nonprovisional applications claiming priority to aforementioned provisional(s) and/or the present Application, including, all divisions, continuations, continuations-in-part, reissues, and reexaminations thereof;

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 any related Letters Patent which may hereafter be granted or filed in any country or countries foreign to the United States, all extensions, renewals and reissues thereof.

ASSIGNOR hereby acknowledges the ASSIGNEE as the Applicant for all aforementioned Patent Properties, and authorizes and requests 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 related Letters Patent to the ASSIGNEE, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

AND ASSIGNOR DOES HEREBY sell, assign, transfer, and convey to ASSIGNEE, its successors, legal representatives, and assigns all claims for damages and all remedies arising out of any violation of the rights assigned hereby that may have accrued prior to the date of assignment to ASSIGNEE, or may accrue hereafter, including, but not limited to, the right to sue for, collect, and retain damages for past infringements of said Letters Patent before or after issuance.

AND ASSIGNOR DOES HEREBY covenant and agree that ASSIGNOR will communicate to said ASSIGNEE, its successors, legal representatives and assigns, any facts known to ASSIGNOR respecting the Work, and testify in any legal proceeding, assist in the preparation of any other Patent Property relating to the Application and the Work or any improvements made thereto, sign/execute all lawful papers, authorize the filing of and execute and make all rightful oaths and/or declarations in connection with the Application and the Work including any improvements made thereto, any patent applications filed therefrom, and any continuing application filed from any of the aforementioned applications, and generally do everything possible to aid the ASSIGNEE, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for the Work in all countries.

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: MASCER.002C4

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Massi Joe E. Kiani

Legal Name of inventor: Massi Joe E. Kiani

IN TESTIMONY WHEREOF, I hereunto set my hand and seal this 5th day of August, 20 19.

Signature: _____

A NOTARY PUBLIC OR OTHER OFFICER COMPLETING THIS CERTIFICATE VERIFIES ONLY THE IDENTITY OF THE INDIVIDUAL WHO SIGNED THE DOCUMENT TO WHICH THIS CERTIFICATE IS ATTACHED, AND NOT THE TRUTHFULNESS, ACCURACY, OR VALIDITY OF THAT DOCUMENT.

STATE OF CALIFORNIA

COUNTY OF ORANGE } ss.

On AUG 5 2019, before me, ELISA M. MULET, notary public, personally appeared Massi Joe E. Kiani who 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 he/~~she/they~~ executed the same in his/~~her/their~~ authorized capacity(ies), and that by his/~~her/their~~ signature(~~s~~) on the instrument the person(~~s~~), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Notary Signature

[SEAL]

ELISA M. MULET
Notary Public - California
Orange County
Commission # 2173718
My Comm. Expires Dec 23, 2020

29717777

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Greg Olsen

Declaration

This Declaration is directed to U.S. or International Application No. **16/212537**, filed December 6, 2018 and incorporating any amendments made thereto prior to the signature date of this Declaration.

As a named inventor, I declare that:

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 USC 1001 by fine or imprisonment of not more than five (5) years, or both.

I have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

Confirmation of Assignment from Inventors

WHEREAS, **above-identified inventors** (individual(s) hereinafter "ASSIGNOR") invented certain new and useful improvements, technology, inventions, developments, ideas, ornamental designs, or discoveries, and hereby assign as the ASSIGNOR may possess or are under an obligation to assign to the below identified Assignee the above-titled application (collectively hereinafter referred to as the "Work") for which an application for Letters Patent in the United States (identified above) has been prepared for filing with the United States Patent and Trademark Office (hereinafter the "Application").

AND WHEREAS, **Cercacor Laboratories, Inc.,** with its principal place of business at 40 Parker, Irvine, CA 92618 (hereinafter the "ASSIGNEE"), desires to acquire the entire right, title, and interest in and to the Application and the Work.

NOW, THEREFORE, for good and valuable consideration of which receipt is hereby acknowledged, ASSIGNOR hereby acknowledges and confirms that ASSIGNOR has sold, assigned, transferred and set over, and by these presents, to the extent not previously assigned, does hereby sell, assign, transfer and set over, unto said ASSIGNEE, its successors, legal representatives and assigns, the entire right, title, and interest throughout the world in the Application and the Work, including all Patent Properties filed or issued upon the Application and the Work; where "Patent Properties" include, but are not limited to:

all provisional applications relating thereto;

all nonprovisional applications claiming priority to aforementioned provisional(s) and/or the present Application, including, all divisions, continuations, continuations-in-part, reissues, and reexaminations thereof;

all Letters Patent of the United States which may be granted thereon and all reissues and extensions thereof; and

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ASSIGNOR hereby acknowledges the ASSIGNEE as the Applicant for all aforementioned Patent Properties, and authorizes and requests 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 related Letters Patent to the ASSIGNEE, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

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AND ASSIGNOR DOES HEREBY covenant and agree that ASSIGNOR will communicate to said ASSIGNEE, its successors, legal representatives and assigns, any facts known to ASSIGNOR respecting the Work, and testify in any legal proceeding, assist in the preparation of any other Patent Property relating to the Application and the Work or any improvements made thereto, sign/execute all lawful papers, authorize the filing of and execute and make all rightful oaths and/or declarations in connection with the Application and the Work including any improvements made thereto, any patent applications filed therefrom, and any continuing application filed from any of the aforementioned applications, and generally do everything possible to aid the ASSIGNEE, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for the Work in all countries.

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: MASCER.002C4 Page 3 of 3

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Inventors: Greg Olsen

Legal Name of inventor: Greg Olsen

IN TESTIMONY WHEREOF, I hereunto set my hand and seal this 25 day of JAN, 20 19.

Signature: _____

A NOTARY PUBLIC OR OTHER OFFICER COMPLETING THIS CERTIFICATE VERIFIES ONLY THE IDENTITY OF THE INDIVIDUAL WHO SIGNED THE DOCUMENT TO WHICH THIS CERTIFICATE IS ATTACHED, AND NOT THE TRUTHFULNESS, ACCURACY, OR VALIDITY OF THAT DOCUMENT.

STATE OF CALIFORNIA }
} ss.
COUNTY OF ORANGE }

On 25 JAN 2019, before me, ELISA M. MULET, notary public, personally appeared Greg Olsen who 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 he/~~she/they~~ executed the same in his/~~her/their~~ authorized capacity~~(ies)~~, and that by his/~~her/their~~ signature~~(s)~~ on the instrument the person~~(s)~~, or the entity upon behalf of which the person~~(s)~~ acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Notary Signature

[SEAL]

ELISA M. MULET
Notary Public - California
Orange County
Commission # 2173718
My Comm. Expires Dec 23, 2020

29717154

Doc code: Oath
Document Description: Oath or declaration filed

MASCER.002C4

PTO/AIA/02 (07-13)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

SUBSTITUTE STATEMENT IN LIEU OF AN OATH OR DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (35 U.S.C. 115(d) AND 37 CFR 1.64)

Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

This statement is directed to:

☐ The attached application,

OR

☒ United States application or PCT international application number 16/212537 filed on December 6, 2018.

LEGAL NAME of inventor to whom this substitute statement applies:

(*E.g.*, Given Name (first and middle (if any)) and Family Name or Surname)

Marcelo Lamego

Residence (except for a deceased or legally incapacitated inventor):

City	State	Country
Cupertino	CA	US

Mailing Address (except for a deceased or legally incapacitated inventor):

10292 Orange Avenue

City	State	Zip	Country
Cupertino	CA	95014	US

I believe the above-named inventor or joint inventor to be the original inventor or an original joint inventor of a claimed invention in the application.

The above-identified application was made or authorized to be made by me.

I hereby acknowledge that any willful false statement made in this statement is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

Relationship to the inventor to whom this substitute statement applies:

- ☐ Legal Representative (for deceased or legally incapacitated inventor only),
- ☒ Assignee,
- ☐ Person to whom the inventor is under an obligation to assign,
- ☐ Person who otherwise shows a sufficient proprietary interest in the matter (petition under 37 CFR 1.46 is required), or
- ☐ Joint Inventor.

PTO/SB/AIA02 (07-13)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

SUBSTITUTE STATEMENT

Circumstances permitting execution of this substitute statement:

- ☐ Inventor is deceased,
- ☐ Inventor is under legal incapacity,
- ☐ Inventor cannot be found or reached after diligent effort, or
- ■ Inventor has refused to execute the oath or declaration under 37 CFR 1.63.

If there are joint inventors, please check the appropriate box below:

- ■ An application data sheet under 37 CFR 1.76 (PTO/AIA/14 or equivalent) naming the entire inventive entity has been or is currently submitted.

OR

- ☐ An application data sheet under 37 CFR 1.76 (PTO/AIA/14 or equivalent) has not been submitted. Thus, a Substitute Statement Supplemental Sheet (PTO/AIA/11 or equivalent) naming the entire inventive entity and providing inventor information is attached. See 37 CFR 1.64(b).

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

PERSON EXECUTING THIS SUBSTITUTE STATEMENT:

Name: Thomas McClenahan | Date (Optional):

Signature:

APPLICANT NAME AND TITLE OF PERSON EXECUTING THIS SUBSTITUTE STATEMENT:

If the applicant is a juristic entity, list the applicant name and the title of the signer:

Applicant Name: Masimo Corporation

Title of Person Executing This Substitute Statement: Executive Vice President and General Counsel

The signer, whose title is supplied above, is authorized to act on behalf of the applicant.

Residence of the signer (unless provided in an application data sheet, PTO/AIA/14 or equivalent):

City Irvine | State CA | Country US

Mailing Address of the signer (unless provided in an application data sheet, PTO/AIA/14 or equivalent)

52 Discovery

City Irvine | State CA | Zip 92618 | Country US

Note: Use an additional PTO/AIA/02 form for each inventor who is deceased, legally incapacitated, cannot be found or reached after diligent effort, or has refused to execute the oath or declaration under 37 CFR 1.63.

DocCode – SCORE

SCORE Placeholder Sheet for IFW Content

Application Number: 16544713 Document Date: 08/19/2019

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

- Drawing

At the time of document entry (noted above):

- USPTO employees may access SCORE content via DAV or via the SCORE web page.
- External customers may access SCORE content via PAIR using the Supplemental Content tab.

Form Revision Date: March 1, 2019

References for Examiner Consideration

Applicant wishes to draw the Examiner's attention to, and encourages the Examiner to review, the following co-owned patents and/or applications and their existing and ongoing prosecution history, including without limitation Office Actions, Amendments, Remarks, and any other potentially relevant documents:

Docket No.	Patent No.	Title	Issued
MASCER.002C1	9,277,880	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	03/08/2016
MASCER.002C2	10,335,068	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	07/02/2019
MASCER.002C3	10,258,265	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	04/16/2019
MASCER.002C4	10,258,266	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	04/16/2019
MASCER.002C5	10,299,708	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	05/28/2019
MASCER.002C6	10,292,628	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	05/21/2019
MASCER.002C7	10,376,190	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/13/2019
MASCER.002C8	10,376,191	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/13/2019
MASCER.003A	8,630,691	MULTI-STREAM SENSOR FRONT ENDS FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	01/14/2014
MASCER.003D1	8,909,310	MULTI-STREAM SENSOR FRONT ENDS FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	12/09/2014
MASCER.004A	8,203,704	MULTI-STREAM SENSOR FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	06/19/2012
MASCER.004C1	8,570,503	HEAT SINK FOR NONINVASIVE MEDICAL SENSOR	10/29/2013
CERCA.005A	8,515,509	MULTI-STREAM EMITTER FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/20/2013
MASCER.006A	8,577,431	NOISE SHIELDING FOR A NONINVASIVE DEVICE	11/05/2013

Docket No.	Patent No.	Title	Issued
MASCER.006C1	9,717,425	NOISE SHIELDING FOR A NONINVASIVE DEVICE	08/01/2017
MASCER.007A	8,437,825	CONTOURED PROTRUSION FOR IMPROVING SPECTROSCOPIC MEASUREMENT OF BLOOD CONSTITUENTS	05/07/2013
MASCER.007C1	9,591,975	CONTOURED PROTRUSION FOR IMPROVING SPECTROSCOPIC MEASUREMENT OF BLOOD CONSTITUENTS	03/14/2017
MASCER.008A	8,688,183	EMITTER DRIVER FOR NONINVASIVE PATIENT MONITOR	04/01/2014
MASCER.008C1	9,186,102	EMITTER DRIVER FOR NONINVASIVE PATIENT MONITOR	11/17/2015
MASCER.008C2	9,668,680	EMITTER DRIVER FOR NONINVASIVE PATIENT MONITOR	06/06/2017
MASCER.009DA	D621516	PATIENT MONITORING SENSOR	08/10/2010
MASCER.010DA	D606659	PATIENT MONITOR	12/22/2009

Docket No.	Serial No.	Title	Filed
MASCER.002A	12/534827	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/03/2009
MASCER.002C9	16/449143	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	06/21/2019
MASCER.002C10	16/534956	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/07/2019
MASCER.002C11	16/534949	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/07/2019
MASCER.002C12	16/541987	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/15/2019
MASCER.002C14	16/544755	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/19/2019
MASCER.004C3	14/064055	MULTI-STREAM SENSOR FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	10/25/2013
MASCER.006C2	15/660743	NOISE SHIELDING FOR A NONINVASIVE DEVICE	07/26/2017
MASCER.011A	12/497506	HEAT SINK FOR NONINVASIVE MEDICAL SENSOR	07/02/2009
MAS.1007A	15/195199	ADVANCED PULSE OXIMETRY SENSOR	06/28/2016
MAS.1007C1	16/226249	ADVANCED PULSE OXIMETRY SENSOR	12/19/2018
MAS.1007C2	16/532061	ADVANCED PULSE OXIMETRY SENSOR	08/05/2019

Docket No.	Serial No.	Title	Filed
MAS.1007C3	16/532065	ADVANCED PULSE OXIMETRY SENSOR	08/05/2019

Applicant notes that cited references, office actions, responses and notices of allowance currently exist or will exist with reference to the above-referenced matters. Applicant also understands that the Examiner has access to sophisticated online Patent Office computing systems that provide ready access to the full file histories of these matters including, for example, specifications, drawings, pending claims, cited art, office actions, responses, declarations, and notices of allowance. Rather than submit copies of these file histories, Applicant respectfully requests that the Examiner continue to review these file histories online for past, current, and future information about these matters that may be relevant to examination of the present application. Also, if the Examiner cannot readily access these file histories, Applicant would be pleased to provide any portion of any of the file histories at any time upon specific Examiner request.

No Disclaimers

To the extent that anything in the Information Disclosure Statement or the listed references could be construed as a disclaimer of any subject matter supported by the present application, Applicant hereby rescinds and retracts such disclaimer.

Timing of Disclosure

This Information Disclosure Statement is being filed within three months of the filing date or date of national phase entry, and no fee is believed to be required.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: August 23, 2019

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
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SHEET 1 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	3,910,701	10-07-1975	Henderson et al.	
	2	4,114,604	09-19-1978	Shaw et al.	
	3	4,258,719	03-31-1981	Lewyn	
	4	4,267,844	05-19-1981	Yamanishi	
	5	4,438,338	03-20-1984	Stitt	
	6	4,444,471	04-24-1984	Ford et al.	
	7	4,653,498	03-31-1987	New, Jr. et al.	
	8	4,655,225	04-07-1987	Dahne et al.	
	9	4,684,245	08-04-1987	Goldring	
	10	4,709,413	11-24-1987	Forrest	
	11	4,755,676	07-05-1988	Gaalema et al.	
	12	4,781,195	11-01-1988	Martin	
	13	4,805,623	02-21-1989	Jöbsis	
	14	4,880,304	11-14-1989	Jaeb et al.	
	15	4,960,128	10-02-1990	Gordon et al.	
	16	4,964,408	10-23-1990	Hink et al.	
	17	5,028,787	07-02-1991	Rosenthal, et al.	
	18	5,035,243	07-30-1991	Muz, Edwin	
	19	5,041,187	08-20-1991	Hink et al.	
	20	5,043,820	08-27-1991	Wyles et al.	
	21	5,069,213	12-03-1991	Polczynski	
	22	5,069,214	12-03-1991	Samaras et al.	
	23	5,077,476	12-31-1991	Rosenthal	
	24	5,086,229	02-04-1992	Rosenthal et al.	
	25	5,099,842	03-31-1992	Mannheimer et al.	
	26	5,122,925	06-16-1992	Inpyn	
	27	5,131,391	07-21-1992	Sakai et al.	
	28	5,137,023	08-11-1992	Mendelson, et al.	
	29	5,159,929	11-03-1992	McMillen et al.	

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	30	5,163,438	11-17-1992	Gordon et al.	
	31	5,222,295	06-29-1993	Dorris, Jr.	
	32	5,222,495	06-29-1993	Clarke et al.	
	33	5,222,496	06-29-1993	Clarke et al.	
	34	5,249,576	10-05-1993	Goldberger et al.	
	35	5,250,342	10-05-1993	Lang	
	36	5,278,627	01-11-1994	Aoyagi et al.	
	37	5,297,548	03-29-1994	Pologe, Jonas A.	
	38	5,319,355	06-07-1994	Russek	
	39	5,337,744	08-16-1994	Branigan	
	40	5,337,745	08-16-1994	Benaron	
	41	5,341,805	08-30-1994	Stavridi, et al.	
	42	5,362,966	11-08-1994	Rosenthal et al.	
	43	5,377,676	01-03-1995	Vari, et al.	
	44	5,427,093	06-27-1995	Ogawa et al.	
	45	5,431,170	07-11-1995	Mathews	
	46	5,437,275	08-01-1995	Amundsen et al.	
	47	5,441,054	08-15-1995	Tsuchiya	
	48	5,452,717	09-26-1995	Branigan et al.	
	49	5,456,252	10-10-1995	Vari, et al.	
	50	5,479,934	01-02-1996	Imran	
	51	5,482,034	01-09-1996	Lewis et al.	
	52	5,482,036	01-09-1996	Diab et al.	
	53	5,490,505	02-13-1996	Diab et al.	
	54	5,490,506	02-13-1996	Takatani et al.	
	55	5,494,043	02-27-1996	O'Sullivan et al.	
	56	5,497,771	03-12-1996	Rosenheimer	
	57	5,511,546	04-30-1996	Hon	
	58	5,533,511	07-09-1996	Kaspari et al.	

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	59	5,534,851	07-09-1996	Russek	
	60	5,551,422	09-03-1996	Simonsen et al.	
	61	5,553,615	09-10-1996	Carim et al.	
	62	5,553,616	09-09-1996	Ham et al.	
	63	5,561,275	10-01-1996	Savage, et al.	
	64	5,562,002	10-08-1996	Lalin	
	65	5,584,296	12-17-1997	Cui et al.	
	66	5,590,649	01-07-1997	Caro et al.	
	67	5,601,079	02-11-1997	Wong et al.	
	68	5,602,924	02-11-1997	Durand et al.	
	69	5,623,925	04-29-1997	Swenson et al.	
	70	5,625,458	04-29-1997	Alfano et al.	
	71	5,632,272	05-27-1997	Diab et al.	
	72	5,638,816	06-17-1997	Kiani-Azarbayjany et al.	
	73	5,638,818	06-17-1997	Diab et al.	
	74	5,645,440	07-08-1997	Tobler et al.	
	75	5,676,143	10-14-1997	Simonsen, et al.	
	76	5,685,299	11-11-1997	Diab et al.	
	77	5,743,262	04-28-1998	Lepper, Jr. et al.	
	78	5,750,927	05-12-1998	Baltazar, Osni	
	79	5,752,914	05-19-1998	Delonzor et al.	
	80	5,758,644	06-02-1998	Diab et al.	
	81	5,760,910	06-02-1998	Lepper, Jr. et al.	
	82	5,766,131	06-16-1998	Kondo et al.	
	83	5,769,785	06-23-1998	Diab et al.	
	84	5,782,757	07-21-1998	Diab et al.	
	85	5,785,659	07-28-1998	Caro et al.	
	86	5,791,347	08-11-1998	Flaherty et al.	
	87	5,792,052	08-11-1998	Isaacson et al.	

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U.S. PATENT DOCUMENTS					
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	88	5,810,734	09-22-1998	Caro et al.	
	89	5,823,950	10-20-1998	Diab et al.	
	90	5,826,885	10-27-1998	Helgeland	
	91	5,830,131	11-03-1998	Caro et al.	
	92	5,830,137	11-03-1998	Scharf	
	93	5,833,618	11-10-1998	Caro et al.	
	94	5,851,178	12-22-1998	Aronow	
	95	5,860,919	01-19-1999	Kiani-Azarbayjany et al.	
	96	5,890,929	04-06-1999	Mills et al.	
	97	5,902,235	05-11-1999	Lewis et al.	
	98	5,903,357	05-11-1999	Colak	
	99	5,904,654	05-18-1999	Wohltmann et al.	
	100	5,919,134	07-06-1999	Diab	
	101	5,934,925	08-10-1999	Tobler et al.	
	102	5,940,182	08-17-1999	Lepper, Jr. et al.	
	103	5,957,840	09-28-1999	Terasawa et al.	
	104	5,987,343	11-16-1999	Kinast	
	105	5,995,855	11-30-1999	Kiani et al.	
	106	5,997,343	12-07-1999	Mills et al.	
	107	6,002,952	12-14-1999	Diab et al.	
	108	6,011,986	01-04-2000	Diab et al.	
	109	6,027,452	02-22-2000	Flaherty et al.	
	110	6,036,642	03-14-2000	Diab et al.	
	111	6,045,509	04-04-2000	Caro et al.	
	112	6,049,727	04-11-2000	Crothall, Katherine D.	
	113	6,067,462	05-23-2000	Diab et al.	
	114	6,081,735	06-27-2000	Diab et al.	
	115	6,088,607	07-11-2000	Diab et al.	
	116	6,110,522	08-29-2000	Lepper, Jr. et al.	

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U.S. PATENT DOCUMENTS					
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	117	6,124,597	09-26-2000	Shehada	
	118	6,128,521	10-03-2000	Marro et al.	
	119	6,129,675	10-10-2000	Jay	
	120	6,144,866	11-07-2000	Miesel et al.	
	121	6,144,868	11-07-2000	Parker	
	122	6,151,516	11-21-2000	Kiani-Azarbayjany et al.	
	123	6,152,754	11-28-2000	Gerhardt et al.	
	124	6,157,850	12-05-2000	Diab et al.	
	125	6,165,005	12-26-2000	Mills et al.	
	126	6,172,743	01-09-2001	Kley, et al.	
	127	6,181,958	01-30-2001	Steuer et al.	
	128	6,184,521	02-06-2001	Coffin, IV et al.	
	129	6,206,830	03-27-2001	Diab et al.	
	130	6,223,063	04-24-2001	Chaiken et al.	
	131	6,229,856	05-08-2001	Diab et al.	
	132	6,232,609	05-15-2001	Snyder, et al.	
	133	6,236,872	05-22-2001	Diab et al.	
	134	6,241,683	06-05-2001	Macklem, et al.	
	135	6,253,097	06-26-2001	Aronow et al.	
	136	6,256,523	07-03-2001	Diab et al.	
	137	6,263,222	07-17-2001	Diab et al.	
	138	6,278,522	08-21-2001	Lepper, Jr. et al.	
	139	6,278,889	08-21-2001	Robinson	
	140	6,280,213	08-28-2001	Tobler et al.	
	141	6,285,896	09-04-2001	Tobler et al.	
	142	6,301,493	10-09-2001	Marro et al.	
	143	6,308,089	10-23-2001	von der Ruhr et al.	
	144	6,317,627	11-13-2001	Ennen et al.	
	145	6,321,100	11-20-2001	Parker	

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	146	6,325,761	12-04-2001	Jay	
	147	6,334,065	12-25-2001	Al-Ali et al.	
	148	6,343,223	01-29-2002	Chin et al.	
	149	6,343,224	01-29-2002	Parker	
	150	6,345,194	02-05-2002	Robert Nelson, et al.	
	151	6,349,228	02-19-2002	Kiani et al.	
	152	6,353,750	03-05-2002	Kimura et al.	
	153	6,360,113	03-09-2002	Dettling, Allen	
	154	6,360,114	03-09-2002	Diab et al.	
	155	6,360,115	03-19-2002	Roger Greenwald, et al.	
	156	6,368,283	04-09-2002	Xu, et al.	
	157	6,371,921	04-16-2002	Caro et al.	
	158	6,377,829	04-23-2002	Al-Ali	
	159	6,388,240	05-14-2002	Schulz et al.	
	160	6,397,091	05-28-2002	Diab et al.	
	161	6,430,437	08-06-2002	Marro	
	162	6,430,525	08-06-2002	Weber et al.	
	163	6,463,311	10-08-2002	Diab	
	164	6,470,199	10-22-2002	Kopotic et al.	
	165	6,501,975	12-31-2002	Diab et al.	
	166	6,505,059	01-07-2003	Kollias, et al.	
	167	6,515,273	02-04-2003	Al-Ali	
	168	6,519,487	02-11-2003	Parker	
	169	6,522,521	02-18-2003	Mizuno et al.	
	170	6,525,386	02-25-2003	Mills et al.	
	171	6,526,300	02-25-2003	Kiani et al.	
	172	6,541,756	04-01-2003	Schulz et al.	
	173	6,542,764	04-01-2003	Al-Ali et al.	
	174	6,580,086	06-17-2003	Schulz et al.	

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	175	6,584,336	06-24-2003	Ali et al.	
	176	6,595,316	07-22-2003	Cybulski et al.	
	177	6,597,932	07-22-2003	Tian et al.	
	178	6,597,933	07-22-2003	Kiani et al.	
	179	6,606,509	08-12-2003	Schmitt, Joseph M.	
	180	6,606,511	08-12-2003	Ali et al.	
	181	6,632,181	10-14-2003	Flaherty et al.	
	182	6,636,759	10-21-2003	Robinson	
	183	6,639,668	10-28-2003	Trepagnier, Pierre	
	184	6,639,867	10-28-2003	Shim	
	185	6,640,116	10-28-2003	Diab	
	186	6,643,530	11-04-2003	Diab et al.	
	187	6,650,917	11-18-2003	Diab et al.	
	188	6,654,624	11-25-2003	Diab et al.	
	189	6,658,276	12-02-2003	Kiani et al.	
	190	6,661,161	12-09-2003	Lanzo et al.	
	191	6,668,185	12-23-2003	Toida	
	192	6,671,526	12-30-2003	Aoyagi et al.	
	193	6,671,531	12-30-2003	Al-Ali et al.	
	194	6,678,543	01-13-2004	Diab et al.	
	195	6,681,133	01-20-2004	Chaiken et al.	
	196	6,684,090	01-27-2004	Ali et al.	
	197	6,684,091	01-27-2004	Parker	
	198	6,697,656	02-24-2004	Al-Ali	
	199	6,697,657	02-24-2004	Shehada, et al.	
	200	6,697,658	02-24-2004	Al-Ali	
	201	6,699,194	03-02-2004	Diab et al.	
	202	6,714,804	03-30-2004	Al-Ali et al.	
	203	6,721,582	04-13-2004	Trepagnier, et al.	

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	204	6,721,585	04-13-2004	Parker	
	205	6,725,075	04-20-2004	Al-Ali	
	206	6,728,560	04-27-2004	Kollias, et al.	
	207	6,735,459	05-11-2004	Parker	
	208	6,745,060	06-01-2004	Diab et al.	
	209	6,748,254	06-08-2004	O'Neil et al.	
	210	6,760,607	07-06-2004	Al-Ali	
	211	6,770,028	08-03-2004	Ali et al.	
	212	6,771,994	08-03-2004	Kiani et al.	
	213	6,792,300	09-14-2004	Diab et al.	
	214	6,801,799	10-05-2004	Mendelson	
	215	6,813,511	11-02-2004	Diab et al.	
	216	6,816,010	11-09-2004	Seetharaman et al.	
	217	6,816,241	11-09-2004	Grubisic, et al.	
	218	6,816,741	11-09-2004	Diab	
	219	6,822,564	11-23-2004	Al-Ali	
	220	6,826,419	11-30-2004	Diab et al.	
	221	6,830,711	12-14-2004	Mills et al.	
	222	6,850,787	02-01-2005	Weber et al.	
	223	6,850,788	02-01-2005	Al-Ali	
	224	6,852,083	02-08-2005	Caro et al.	
	225	6,861,639	03-01-2005	Al-Ali	
	226	6,898,452	05-24-2005	Al-Ali et al.	
	227	6,912,413	06-28-2005	Rantala et al.	
	228	6,920,345	07-19-2005	Al-Ali et al.	
	229	6,931,268	08-16-2005	Kiani-Azarbayjany et al.	
	230	6,934,570	08-23-2005	Kiani et al.	
	231	6,939,305	09-06-2005	Flaherty et al.	
	232	6,943,348	09-13-2005	Coffin IV	

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Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	233	6,950,687	09-27-2005	Al-Ali	
	234	6,961,598	11-01-2005	Diab	
	235	6,970,792	11-29-2005	Diab	
	236	6,979,812	12-27-2005	Al-Ali	
	237	6,985,764	01-10-2006	Mason et al.	
	238	6,993,371	01-31-2006	Kiani et al.	
	239	6,995,400	02-07-2006	Mizuyoshi	
	240	6,996,427	02-07-2006	Ali et al.	
	241	6,999,904	02-14-2006	Weber et al.	
	242	7,003,338	02-21-2006	Weber et al.	
	243	7,003,339	02-21-2006	Diab et al.	
	244	7,015,451	03-21-2006	Dalke et al.	
	245	7,024,233	04-04-2006	Ali et al.	
	246	7,026,619	04-11-2006	Cranford	
	247	7,027,849	04-11-2006	Al-Ali	
	248	7,030,749	04-18-2006	Al-Ali	
	249	7,039,449	05-02-2006	Al-Ali	
	250	7,041,060	05-09-2006	Flaherty et al	
	251	7,044,918	05-16-2006	Diab	
	252	7,047,054	05-16-2006	Benni	
	253	7,048,687	05-23-2006	Reuss et al.	
	254	7,067,893	06-27-2006	Mills et al.	
	255	7,092,757	08-15-2006	Larson et al.	
	256	7,096,052	08-22-2006	Mason et al.	
	257	7,096,054	08-22-2006	Abdul-Hafiz et al.	
	258	7,113,815	09-26-2006	O'Neil et al.	
	259	7,132,641	11-07-2006	Schulz et al.	
	260	7,142,901	11-28-2006	Kiani et al.	
	261	7,149,561	12-12-2006	Diab	

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	262	7,186,966	03-06-2007	Al-Ali	
	263	7,190,261	03-13-2007	Al-Ali	
	264	7,215,984	05-08-2007	Diab	
	265	7,215,986	05-08-2007	Diab	
	266	7,221,971	05-22-2007	Diab	
	267	7,225,006	05-29-2007	Al-Ali et al.	
	268	7,225,007	05-29-2007	Al-Ali	
	269	7,230,227	06-12-2007	Wilcken et al.	
	270	7,239,905	07-03-2007	Kiani-Azarbayjany et al.	
	271	7,245,953	07-17-2007	Parker	
	272	7,254,429	08-07-2007	Schurman et al.	
	273	7,254,431	08-07-2007	Al-Ali	
	274	7,254,433	08-07-2007	Diab et al.	
	275	7,254,434	08-07-2007	Schulz et al.	
	276	7,272,425	09-18-2007	Al-Ali	
	277	7,274,955	09-25-2007	Kiani et al.	
	278	7,280,858	10-09-2007	Al-Ali et al.	
	279	7,289,835	10-30-2007	Mansfield et al.	
	280	7,292,883	11-06-2007	De Felice et al.	
	281	7,295,866	11-13-2007	Al-Ali	
	282	7,328,053	02-05-2008	Diab et al.	
	283	7,332,784	02-19-2008	Mills, et al.	
	284	7,340,287	03-04-2008	Mason et al.	
	285	7,341,559	03-11-2008	Schulz et al.	
	286	7,343,186	03-11-2008	Lamego et al.	
	287	7,355,512	04-08-2008	Al-Ali	
	288	7,356,365	04-08-2008	Schurman	
	289	7,365,923	04-29-2008	Hargis et al.	
	290	7,371,981	05-13-2008	Abdul-Hafiz	

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	291	7,373,193	05-13-2008	Al-Ali et al.	
	292	7,373,194	05-13-2008	Weber et al.	
	293	7,376,453	05-20-2008	Diab et al.	
	294	7,377,794	05-27-2008	Al Ali et al.	
	295	7,377,899	05-27-2008	Weber et al.	
	296	7,383,070	06-03-2008	Diab et al.	
	297	7,395,189	07-01-2008	Qing et al.	
	298	7,415,297	08-19-2008	Al-Ali et al.	
	299	7,428,432	09-23-2008	Ali et al.	
	300	7,438,683	10-21-2008	Al-Ali et al.	
	301	7,440,787	10-21-2008	Diab	
	302	7,454,240	11-18-2008	Diab et al.	
	303	7,467,002	12-16-2008	Weber et al.	
	304	7,469,157	12-23-2008	Diab et al.	
	305	7,471,969	12-30-2008	Diab et al.	
	306	7,471,971	12-30-2008	Diab et al.	
	307	7,483,729	01-27-2009	Al-Ali et al.	
	308	7,483,730	01-27-2009	Diab et al.	
	309	7,489,958	02-10-2009	Diab et al.	
	310	7,496,391	02-24-2009	Diab et al.	
	311	7,496,393	02-24-2009	Diab et al.	
	312	7,499,741	03-03-2009	Diab et al.	
	313	7,499,835	03-03-2009	Weber et al.	
	314	7,500,950	03-10-2009	Al-Ali et al.	
	315	7,509,153	03-24-2009	Blank et al.	
	316	7,509,154	03-24-2009	Diab et al.	
	317	7,509,494	03-24-2009	Al-Ali	
	318	7,510,849	03-31-2009	Schurman et al.	
	319	7,519,327	04-14-2009	White	

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	320	7,526,328	04-28-2009	Diab et al.	
	321	7,530,942	05-12-2009	Diab	
	322	7,530,949	05-12-2009	Al Ali et al.	
	323	7,530,955	05-12-2009	Diab et al.	
	324	7,563,110	07-21-2009	Al-Ali et al.	
	325	7,596,398	09-29-2009	Al-Ali et al.	
	326	7,601,123	10-13-2009	Tweed, et al.	
	327	7,606,606	10-20-2009	Laakkonen	
	328	7,618,375	11-17-2009	Flaherty	
	329	7,647,083	01-12-2010	Al-Ali et al.	
	330	7,657,294	02-02-2010	Eghbal et al.	
	331	7,657,295	02-02-2010	Coakley et al.	
	332	7,657,296	02-02-2010	Raridan et al.	
	333	7,726,209	06-01-2010	Ruotoistenmäki	
	334	7,729,733	06-01-2010	Al-Ali et al.	
	335	7,734,320	06-08-2010	Al-Ali	
	336	7,761,127	07-20-2010	Al-Ali et al.	
	337	7,761,128	07-20-2010	Al-Ali et al.	
	338	7,764,982	07-27-2010	Dalke et al.	
	339	7,791,155	09-07-2010	Diab	
	340	7,801,581	09-21-2010	Diab	
	341	7,809,418	10-05-2010	Xu	
	342	7,822,452	10-26-2010	Schurman et al.	
	343	7,844,313	11-30-2010	Kiani et al.	
	344	7,844,314	11-30-2010	Al-Ali	
	345	7,844,315	11-30-2010	Al-Ali	
	346	7,862,523	01-04-2011	Ruotoistenmaki	
	347	7,865,222	01-04-2011	Weber et al.	
	348	7,873,497	01-18-2011	Weber et al.	

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	349	7,880,606	02-01-2011	Al-Ali	
	350	7,880,626	02-01-2011	Al-Ali et al.	
	351	7,891,355	02-22-2011	Al-Ali et al.	
	352	7,894,868	02-22-2011	Al-Ali et al.	
	353	7,899,506	03-01-2011	Xu et al.	
	354	7,899,507	03-01-2011	Al-Ali et al.	
	355	7,899,518	03-01-2011	Trepagnier et al.	
	356	7,904,132	03-08-2011	Weber et al.	
	357	7,909,772	03-22-2011	Popov et al.	
	358	7,910,875	03-22-2011	Al-Ali	
	359	7,919,713	04-05-2011	Al-Ali et al.	
	360	7,937,128	05-03-2011	Al-Ali	
	361	7,937,129	05-03-2011	Mason et al.	
	362	7,937,130	05-03-2011	Diab et al.	
	363	7,941,199	05-10-2011	Kiani	
	364	7,951,086	05-31-2011	Flaherty et al.	
	365	7,957,780	06-07-2011	Lamego et al.	
	366	7,962,188	06-14-2011	Kiani et al.	
	367	7,962,190	06-14-2011	Diab et al.	
	368	7,976,472	07-12-2011	Kiani	
	369	7,988,637	08-02-2011	Diab	
	370	7,990,382	08-02-2011	Kiani	
	371	7,991,446	08-02-2011	Ali et al.	
	372	8,000,761	08-16-2011	Al-Ali	
	373	8,008,088	08-08-2011	Bellott et al.	
	374	8,019,400	09-13-2011	Diab et al.	
	375	8,028,701	10-04-2011	Al-Ali et al.	
	376	8,029,765	10-04-2011	Bellott et al.	
	377	8,036,727	10-11-2011	Schurman et al.	

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	378	8,036,728	10-11-2011	Diab et al.	
	379	8,044,998	10-25-2011	Heenan	
	380	8,046,040	10-25-2011	Ali et al.	
	381	8,046,041	10-25-2011	Diab et al.	
	382	8,046,042	10-25-2011	Diab et al.	
	383	8,048,040	11-01-2011	Kiani	
	384	8,050,728	11-01-2011	Al-Ali et al.	
	385	8,118,620	02-21-2012	Al-Ali et al.	
	386	8,126,528	02-28-2012	Diab et al.	
	387	8,126,531	02-28-2012	Crowley	
	388	8,128,572	03-06-2012	Diab et al.	
	389	8,130,105	03-06-2012	Al-Ali et al.	
	390	8,145,287	03-27-2012	Diab et al.	
	391	8,150,487	04-03-2012	Diab et al.	
	392	8,175,672	05-08-2012	Parker	
	393	8,180,420	05-15-2012	Diab et al.	
	394	8,182,443	05-22-2012	Kiani	
	395	8,185,180	05-22-2012	Diab et al.	
	396	8,190,223	05-29-2012	Al-Ali et al.	
	397	8,190,227	05-29-2012	Diab et al.	
	398	8,203,438	06-19-2012	Kiani et al.	
	399	8,203,704	06-19-2012	Merritt et al.	
	400	8,204,566	06-19-2012	Schurman et al.	
	401	8,219,172	07-10-2012	Schurman et al.	
	402	8,219,170	07-10-2012	Hausmann et al.	
	403	8,224,411	07-17-2012	Al-Ali et al.	
	404	8,228,181	07-24-2012	Al-Ali	
	405	8,229,532	07-24-2012	Davis	
	406	8,229,533	07-24-2012	Diab et al.	

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	407	8,233,955	07-31-2012	Al-Ali et al.	
	408	8,244,325	08-14-2012	Al-Ali et al.	
	409	8,255,026	08-28-2012	Al-Ali	
	410	8,255,027	08-28-2012	Al-Ali et al.	
	411	8,255,028	08-28-2012	Al-Ali et al.	
	412	8,260,577	09-04-2012	Weber et al.	
	413	8,265,723	09-11-2012	McHale et al.	
	414	8,274,360	09-25-2012	Sampath et al.	
	415	8,280,473	10-02-2012	Al-Ali	
	416	8,289,130	10-16-2012	Nakajima et al.	
	417	8,301,217	10-30-2012	Al-Ali et al.	
	418	8,306,596	11-06-2012	Schurman et al.	
	419	8,310,336	11-13-2012	Muhsin et al.	
	420	8,315,683	11-20-2012	Al-Ali et al.	
	421	8,332,006	12-11-2012	Naganuma et al.	
	422	8,337,403	12-25-2012	Al-Ali et al.	
	423	8,346,330	01-01-2013	Lamego	
	424	8,353,842	01-15-2013	Al-Ali et al.	
	425	8,355,766	01-15-2013	MacNeish, III et al.	
	426	8,359,080	01-22-2013	Diab et al.	
	427	8,364,223	01-29-2013	Al-Ali et al.	
	428	8,364,226	01-29-2013	Diab et al.	
	429	8,364,389	01-29-2013	Dorogusker et al.	
	430	8,374,665	02-12-2013	Lamego	
	431	8,380,272	02-19-2013	Barrett et al.	
	432	8,385,995	02-26-2013	Al-ali et al.	
	433	8,385,996	02-26-2013	Smith et al.	
	434	8,388,353	03-05-2013	Kiani et al.	
	435	8,399,822	03-19-2013	Al-Ali	

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	436	8,401,602	03-19-2013	Kiani	
	437	8,405,608	03-26-2013	Al-Ali et al.	
	438	8,414,499	04-09-2013	Al-Ali et al.	
	439	8,418,524	04-16-2013	Al-Ali	
	440	8,421,022	04-16-2013	Rozenfeld	
	441	8,423,106	04-16-2013	Lamego et al.	
	442	8,428,674	04-23-2013	Duffy et al.	
	443	8,428,967	04-23-2013	Olsen et al.	
	444	8,430,817	04-30-2013	Al-Ali et al.	
	445	8,437,825	05-07-2013	Dalvi et al.	
	446	8,452,364	05-28-2013	Hannula et al.	
	447	8,455,290	06-04-2013	Siskavich	
	448	8,457,703	06-04-2013	Al-Ali	
	449	8,457,707	06-04-2013	Kiani	
	450	8,463,349	06-11-2013	Diab et al.	
	451	8,466,286	06-18-2013	Bellot et al.	
	452	8,471,713	06-25-2013	Poeze et al.	
	453	8,473,020	06-25-2013	Kiani et al.	
	454	8,483,787	07-09-2013	Al-Ali et al.	
	455	8,489,364	07-16-2013	Weber et al.	
	456	8,498,684	07-30-2013	Weber et al.	
	457	8,504,128	08-06-2013	Blank et al.	
	458	8,509,867	08-13-2013	Workman et al.	
	459	8,515,509	08-20-2013	Bruinsma et al.	
	460	8,523,781	09-03-2013	Al-Ali	
	461	8,529,301	09-10-2013	Al-Ali et al.	
	462	8,532,727	09-10-2013	Ali et al.	
	463	8,532,728	09-10-2013	Diab et al.	
	464	8,547,209	10-01-2013	Kiani et al.	

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	465	8,548,548	10-01-2013	Al-Ali	
	466	8,548,549	10-01-2013	Schurman et al.	
	467	8,548,550	10-01-2013	Al-Ali et al.	
	468	8,560,032	10-15-2013	Al-Ali et al.	
	469	8,560,034	10-15-2013	Diab et al.	
	470	8,570,167	10-29-2013	Al-Ali	
	471	8,570,503	10-29-2013	Hung Vo	
	472	8,571,617	10-29-2013	Reichgott et al.	
	473	8,571,618	10-29-2013	Lamego et al.	
	474	8,571,619	10-29-2013	Al-Ali et al.	
	475	8,577,431	11-05-2013	Lamego et al.	
	476	8,581,732	11-12-2013	Al-Ali et al.	
	477	8,584,345	11-19-2013	Al-Ali et al.	
	478	8,588,880	11-19-2013	Abdul-Hafiz et al.	
	479	8,600,467	12-03-2013	Al-Ali et al.	
	480	8,602,971	12-10-2013	Farr	
	481	8,606,342	12-10-2013	Diab	
	482	8,615,290	12-24-2013	Lin et al.	
	483	8,626,255	01-07-2014	Al-Ali et al.	
	484	8,630,691	01-14-2014	Lamego et al.	
	485	8,634,889	01-21-2014	Al-Ali et al.	
	486	8,641,631	02-04-2014	Sierra et al.	
	487	8,652,060	02-18-2014	Al-Ali	
	488	8,655,004	02-18-2014	Prest et al.	
	489	8,663,107	03-04-2014	Kiani	
	490	8,666,468	03-04-2014	Al-Ali	
	491	8,667,967	03-11-2014	Al-Ali et al.	
	492	8,670,811	03-11-2014	O'Reilly	
	493	8,670,814	03-11-2014	Diab et al.	

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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	494	8,676,286	03-18-2014	Weber et al.	
	495	8,682,407	03-25-2014	Al-Ali	
	496	8,688,183	04-01-2014	Bruinsma et al.	
	497	8,690,799	04-08-2014	Telfort et al.	
	498	8,700,111	04-15-2014	LeBoeuf et al.	
	499	8,700,112	04-15-2014	Kiani	
	500	8,702,627	04-22-2014	Telfort et al.	
	501	8,706,179	04-22-2014	Parker	
	502	8,712,494	04-29-2014	MacNeish, III et al.	
	503	8,715,206	05-06-2014	Telfort et al.	
	504	8,718,735	05-06-2014	Lamego et al.	
	505	8,718,737	05-06-2014	Diab et al.	
	506	8,718,738	05-01-2014	Blank et al.	
	507	8,720,249	05-13-2014	Al-Ali	
	508	8,721,541	05-13-2014	Al-Ali et al.	
	509	8,721,542	05-13-2014	Al-Ali et al.	
	510	8,723,677	05-13-2014	Kiani	
	511	8,740,792	06-03-2014	Kiani et al.	
	512	8,754,776	06-17-2014	Poeze et al.	
	513	8,755,535	06-17-2014	Telfort et al.	
	514	8,755,856	06-17-2014	Diab et al.	
	515	8,755,872	06-17-2014	Marinow	
	516	8,760,517	06-24-2014	Sarwar et al.	
	517	8,761,850	06-24-2014	Lamego	
	518	8,764,671	07-01-2014	Kiani	
	519	8,768,423	07-01-2014	Shakespeare et al.	
	520	8,771,204	07-08-2014	Telfort et al.	
	521	8,777,634	07-15-2014	Kiani et al.	
	522	8,781,543	07-15-2014	Diab et al.	

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	523	8,781,544	07-15-2014	Al-Ali et al.	
	524	8,781,549	07-15-2014	Al-Ali et al.	
	525	8,788,003	07-22-2014	Schurman et al.	
	526	8,790,268	07-29-2014	Al-Ali	
	527	8,801,613	08-12-2014	Al-Ali et al.	
	528	8,821,397	09-02-2014	Al-Ali et al.	
	529	8,821,415	09-02-2014	Al-Ali et al.	
	530	8,830,449	09-09-2014	Lamego et al.	
	531	8,831,700	09-09-2014	Schurman et al.	
	532	8,840,549	09-23-2014	Al-Ali et al.	
	533	8,845,543	09-30-2014	Diab et al.	
	534	8,847,740	09-30-2014	Kiani et al.	
	535	8,849,365	09-30-2014	Smith et al.	
	536	8,852,094	10-07-2014	Al-Ali et al.	
	537	8,852,994	10-07-2014	Wojtczuk et al.	
	538	8,868,147	10-21-2014	Stippick et al.	
	539	8,868,150	10-21-2014	Al-Ali et al.	
	540	8,870,792	10-28-2014	Al-Ali et al.	
	541	8,886,271	11-11-2014	Kiani et al.	
	542	8,888,539	11-18-2014	Al-Ali et al.	
	543	8,888,708	11-18-2014	Diab et al.	
	544	8,892,180	11-18-2014	Weber et al.	
	545	8,897,847	11-25-2014	Al-Ali	
	546	8,909,310	12-09-2014	Lamego et al.	
	547	8,911,377	12-16-2014	Al-Ali	
	548	8,912,909	12-16-2014	Al-Ali et al.	
	549	8,920,317	12-30-2014	Al-Ali et al.	
	550	8,921,699	12-30-2014	Al-Ali et al	
	551	8,922,382	12-30-2014	Al-Ali et al.	

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	552	8,929,964	01-06-2015	Al-Ali et al.	
	553	8,942,777	01-27-2015	Diab et al.	
	554	8,948,834	02-03-2015	Diab et al.	
	555	8,948,835	02-03-2015	Diab	
	556	8,965,471	02-24-2015	Lamego	
	557	8,983,564	03-17-2015	Al-Ali	
	558	8,989,831	03-24-2015	Al-Ali et al.	
	559	8,996,085	03-31-2015	Kiani et al.	
	560	8,998,809	04-07-2015	Kiani	
	561	9,028,429	05-12-2015	Telfort et al.	
	562	9,037,207	05-19-2015	Al-Ali et al.	
	563	9,060,721	06-23-2015	Reichgott et al.	
	564	9,066,666	06-30-2015	Kiani	
	565	9,066,680	06-30-2015	Al-Ali et al.	
	566	9,072,437	07-07-2015	Paalasmaa	
	567	9,072,474	07-07-2015	Al-Ali et al.	
	568	9,078,560	07-14-2015	Schurman et al.	
	569	9,081,889	07-14-2015	Ingrassia, Jr. et al.	
	570	9,084,569	07-21-2015	Weber et al.	
	571	9,095,316	08-04-2015	Welch et al.	
	572	9,106,038	08-11-2015	Telfort et al.	
	573	9,107,625	08-18-2015	Telfort et al.	
	574	9,107,626	08-18-2015	Al-Ali et al.	
	575	9,113,831	08-25-2015	Al-Ali	
	576	9,113,832	08-25-2015	Al-Ali	
	577	9,119,595	09-01-2015	Lamego	
	578	9,131,881	09-15-2015	Diab et al.	
	579	9,131,882	09-15-2015	Al-Ali et al.	
	580	9,131,883	09-15-2015	Al-Ali	

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	581	9,131,917	09-15-2015	Telfort et al.	
	582	9,138,180	09-22-2015	Coverston et al.	
	583	9,138,182	09-22-2015	Al-Ali et al.	
	584	9,138,192	09-22-2015	Weber et al.	
	585	9,142,117	09-22-2015	Muhsin et al.	
	586	9,153,112	10-06-2015	Kiani et al.	
	587	9,153,121	10-06-2015	Kiani et al.	
	588	9,161,696	10-20-2015	Al-Ali et al.	
	589	9,161,713	10-20-2015	Al-Ali et al.	
	590	9,167,995	10-27-2015	Lamego et al.	
	591	9,176,141	11-03-2015	Al-Ali et al.	
	592	9,186,102	11-17-2015	Bruinsma et al.	
	593	9,192,312	11-24-2015	Al-Ali	
	594	9,192,329	11-24-2015	Al-Ali	
	595	9,192,351	11-24-2015	Telfort et al.	
	596	9,195,385	11-24-2015	Al-Ali et al.	
	597	9,210,566	12-08-2015	Ziemianska et al.	
	598	9,211,072	12-15-2015	Kiani	
	599	9,211,095	12-15-2015	Al-Ali	
	600	9,218,454	12-22-2015	Kiani et al.	
	601	9,226,696	01-05-2016	Kiani	
	602	9,241,662	01-26-2016	Al-Ali et al.	
	603	9,245,668	01-26-2016	Vo et al.	
	604	9,259,185	02-16-2016	Abdul-Hafiz et al.	
	605	9,267,572	02-23-2016	Barker et al.	
	606	9,277,880	03-08-2016	Poeze et al.	
	607	9,289,167	03-22-2016	Diab et al.	
	608	9,295,421	03-29-2016	Kiani et al.	
	609	9,307,928	04-12-2016	Al-Ali et al.	

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	610	9,311,382	04-12-2016	Varoglu et al.	
	611	9,323,894	04-26-2016	Kiani	
	612	9,326,712	05-03-2016	Kiani	
	613	9,333,316	05-10-2016	Kiani	
	614	9,339,220	05-17-2016	Lamego et al.	
	615	9,341,565	05-17-2016	Lamego et al.	
	616	9,351,673	05-31-2016	Diab et al.	
	617	9,351,675	05-31-2016	Al-Ali et al.	
	618	9,357,665	05-31-2016	Myers et al.	
	619	9,364,181	06-14-2016	Kiani et al.	
	620	9,368,671	06-14-2016	Wojtczuk et al.	
	621	9,370,325	06-21-2016	Al-Ali et al.	
	622	9,370,326	06-21-2016	McHale et al.	
	623	9,370,335	06-21-2016	Al-ali et al.	
	624	9,375,185	06-28-2016	Ali et al.	
	625	9,386,953	07-12-2016	Al-Ali	
	626	9,386,961	07-12-2016	Al-Ali et al.	
	627	9,392,945	07-19-2016	Al-Ali et al.	
	628	9,397,448	07-19-2016	Al-Ali et al.	
	629	9,408,542	08-09-2016	Kinast et al.	
	630	9,436,645	09-06-2016	Al-Ali et al.	
	631	9,466,919	10-11-2016	Kiani et al.	
	632	9,445,759	09-20-2016	Lamego et al.	
	633	9,474,474	10-25-2016	Lamego et al.	
	634	9,480,422	11-01-2016	Al-Ali	
	635	9,480,435	11-01-2016	Olsen	
	636	9,489,081	11-08-2016	Anzures et al.	
	637	9,492,110	11-15-2016	Al-Ali et al.	
	638	9,497,534	11-15-2016	Prest et al.	

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	639	9,510,779	12-06-2016	Poeze et al.	
	640	9,517,024	12-13-2016	Kiani et al.	
	641	9,526,430	12-27-2016	Srinivas et al.	
	642	9,532,722	01-03-2017	Lamego et al.	
	643	9,538,949	01-10-2017	Al-Ali et al.	
	644	9,538,980	01-10-2017	Telfort et al.	
	645	9,549,696	01-24-2017	Lamego et al.	
	646	9,553,625	01-24-2017	Hatanaka et al.	
	647	9,554,737	01-31-2017	Schurman et al.	
	648	9,560,996	02-07-2017	Kiani	
	649	9,560,998	02-07-2017	Al-Ali et al.	
	650	9,566,019	02-14-2017	Al-Ali et al.	
	651	9,579,039	02-28-2017	Jansen et al.	
	652	9,591,975	03-14-2017	Dalvi et al.	
	653	9,593,969	03-14-2017	King	
	654	9,622,692	04-18-2017	Lamego et al.	
	655	9,622,693	04-18-2017	Diab	
	656	9,636,055	05-02-2017	Al-Ali et al.	
	657	9,636,056	05-02-2017	Al-Ali	
	658	9,649,054	05-16-2017	Lamego et al.	
	659	9,651,405	05-16-2017	Gowreesunker et al.	
	660	9,662,052	05-30-2017	Al-Ali et al.	
	661	9,668,676	06-06-2017	Culbert	
	662	9,668,679	06-06-2017	Schurman et al	
	663	9,668,680	06-06-2017	Bruinsma et al.	
	664	9,668,703	06-06-2017	Al-Ali	
	665	9,675,286	06-13-2017	Diab	
	666	9,687,160	06-27-2017	Kiani	
	667	9,693,719	07-04-2017	Al-Ali et al.	

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	668	9,693,737	07-04-2017	Al-Ali	
	669	9,697,928	07-04-2017	Al-Ali et al.	
	670	9,699,546	07-04-2017	Qian et al.	
	671	9,716,937	07-25-2017	Qian et al.	
	672	9,717,425	08-01-2017	Kiani et al.	
	673	9,717,458	08-01-2017	Lamego et al.	
	674	9,723,997	08-08-2017	Lamego	
	675	9,724,016	08-08-2017	Al-Ali et al.	
	676	9,724,024	08-08-2017	Al-Ali	
	677	9,724,025	08-08-2017	Kiani et al.	
	678	9,743,887	08-29-2017	Al-Ali et al.	
	679	9,749,232	08-29-2017	Sampath et al.	
	680	9,750,461	09-05-2017	Telfort	
	681	9,750,442	09-05-2017	Olsen	
	682	9,781,984	10-10-2017	Baranski et al.	
	683	9,782,077	10-10-2017	Lamego et al.	
	684	9,782,110	10-10-2017	Kiani	
	685	9,787,568	10-10-2017	Lamego et al.	
	686	9,775,545	10-03-2017	Al-Ali et al.	
	687	9,730,640	08-15-2017	Diab et al.	
	688	9,750,443	09-05-2017	Smith et al.	
	689	9,775,546	10-03-2017	Diab et al.	
	690	9,775,570	10-03-2017	Al-Ali	
	691	9,778,079	10-03-2017	Al-Ali et al.	
	692	9,788,735	10-17-2017	Al-Ali	
	693	9,788,768	10-17-2017	Al-Ali et al.	
	694	9,795,300	10-24-2017	Al-Ali	
	695	9,795,310	10-24-2017	Al-Ali	
	696	9,795,358	10-24-2017	Telfort et al.	

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	697	9,795,739	10-24-2017	Al-Ali et al.	
	698	9,801,556	10-31-2017	Kiani	
	699	9,801,588	10-31-2017	Weber et al.	
	700	9,808,188	11-07-2017	Perea et al.	
	701	9,814,418	11-14-2017	Weber et al.	
	702	9,820,691	11-21-2017	Kiani	
	703	9,833,152	12-05-2017	Kiani et al.	
	704	9,833,180	12-05-2017	Shakespeare et al.	
	705	9,838,775	12-05-2017	Qian et al.	
	706	9,839,379	12-12-2017	Al-Ali et al.	
	707	9,839,381	12-12-2017	Weber et al.	
	708	9,847,002	12-19-2017	Kiani et al.	
	709	9,847,749	12-19-2017	Kiani et al.	
	710	9,848,800	12-26-2017	Lee et al.	
	711	9,848,806	12-26-2017	Al-Ali et al.	
	712	9,848,807	12-26-2017	Lamego	
	713	9,848,823	12-26-2017	Raghuram et al.	
	714	9,861,298	01-09-2018	Eckerbom et al.	
	715	9,861,304	01-09-2018	Al-Ali et al.	
	716	9,861,305	01-09-2018	Weber et al.	
	717	9,866,671	01-09-2018	Thompson et al.	
	718	9,867,575	01-16-2018	Maani et al.	
	719	9,867,578	01-16-2018	Al-Ali et al.	
	720	9,872,623	01-23-2018	Al-Ali	
	721	9,876,320	01-23-2018	Coverston et al.	
	722	9,877,650	01-30-2018	Muhsin et al.	
	723	9,877,686	01-30-2018	Al-Ali et al.	
	724	9,891,079	02-13-2018	Dalvi	
	725	9,895,107	02-20-2018	Al-Ali et al.	

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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	726	9,898,049	02-20-2018	Myers et al.	
	727	9,918,646	03-20-2018	Singh Alvarado et al.	
	728	9,924,893	03-27-2018	Schurman et al.	
	729	9,924,897	03-27-2018	Abdul-Hafiz	
	730	9,913,617	03-13-2018	Al-Ali et al.	
	731	9,936,917	04-10-2018	Poeze et al.	
	732	9,943,269	04-17-2018	Muhsin et al.	
	733	9,949,676	04-24-2018	Al-Ali	
	734	9,952,095	04-24-2018	Hotelling et al.	
	735	9,955,937	05-01-2018	Telfort	
	736	9,965,946	05-08-2018	Al-Ali	
	737	9,980,667	05-29-2018	Kiani et al.	
	738	9,986,919	06-05-2018	Lamego et al.	
	739	9,986,952	06-05-2018	Dalvi et al.	
	740	9,989,560	06-05-2018	Poeze et al.	
	741	9,993,207	06-12-2018	Al-Ali et al.	
	742	10,007,758	06-26-2018	Al-Ali et al.	
	743	10,010,276	07-03-2018	Al-Ali et al.	
	744	10,032,002	07-24-2018	Kiani et al.	
	745	10,039,080	07-31-2018	Miller et al.	
	746	10,039,482	08-07-2018	Al-Ali et al.	
	747	10,052,037	08-21-2018	Kinast et al.	
	748	10,055,121	08-21-2018	Chaudhri et al.	
	749	10,058,275	08-28-2018	Al-Ali et al.	
	750	10,064,562	09-04-2018	Al-Ali	
	751	10,066,970	09-04-2018	Gowreesunker et al.	
	752	10,076,257	09-18-2018	Lin et al.	
	753	10,078,052	09-18-2018	Ness et al.	
	754	10,086,138	10-02-2018	Novak, Jr.	

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	755	10,092,200	10-09-2018	Al-Ali et al.	
	756	10,092,249	10-09-2018	Kiani et al.	
	757	10,098,550	10-16-2018	Al-Ali et al.	
	758	10,098,591	10-16-2018	Al-Ali et al.	
	759	10,098,610	10-16-2018	Al-Ali et al.	
	760	10,123,726	11-13-2018	Al-Ali et al.	
	761	10,130,289	11-20-2018	Al-Ali et al.	
	762	10,130,291	11-20-2018	Schurman et al.	
	763	10,149,616	12-11-2018	Al-Ali et al.	
	764	10,154,815	12-18-2018	Al-Ali et al.	
	765	10,159,412	12-25-2018	Lamego et al.	
	766	10,188,296	01-29-2019	Al-Ali et al.	
	767	10,188,331	01-29-2019	Al-Ali et al.	
	768	10,188,348	01-29-2019	Kiani et al.	
	769	10,194,847	02-05-2019	Al-Ali	
	770	10,194,848	02-05-2019	Kiani et al.	
	771	10,201,298	02-12-2019	Al-Ali et al.	
	772	10,205,272	02-12-2019	Kiani et al.	
	773	10,205,291	02-12-2019	Scruggs et al.	
	774	10,213,108	02-26-2019	Al-Ali	
	775	10,219,706	03-05-2019	Al-Ali	
	776	10,219,746	03-05-2019	McHale et al.	
	777	10,226,187	03-12-2019	Al-Ali et al	
	778	10,226,576	03-12-2019	Kiani	
	779	10,231,657	03-19-2019	Al-Ali et al	
	780	10,231,670	03-19-2019	Blank et al.	
	781	10,231,676	03-19-2019	Al-Ali et al	
	782	10,255,994	04-09-2019	Sampath et al.	
	783	10,251,585	04-09-2019	Al-Ali et al.	

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	784	10,251,586	04-09-2019	Lamego	
	785	10,258,265	04-16-2019	Poeze et al.	
	786	10,258,266	04-16-2019	Poeze et al.	
	787	10,271,748	04-30-2019	Al-Ali	
	788	10,278,626	05-07-2019	Schurman et al.	
	789	10,278,648	05-07-2019	Al-Ali et al.	
	790	10,279,247	05-07-2019	Kiani	
	791	10,292,628	05-21-2019	Poeze et al.	
	792	10,292,657	05-21-2019	Abdul-Hafiz et al.	
	793	10,292,664	05-21-2019	Al-Ali	
	794	10,299,708	05-28-2019	Poeze et al.	
	795	10,299,709	05-28-2019	Perea et al.	
	796	10,305,775	05-28-2019	Lamego et al.	
	797	10,307,111	06-04-2019	Muhsin et al.	
	798	10,325,681	06-18-2019	Sampath et al.	
	799	10,327,337	06-18-2019	Triman et al.	
	800	10,332,630	06-25-2019	Al-Ali	
	801	10,327,713	06-25-2019	Barker et al.	
	802	10,335,033	07-02-2019	Al-Ali	
	803	10,335,068	07-02-2019	Poeze et al.	
	804	10,335,072	07-02-2019	Al-Ali et al.	
	805	10,342,470	07-09-2019	Al-Ali et al.	
	806	10,342,487	07-09-2019	Al-Ali et al.	
	807	10,342,497	07-09-2019	Al-Ali et al.	
	808	10,349,898	07-16-2019	Al-Ali et al.	
	809	10,349,895	07-16-2019	Telfort et al.	
	810	10,354,504	07-16-2019	Kiani et al.	
	811	10,357,206	07-23-2019	Weber et al.	
	812	10,357,209	07-23-2019	Al-Ali	

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	813	10,366,787	07-30-2019	Sampath et al.	
	814	10,368,787	08-06-2019	Reichgott et al.	
	815	10,376,190	08-13-2019	Poeze et al.	
	816	10,376,191	08-13-2019	Poeze et al.	
	817	2002/0099279	07-25-2002	Pfeiffer et al.	
	818	2003/0036690	02-20-2003	Geddes et al.	
	819	2004/0054290	03-18-2004	Chance	
	820	2004/0114783	06-17-2004	Spycher et al.	
	821	2006/0005944	01-12-2006	Wang et al.	
	822	2006/0025659	02-02-2006	Kiguchi et al.	
	823	2006/0161054	07-20-2006	Reuss et al.	
	824	2007/0149864	06-28-2007	Laakkonen	
	825	2007/0238955	10-11-2007	Tearney et al.	
	826	2007/0293792	12-20-2007	Sliwa et al.	
	827	2008/0130232	06-05-2008	Yamamoto	
	828	2008/0139908	06-12-2008	Kurth	
	829	2009/0030327	01-29-2009	Chance, Britton	
	830	2009/0043180	02-12-2009	Tschautscher et al.	
	831	2009/0129102	05-21-2009	Xiao et al.	
	832	2009/0247984	10-01-2009	Lamego et al.	
	833	2009/0259114	10-15-2009	Johnson et al.	
	834	2009/0275813	11-05-2009	Davis	
	835	2009/0275844	11-05-2009	Al-Ali	
	836	2009/0306487	12-10-2009	Crowe et al.	
	837	2010/0004518	01-07-2010	Vo et al.	
	838	2010/0030040	02-04-2010	Poeze et al.	
	839	2011/0001605	01-06-2011	Kiani et al.	
	840	2011/0004106	01-06-2011	Iwamiya et al.	
	841	2011/0082711	04-07-2011	Poeze et al.	

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	842	2011/0085721	04-14-2011	Guyon et al.	
	843	2011/0105854	05-05-2011	Kiani et al.	
	844	2011/0105865	05-05-2011	Yu et al.	
	845	2011/0125060	05-26-2011	Telfort et al.	
	846	2012/0165629	06-28-2012	Merritt et al.	
	847	2011/0208015	08-25-2011	Welch et al.	
	848	2011/0213212	09-01-2011	Al-Ali	
	849	2011/0230733	09-22-2011	Al-Ali	
	850	2011/0237911	09-29-2011	Lamego et al.	
	851	2012/0059267	03-08-2012	Lamego et al.	
	852	2012/0179006	07-12-2012	Jansen et al.	
	853	2012/0209084	08-16-2012	Olsen et al.	
	854	2012/0227739	09-13-2012	Kiani	
	855	2012/0283524	11-08-2012	Kiani et al.	
	856	2012/0296178	11-22-2012	Lamego et al.	
	857	2012/0319816	12-20-2012	Al-Ali	
	858	2012/0330112	12-27-2012	Lamego et al.	
	859	2013/0023775	01-24-2013	Lamego et al.	
	860	2013/0041591	02-14-2013	Lamego	
	861	2013/0045685	02-21-2013	Kiani	
	862	2013/0046204	02-21-2013	Lamego et al.	
	863	2013/0060147	03-07-2013	Welch et al.	
	864	2013/0096405	04-18-2013	Garfio	
	865	2013/0096936	04-18-2013	Sampath et al.	
	866	2013/0190581	07-25-2013	Al-Ali et al.	
	867	2013/0197328	08-01-2013	Diab et al.	
	868	2013/0211214	08-15-2013	Olsen	
	869	2013/0243021	09-19-2013	Siskavich	
	870	2013/0296672	11-07-2013	O'Neil et al.	

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	871	2013/0324808	12-05-2013	Al-Ali et al.	
	872	2013/0331660	12-12-2013	Al-Ali et al.	
	873	2013/0331670	12-12-2013	Kiani	
	874	2013/0338461	12-19-2013	Lamego et al.	
	875	2014/0012100	01-09-2014	Al-Ali et al.	
	876	2014/0034353	02-06-2014	Al-Ali et al.	
	877	2014/0051953	02-20-2014	Lamego et al.	
	878	2014/0058230	02-27-2014	Abdul-Hafiz et al.	
	879	2014/0077956	03-20-2014	Sampath et al.	
	880	2014/0081100	03-20-2014	Muhsin et al.	
	881	2014/0081175	03-20-2014	Telfort	
	882	2014/0094667	04-03-2014	Schurman et al.	
	883	2014/0100434	04-10-2014	Diab et al.	
	884	2014/0114199	04-24-2014	Lamego et al.	
	885	2014/0120564	05-01-2014	Workman et al.	
	886	2014/0121482	05-01-2014	Merritt et al.	
	887	2014/0121483	05-01-2014	Kiani	
	888	2014/0127137	05-08-2014	Bellott et al.	
	889	2014/0129702	05-08-2014	Lamego et al.	
	890	2014/0135588	05-15-2014	Al-Ali et al.	
	891	2014/0142401	05-22-2014	Al-Ali et al.	
	892	2014/0163344	06-12-2014	Al-Ali	
	893	2014/0163402	06-12-2014	Lamego et al.	
	894	2014/0166076	06-19-2014	Kiani et al.	
	895	2014/0171146	06-19-2014	Ma et al.	
	896	2014/0171763	06-19-2014	Diab	
	897	2014/0180154	06-26-2014	Sierra et al.	
	898	2014/0180160	06-26-2014	Brown et al.	
	899	2014/0187973	07-03-2014	Brown et al.	

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	900	2014/0194709	07-10-2014	Al-Ali et al.	
	901	2014/0194711	07-10-2014	Al-Ali	
	902	2014/0194766	07-10-2014	Al-Ali et al.	
	903	2014/0206963	07-24-2014	Al-Ali	
	904	2014/0213864	07-31-2014	Abdul-Hafiz et al.	
	905	2014/0243627	08-28-2014	Diab et al.	
	906	2014/0266790	09-18-2014	Al-Ali et al.	
	907	2014/0275808	09-18-2014	Poeze et al.	
	908	2014/0275835	09-18-2014	Lamego et al.	
	909	2014/0275871	09-18-2014	Lamego et al.	
	910	2014/0275872	09-18-2014	Merritt et al.	
	911	2014/0275881	09-18-2014	Lamego et al.	
	912	2014/0288400	09-25-2014	Diab et al.	
	913	2014/0296664	10-27-2014	Bruinsma et al.	
	914	2014/0303520	10-09-2014	Telfort et al.	
	915	2014/0316217	10-23-2014	Purdon et al.	
	916	2014/0316218	10-23-2014	Purdon et al.	
	917	2014/0316228	10-23-2014	Blank et al.	
	918	2014/0323825	10-30-2014	Al-Ali et al.	
	919	2014/0323897	10-30-2014	Brown et al.	
	920	2014/0323898	10-30-2014	Purdon et al.	
	921	2014/0330098	11-06-2014	Merritt et al.	
	922	2014/0330099	11-06-2014	Al-Ali et al.	
	923	2014/0333440	11-13-2014	Kiani	
	924	2014/0336481	11-13-2014	Shakespeare et al.	
	925	2014/0343436	11-20-2014	Kiani	
	926	2014/0357966	12-04-2014	Al-Ali et al.	
	927	2015/0005600	01-01-2015	Blank et al.	
	928	2015/0011907	01-08-2015	Purdon et al.	

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	929	2015/0018650	01-15-2015	Al-Ali et al.	
	930	2015/0032029	01-29-2015	Al-Ali et al.	
	931	2015/0038859	02-05-2015	Dalvi et al.	
	932	2015/0080754	03-19-2015	Purdon et al.	
	933	2015/0087936	03-26-2015	Al-Ali et al.	
	934	2015/0094546	04-02-2015	Al-Ali	
	935	2015/0099950	04-09-2015	Al-Ali et al.	
	936	2015/0101844	04-16-2015	Al-Ali et al.	
	937	2015/0106121	04-16-2015	Muhsin et al.	
	938	2015/0173671	06-25-2015	Paalasmaa et al.	
	939	2015/0196249	07-16-2015	Brown et al.	
	940	2015/0216459	08-06-2015	Al-Ali et al.	
	941	2015/0238722	08-27-2015	Al-Ali	
	942	2015/0255001	09-10-2015	Haughav et al.	
	943	2015/0257689	09-17-2015	Al-Ali et al.	
	944	2015/0281424	10-01-2015	Vock et al.	
	945	2015/0318100	11-05-2015	Rothkopf et al.	
	946	2015/0351697	11-05-2015	Weber et al.	
	947	2015/0351704	12-20-2015	Kiani et al.	
	948	2015/0366472	12-24-2015	Kiani	
	949	2015/0366507	12-24-2015	Blank	
	950	2015/0374298	12-31-2015	Al-Ali et al.	
	951	2015/0380875	12-31-2015	Coverston et al.	
	952	2016/0000362	01-07-2016	Diab et al.	
	953	2016/0007930	01-14-2016	Weber et al.	
	954	2016/0019360	01-21-2016	Pahwa et al.	
	955	2016/0023245	01-28-2016	Zadesky et al.	
	956	2016/0029932	02-04-2016	Al-Ali	
	957	2016/0029933	02-04-2016	Al-Ali et al.	

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	958	2016/0038045	02-11-2016	Shapiro	
	959	2016/0045118	02-18-2016	Kiani	
	960	2016/0051157	02-25-2016	Waydo	
	961	2016/0051158	02-25-2016	Silva	
	962	2016/0051205	02-25-2016	Al-Ali et al.	
	963	2016/0058302	03-03-2016	Raghuram et al.	
	964	2016/0058309	03-03-2016	Han	
	965	2016/0058312	03-03-2016	Han et al.	
	966	2016/0058338	03-03-2016	Schurman et al.	
	967	2016/0058356	03-03-2016	Raghuram et al.	
	968	2016/0058370	03-03-2016	Raghuram et al.	
	969	2016/0066823	03-10-2016	Al-Ali et al.	
	970	2016/0066824	03-10-2016	Al-Ali et al.	
	971	2016/0066879	03-10-2016	Telfort et al.	
	972	2016/0071392	03-10-2016	Hankey et al.	
	973	2016/0072429	03-10-2016	Kiani et al.	
	974	2016/0073967	03-17-2016	Lamego et al.	
	975	2016/0081552	03-24-2016	Wojtczuk et al.	
	976	2016/0095543	04-07-2016	Telfort et al.	
	977	2016/0103598	04-14-2016	Al-Ali et al.	
	978	2016/0113527	04-28-2016	Al-Ali et al.	
	979	2016/0143548	05-26-2016	Al-Ali	
	980	2016/0154950	06-02-2016	Nakajima et al.	
	981	2016/0157780	06-09-2016	Rimminen et al.	
	982	2016/0166210	06-16-2016	Al-Ali	
	983	2016/0192869	07-07-2016	Kiani et al.	
	984	2016/0196388	07-07-2016	Lamego	
	985	2016/0197436	07-07-2016	Barker et al.	
	986	2016/0213281	07-28-2016	Eckerbom, et al.	

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Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	987	2016/0213309	07-28-2016	Sannholm et al.	
	988	2016/0228043	08-11-2016	O'Neil et al.	
	989	2016/0256058	09-08-2016	Pham et al.	
	990	2016/0256082	09-08-2016	Ely et al.	
	991	2016/0267238	09-15-2016	Nag	
	992	2016/0270735	09-22-2016	Diab et al.	
	993	2016/0283665	09-29-2016	Sampath et al.	
	994	2016/0287181	10-06-2016	Han et al.	
	995	2016/0287786	10-06-2016	Kiani	
	996	2016/0296173	10-13-2016	Culbert	
	997	2016/0296174	10-13-2016	Isikman et al.	
	998	2016/0310027	10-27-2016	Han	
	999	2016/0314260	10-27-2016	Kiani	
	1000	2016/0324488	11-10-2016	Olsen	
	1001	2016/0327984	11-10-2016	Al-Ali et al.	
	1002	2016/0367173	12-22-2016	Dalvi et al.	
	1003	2016/0378069	12-29-2016	Rothkopf	
	1004	2016/0378071	12-29-2016	Rothkopf	
	1005	2017/0000394	01-05-2017	Al-Ali et al.	
	1006	2017/0007183	01-12-2017	Dusan et al.	
	1007	2017/0010858	01-12-2017	Prest et al.	
	1008	2017/0014083	01-19-2017	Diab et al.	
	1009	2017/0024748	01-26-2017	Haider	
	1010	2017/0042488	02-16-2017	Muhsin	
	1011	2017/0055882	03-02-2017	Al-Ali et al.	
	1012	2017/0055887	03-02-2017	Al-Ali	
	1013	2017/0055896	03-02-2017	Al-Ali et al.	
	1014	2017/0074897	03-16-2017	Mermel et al.	
	1015	2017/0084133	03-23-2017	Cardinali et al.	

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	1016	2017/0086689	03-30-2017	Shui et al.	
	1017	2017/0086723	03-30-2017	Al-Ali et al.	
	1018	2017/0086742	03-30-2017	Harrison-Noonan et al.	
	1019	2017/0086743	03-30-2017	Bushnell et al.	
	1020	2017/0094450	03-30-2017	Tu et al.	
	1021	2017/0143281	05-25-2017	Olsen	
	1022	2017/0147774	05-25-2017	Kiani	
	1023	2017/0156620	06-08-2017	Al-Ali et al.	
	1024	2017/0164884	06-15-2017	Culbert et al.	
	1025	2017/0173632	06-22-2017	Al-Ali	
	1026	2017/0196464	07-13-2017	Jansen et al.	
	1027	2017/0196470	07-13-2017	Lamego et al.	
	1028	2017/0228516	08-10-2017	Sampath et al.	
	1029	2017/0245790	08-31-2017	Al-Ali et al.	
	1030	2017/0248446	08-31-2017	Gowreesunker et al.	
	1031	2017/0251974	09-07-2017	Shreim et al.	
	1032	2017/0251975	09-07-2017	Shreim et al.	
	1033	2017/0273619	09-28-2017	Alvarado et al.	
	1034	2017/0281024	10-05-2017	Narasimhan et al.	
	1035	2017/0293727	10-12-2017	Klaassen et al.	
	1036	2017/0311891	11-02-2017	Kiani et al.	
	1037	2017/0325698	11-16-2017	Allec et al.	
	1038	2017/0325744	11-16-2017	Allec et al.	
	1039	2017/0332976	11-23-2017	Al-Ali et al.	
	1040	2017/0340209	11-30-2017	Klaassen et al.	
	1041	2017/0340219	11-30-2017	Sullivan et al.	
	1042	2017/0340293	11-30-2017	Al-Ali et al.	
	1043	2017/0347885	12-07-2017	Tan et al.	
	1044	2017/0354332	12-14-2017	Lamego	

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	1045	2017/0354795	12-14-2017	Blahnik et al.	
	1046	2017/0358239	12-14-2017	Arney et al.	
	1047	2017/0358240	12-14-2017	Blahnik et al.	
	1048	2017/0358242	12-14-2017	Thompson et al.	
	1049	2017/0360306	12-14-2017	Narasimhan et al.	
	1050	2017/0360310	12-21-2017	Kiani et al.	
	1051	2017/0366657	12-21-2017	Thompson et al.	
	1052	2018/0008146	01-11-2018	Al-Ali et al.	
	1053	2018/0013562	01-11-2018	Haider et al.	
	1054	2018/0014752	01-18-2018	Al-Ali et al.	
	1055	2018/0014781	01-18-2018	Clavelle et al.	
	1056	2018/0025287	01-25-2018	Mathew et al.	
	1057	2018/0028124	02-01-2018	Al-Ali et al.	
	1058	2018/0042556	02-15-2018	Shahparnia et al.	
	1059	2018/0049694	02-22-2018	Singh Alvarado et al.	
	1060	2018/0050235	02-22-2018	Tan et al.	
	1061	2018/0055375	03-01-2018	Martinez et al.	
	1062	2018/0055390	03-01-2018	Kiani	
	1063	2018/0055430	03-01-2018	Diab et al.	
	1064	2018/0055439	03-01-2018	Pham et al.	
	1065	2018/0056129	03-01-2018	Narasimha Rao et al.	
	1066	2018/0064381	03-08-2018	Shakespeare et al.	
	1067	2018/0070867	03-15-2018	Smith et al.	
	1068	2018/0078151	03-22-2018	Allec et al.	
	1069	2018/0078182	03-22-2018	Chen et al.	
	1070	2018/0082767	03-22-2018	Al-Ali et al.	
	1071	2018/0085068	03-29-2018	Telfort	
	1072	2018/0087937	03-29-2018	Al-Ali et al.	
	1073	2018/0103874	04-19-2018	Lee et al.	

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	1074	2018/0103905	04-19-2018	Kiani	
	1075	2018/0110469	04-26-2018	Maani et al.	
	1076	2018/0125368	05-10-2018	Lamego et al.	
	1077	2018/0125430	05-10-2018	Al-Ali et al.	
	1078	2018/0125445	05-10-2018	Telfort et al.	
	1079	2018/0132769	05-17-2018	Weber et al.	
	1080	2018/0146901	05-31-2018	Al-Ali et al.	
	1081	2018/0146902	05-31-2018	Kiani et al.	
	1082	2018/0153418	06-07-2018	Sullivan et al.	
	1083	2018/0153442	06-07-2018	Eckerbom, et al.	
	1084	2018/0153446	06-07-2018	Kiani	
	1085	2018/0153447	06-07-2018	Al-Ali et al.	
	1086	2018/0153448	06-07-2018	Weber et al.	
	1087	2018/0161499	06-14-2018	Al-Ali et al.	
	1088	2018/0164853	06-14-2018	Myers et al.	
	1089	2018/0168491	06-21-2018	Al-Ali et al.	
	1090	2018/0184917	07-05-2018	Kiani	
	1091	2018/0192924	07-12-2018	Al-Ali	
	1092	2018/0192953	07-12-2018	Shreim et al.	
	1093	2018/0196514	07-12-2018	Allec et al.	
	1094	2018/0199871	07-19-2018	Pauley et al.	
	1095	2018/0206795	07-26-2018	Al-Ali	
	1096	2018/0206815	07-26-2018	Telfort	
	1097	2018/0213583	07-26-2018	Al-Ali	
	1098	2018/0214031	08-02-2018	Kiani et al.	
	1099	2018/0214090	08-02-2018	Al-Ali et al.	
	1100	2018/0218792	08-02-2018	Muhsin et al.	
	1101	2018/0225960	08-09-2018	Al-Ali et al.	
	1102	2018/0228414	08-16-2018	Shao et al.	

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	1103	2018/0238718	08-23-2018	Dalvi	
	1104	2018/0238734	08-23-2018	Hotelling et al.	
	1105	2018/0242853	08-30-2018	Al-Ali	
	1106	2018/0242921	08-30-2018	Muhsin et al.	
	1107	2018/0242923	08-30-2018	Al-Ali et al.	
	1108	2018/0242926	08-30-2018	Muhsin et al.	
	1109	2018/0247353	08-30-2018	Al-Ali et al.	
	1110	2018/0247712	08-30-2018	Muhsin et al.	
	1111	2018/0253947	09-06-2018	Muhsin et al.	
	1112	2018/0256087	09-13-2018	Al-Ali et al.	
	1113	2018/0279956	10-04-2018	Waydo et al.	
	1114	2018/0285094	10-04-2018	Housel et al.	
	1115	2018/0289325	10-11-2018	Poeze et al.	
	1116	2018/0296161	10-18-2018	Shreim et al.	
	1117	2018/0300919	10-18-2018	Muhsin et al.	
	1118	2018/0310822	11-01-2018	Indorf et al.	
	1119	2018/0310823	11-01-2018	Al-Ali et al.	
	1120	2018/0317826	11-08-2018	Muhsin	
	1121	2018/0317841	11-08-2018	Novak, Jr.	
	1122	2018/0333055	11-22-2018	Lamego et al.	
	1123	2018/0333087	11-22-2019	Al-Ali	
	1124	2019/0000317	01-03-2019	Muhsin et al.	
	1125	2019/0000362	01-03-2019	Kiani et al.	
	1126	2019/0015023	01-17-2019	Monfre	
	1127	2019/0029574	01-31-2019	Schurman et al.	
	1128	2019/0029578	01-31-2019	Al-Ali et al.	
	1129	2019/0058280	02-21-2019	Al-Ali et al.	
	1130	2019/0058281	02-21-2019	Al-Ali et al.	
	1131	2019/0069813	03-07-2019	Al-Ali	

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	1132	2019/0069814	03-07-2019	Al-Ali	
	1133	2019/0076028	03-14-2019	Al-Ali et al.	
	1134	2019/0082979	03-21-2019	Al-Ali et al.	
	1135	2019/0090760	03-28-2019	Kinast et al.	
	1136	2019/0090764	03-28-2019	Al-Ali	
	1137	2019/0117070	04-25-2019	Muhsin et al.	
	1138	2019/0117139	04-25-2019	Al-Ali et al.	
	1139	2019/0117140	04-25-2019	Al-Ali et al.	
	1140	2019/0117141	04-25-2019	Al-Ali	
	1141	2019/0117930	04-25-2019	Al-Ali	
	1142	2019/0122763	04-25-2019	Sampath et al.	
	1143	2019/0133525	05-09-2019	Al-Ali et al.	
	1144	2019/0142283	05-16-2019	Lamego et al.	
	1145	2019/0142344	05-16-2019	Telfort et al.	
	1146	2019/0150856	05-23-2019	Kiani et al.	
	1147	2019/0167161	06-06-2019	Al-Ali et al.	
	1148	2019/0175019	06-13-2019	Al-Ali et al.	
	1149	2019/0192076	06-27-2010	McHale et al.	
	1150	2019/0200941	07-04-2019	Chandran et al.	
	1151	2019/0201623	07-04-2019	Kiani	
	1152	2019/0214778	07-11-2019	Scruggs et al.	
	1153	2019/0209025	07-11-2019	Al-Ali	
	1154	2019/0216319	07-18-2019	Poeze et al.	
	1155	2018/0216370	07-18-2019	Schurman et al.	
	1156	2019/0216379	07-18-2019	Al-Ali et al.	
	1157	2019/0221966	07-18-2019	Kiani et al.	
	1158	2019/0223804	07-25-2019	Blank et al	
	1159	2019/0231199	08-01-2019	Al-Ali et al.	
	1160	2019/0231241	08-01-2019	Al-Ali et al.	

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	1161	2019/0231270	08-01-2019	Abdul-Hafiz et al.	
	1162	2019/0239787	08-08-2019	Pauley et al.	
	1163	2019/0239824	08-08-2019	Muhsin et al.	
	1164	D326,715	06-02-1992	Schmidt, Michael	
	1165	D353,195	12-06-1994	Savage et al.	
	1166	D353,196	12-06-1994	Savage et al.	
	1167	D356,870	03-28-1995	Ivers et al.	
	1168	D359,546	06-20-1995	Savage, et al.	
	1169	D361,840	08-29-1995	Savage et al.	
	1170	D362,063	09-05-1995	Savage et al.	
	1171	D363,120	10-10-1995	Savage et al.	
	1172	D378,414	03-11-1997	Allen et al.	
	1173	D390,666	02-01-1998	Lagerlof, Ingemar	
	1174	D393,830	04-28-1998	Tobler et al.	
	1175	D403,070	12-22-1998	Maeda et al.	
	1176	D414,870	10-05-1999	Saltzstein et al.	
	1177	D452,012	12-11-2001	Phillips, Barney L.	
	1178	D455,834	04-16-2002	Donars et al.	
	1179	D463,561	09-24-2002	Fukatsu et al.	
	1180	D481,459	10-28-2003	Nahm, Werner	
	1181	D502,655	03-08-2005	Huang, Chun-Mu	
	1182	D508,862	08-30-2005	Behar et al.	
	1183	D510,625	10-11-2005	Widener et al.	
	1184	D514,461	02-07-2006	Harju, Jonne	
	1185	D535,031	01-09-2007	Barrett et al.	
	1186	D537,164	02-20-2007	Shigemori et al.	
	1187	D547,454	07-24-2007	Hsieh, Chin-Chih	
	1188	D549,830	08-28-2007	Behar et al.	
	1189	D550,364	09-04-2007	Glover et al.	

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	1190	D551,350	09-18-2007	Lorimer et al.	
	1191	D553,248	10-16-2007	Nguyen	
	1192	D554,263	10-30-2007	Al-Ali	
	1193	D562,985	02-26-2008	Brefka et al.	
	1194	D566,282	04-08-2008	Al-Ali et al.	
	1195	D567,125	04-22-2008	Okabe et al.	
	1196	D569,001	05-13-2008	Omaki	
	1197	D569,521	05-20-2008	Omaki	
	1198	D587,657	03-03-2009	Al-Ali et al.	
	1199	D603,966	11-10-2009	Jones et al.	
	1200	D606,659	12-22-2009	Kiani et al.	
	1201	D609,193	02-02-2010	Al-Ali et al.	
	1202	D614,305	04-20-2010	Al-Ali et al.	
	1203	D621,516	08-10-2010	Kiani et al.	
	1204	D692,145	10-22-2013	Al-Ali et al.	
	1205	D755,392	05-03-2016	Hwang et al.	
	1206	D788,312	05-30-2017	Al-Ali et al.	
	1207	D820,865	06-19-2018	Muhsin et al.	
	1208	D822,215	07-03-2018	Al-Ali et al.	
	1209	D822,216	07-03-2018	Barker et al.	
	1210	D833,624	11-13-2018	DeJong et al.	
	1211	D835,282	12-04-2018	Barker et al.	
	1212	D835,283	12-04-2018	Barker et al.	
	1213	D835,284	12-04-2018	Barker et al.	
	1214	D835,285	12-04-2018	Barker et al.	
	1215	RE 37,922	12-10-2002	Sharan	
	1216	RE 38,476	03-01-2004	Diab et al.	
	1217	RE 38,492	04-06-2004	Diab et al.	
	1218	RE 39,672	06-05-2007	Shehada et al.	

Examiner Signature	Date Considered
***Examiner:** Initial if reference 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.	

T[1] - Place a check mark in this area when an English language Translation is attached.

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 43 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1219	RE 41,317	05-04-2010	Parker	
	1220	RE 41,912	11-02-2010	Parker	
	1221	RE 42,753	09-27-2011	Kiani-Azarbayjany et al.	
	1222	RE 43,169	02-07-2012	Parker	
	1223	RE 43,860	12-11-2012	Parker	
	1224	RE 44,823	04-01-2014	Parker	
	1225	RE 44,875	04-29-2014	Kiani et al.	
	1226	RE47,218	02-05-2019	Ali-Ali	
	1227	RE47,244	02-19-2019	Kiani et al.	
	1228	RE47,249	02-19-2019	Kiani et al.	
	1229	RE47,353	04-16-2019	Kiani et al.	

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	1230	EP 419223	03-27-1991	Minnesota Mining and Manufacturing Company		
	1231	EP 0 781 527	07-02-1997	Instrumentarium Oy		
	1232	EP 1 518 494	03-30-2005	Hitachi, Ltd.		
	1233	EP 2 277 440	01-26-2011	Pioneer Corp		
	1234	JP 08-185864	07-16-1996	Matsushita Electric Ind Co Ltd		Abs
	1235	JP 2002-500908 A	01-15-2002	Lightouch Medical Inc.		Abs
	1236	JP 2007-389463 A	11-08-2007	Konica Minolta Sensing Inc.		Abs
	1237	JP 2003-265444 A	09-24-2003	Shimadzu Corp.		Abs
	1238	JP 2003-508104 A	09-24-2003	Shimadzu Corp.		Abs
	1239	JP 08-185864	07-16-1996	Matsushita Electric Ind Co Ltd		Abs
	1240	JP 2001-66990	03-16-2001	Sumitomo Bakelite Co Ltd		Abs
	1241	JP 05-325705 A	12-10-1993	Fuji Porimatetsuku KK		Abs

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PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 44 OF 46	Attorney Docket No.	MASCER.002C13

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	1242	JP 2001-087250 A	04-03-2001	Cas Medical Systems Inc.		Abs
	1243	JP 2006-177837 A	07-06-2006	Hitachi Ltd.		Abs
	1244	JP 2003-024276 A	01-28-2003	Pentax Corp.		Abs
	1245	JP 2008-099222 A	04-24-2008	Konica Minolta Holdings Inc.		Abs
	1246	JP 2006-198321 A	08-03-2006	Hitachi Ltd.		Abs
	1247	JP 2003-508104 A	03-04-2003	Quantum Vision Inc.		Abs
	1248	JP 5756752	06-05-2015	Masimo Laboratories, Inc.		Abs
	1249	WO 1993/12712	07-08-1993	Vivascan Corp		
	1250	WO 1996/27325	09-12-1996	Huch et al.		X
	1251	WO 1999/000053	01-07-1999	TOA Medical Electronics		
	1252	WO 2000/25112	05-04-2000	Rolfe		
	1253	WO 2001/09589	02-08-2001	Abbott Laboratories		
	1254	WO 2010/003134	01-07-2010	Masimo Laboratories, Inc.		
	1255	WO 2014/149781	09-25-2014	Cercacor Laboratories, Inc.		
	1256	WO 2014/158820	10-02-2014	Cercacor Laboratories, Inc.		
	1257	WO 1999/01704	07-29-1999	General Electric Company		

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
	1258	PCT International Search Report, App. No. PCT/US2010/047899, Date of Actual Completion of Search: 01/26/2011, 4 pages.	
	1259	International Search Report and Written Opinion for PCT/US2009/049638, mailed January 7, 2010.	
	1260	International Search Report issued in Application No. PCT/US2009/052756, mailed February 10, 2009 in 14 pages.	
	1261	International Preliminary Report on Patentability and Written Opinion of the International Searching Authority issued in Application No. PCT US2009/049638, mailed January 5, 2011 in 9 pages.	
	1262	International Preliminary Report on Patentability and Written Opinion of the International Searching Authority issued in Application No. PCT/US2009/052756, mailed February 8, 2011 in 8 pages.	

Examiner Signature	Date Considered
***Examiner:** Initial if reference 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.	

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PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 45 OF 46	Attorney Docket No.	MASCER.002C13

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
	1263	International Preliminary Report on Patentability and Written Opinion for International Application No. PCT/US2016/040190, dated January 2, 2018, in 7 pages.	
	1264	Burritt, Mary F.; Current Analytical Approaches to Measuring Blood Analytes; Vol. 36; No. 8(B); 1990	
	1265	Hall, et al., Jeffrey W.; Near-Infrared Spectrophotometry: A New Dimension in Clinical Chemistry; Vol. 38; No. 9; 1992	
	1266	Kuenstner, et al., J. Todd; Measurement of Hemoglobin in Unlysed Blood by Near-Infrared Spectroscopy; Vol. 48; Number 4, 1994	
	1267	Manzke, et al., B., Multi Wavelength Pulse Oximetry in the Measurement of Hemoglobin Fractions; SPIE, Vol. 2676, April 24, 1996	
	1268	Naumenko, E. K.; Choice of Wavelengths for Stable Determination of Concentrations of Hemoglobin Derivatives from Absorption Spectra of Erythrocytes; Vol. 63; No. 1; pp. 60-66 January – February 1996; Original article submitted November 3, 1994	
	1269	Schmitt, Joseph M.; Simple Photon Diffusion Anaylsis of the Effects of Multiple Scattering on Pulse Oximetry; March 14, 1991; revised August 30, 1991	
	1270	Schmitt, et al., Joseph M.; Measurement of Blood Hematocrit by Dual-Wavelength near-IR Photoplethysmography; Vol. 1641; 1992	
	1271	Schnapp, et al., L.M.; Pulse Oximetry. Uses and Abuses.; Chest 1990; 98; 1244-1250 DOI 10.1378/Chest.98.5.1244	
	1272	http://www.masimo.com/rainbow/pronto.htm Noninvasive & Immediate Hemoglobin Testing, printed on August 20, 2009	
	1273	http://www.masimo.com/pulseOximeter/Rad5.htm; Signal Extraction Pulse Oximeter, printed on August 20, 2009	
	1274	http://blogderoliveira.blogspot.com/2008_02_01_archive.html; Ricardo Oliveira, printed on August 20, 2009	
	1275	http://www.masimo.com/rad-57/; Noninvasive Measurement of Methemoglobin, Carboxyhemoglobin and Oxyhemoglobin in the blood. Printed on August 20, 2009	
	1276	http://amivital.ugr.es/blog/?tag+spo2; Monitorizacion de la hemoglobina...y mucho mas, printed on August 20, 2009	
	1277	http://www.masimo.com/spco/; Carboxyhemoglobin Noninvasive > Continuous > Immediate, printed on August 20, 2009	
	1278	http://www.masimo.com/PARTNERS/WELCHALLYN.htm; Welch Allyn Expands Patient Monitor Capabilities with Masimo Pulse Oximetry Technology, printed on August 20, 2009	
	1279	http://www.masimo.com/pulseOximeter/PPO.htm; Masimo Personal Pulse Oximeter, printed on August 20, 2009	
	1280	http://www.masimo.com/generalFloor/system.htm; Masimo Patient SafetyNet System at a Glance, printed on August 20, 2009	
	1281	http://www.masimo.com/partners/GRASEBY.htm; Graseby Medical Limited, printed on August 20, 2009	

Examiner Signature	Date Considered
***Examiner:** Initial if reference 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.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 46 OF 46	Attorney Docket No.	MASCER.002C13

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
	1282	Japanese Office Action, re JP Application No. 2011-516895, mailed September 2, 2014, with translation. (CERCA.007JP).	
	1283	Japanese Notice of Allowance, re JP Application No. 2011-516895, issued on May 12, 2015, no translation. (CERCA/MASCER.007JP).	
	1284	European Office Action issued in application no. 10763901.5 on 01/11/2013. (CERCA.008EP).	
	1285	European Office Action issued in application no. 10763901.5 on 08/27/2014. (CERCA.008EP).	
	1286	European Office Action issued in application no. 10763901.5 on 08/06/2015. (CERCA.008EP).	
	1287	European Office Action issued in Application No. 09791157.2, dated June 20, 2016. (MASCER.002EP).	
	1288	KANUKURTHY et al., "Data Acquisition Unit for an Implantable Multi-Channel Optical Glucose Sensor", Electro/Information Technology Conference, Chicago, IL, USA, May 17-20, 2007, pp. 1-6	
	1289	KONIG et al., "Reflectance Pulse Oximetry - Principles and Obstetric Application in the Zurich System", Journal of Clinical Monitoring and Computing, Vol. 14, No. 6, August 1998, pp. 403-412.	
	1290	SMITH, "The Pursuit of Noninvasive Glucose: 'Hunting the Deceitful Turkey'", 2006	
	1291	SMALL et al., "Data Handling Issues for Near-Infrared Glucose Measurements", http://www.ieee.org/organizations/pubs/newsletters/leos/apr98/datahandling.htm, accessed 11/27/2007	

Examiner Signature	Date Considered
***Examiner:** Initial if reference 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.	

T[1] - Place a check mark in this area when an English language Translation is attached.

Electronic Acknowledgement Receipt

EFS ID:	36963780
Application Number:	16544713
International Application Number:	
Confirmation Number:	9381
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Customer Number:	64735
Filer:	Scott Cromar/Frances Tsai
Filer Authorized By:	Scott Cromar
Attorney Docket Number:	MASCER.002C13
Receipt Date:	23-AUG-2019
Filing Date:	
Time Stamp:	16:54:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		IDS_002C13.pdf	358427 b6a3b3bb73b6378f545ab024e87cc6b78553d702	yes	50

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	1
	Information Disclosure Statement (IDS) Form (SB08)	2	50
Warnings:			
Information:			
	Total Files Size (in bytes):	358427	

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

INFORMATION DISCLOSURE STATEMENT

First Inventor	:	Jeroen Poeze
App. No.	:	16/544713
Filed	:	August 19, 2019
For	:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
Examiner	:	Unassigned
Art Unit	:	2688
Conf. No.	:	9381

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

References and Listing

Pursuant to 37 CFR 1.56, an Information Disclosure Statement listing references is provided herewith. Listed references are of record in U.S. patent application No. 16/534949, filed August 7, 2019, which is the parent of this continuation application, and is relied upon for an earlier filing date under 35 USC 120. Accordingly, copies of references are not submitted pursuant to 37 CFR 1.98(d).

For certain cited non-English patent and/or non-patent references, machine translations of the references (and/or Abstracts) are included, and inclusion is indicated in the last column. Applicant makes no representation as to the accuracy of the English machine translations. If the Examiner would like additional information regarding these references or if anything is unclear, the Examiner is invited to request such information, and Applicant will attempt to comply with any such request.

Pursuant to 37 CFR 1.97(g) and (h), Applicant makes no representation that the information is considered to be material to patentability. Additionally, inclusion on this list is not an admission that any of the cited documents are prior art in this application. Further, Applicant makes no representation regarding the completeness of this list, or that better art does not exist.

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 1 OF 1	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	5,358,519	10-25-1994	Grandjean	
	2	5,687,717	11-18-1997	Halpern et al.	
	3	6,018,673	01-25-2000	Chin et al.	
	4	6,167,258	12-26-2000	Schmidt et al.	
	5	6,175,752	01-16-2001	Say et al.	
	6	6,241,684	06-05-2001	Amano et al.	
	7	6,470,893	10-29-2002	Boesen, Peter V.	
	8	6,516,289	02-04-2003	David et al.	
	9	6,650,939	11-18-2003	Takpke, II et al.	
	10	6,897,788	05-24-2005	Khair et al.	
	11	7,884,314	02-08-2011	Hamada	
	12	2002/0045836	04-18-2002	Alkawwas	

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	**T[1]**

NON PATENT LITERATURE DOCUMENTS			
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Examiner Signature	Date Considered
***Examiner:** Initial if reference 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.	

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Electronic Acknowledgement Receipt	
EFS ID:	36995947
Application Number:	16544713
International Application Number:	
Confirmation Number:	9381
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Customer Number:	64735
Filer:	Scott Cromar/Frances Tsai
Filer Authorized By:	Scott Cromar
Attorney Docket Number:	MASCER.002C13
Receipt Date:	27-AUG-2019
Filing Date:	
Time Stamp:	18:08:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		IDS_002C13.pdf	47582 eac3ef3ad652f2685b804b0297209a6c3c57aea4	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	2
	Information Disclosure Statement (IDS) Form (SB08)	3	3
Warnings:			
Information:			
	Total Files Size (in bytes):	47582	

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New International Application Filed with the USPTO as a Receiving Office
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INFORMATION DISCLOSURE STATEMENT

First Inventor	:	Jeroen Poeze
App. No.	:	16/544713
Filed	:	August 19, 2019
For	:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
Examiner	:	Unassigned
Art Unit	:	2688
Conf. No.	:	9381

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

References and Listing

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Pursuant to 37 CFR 1.97(g) and (h), Applicant makes no representation that the information is considered to be material to patentability. Additionally, inclusion on this list is not an admission that any of the cited documents are prior art in this application. Further, Applicant makes no representation regarding the completeness of this list, or that better art does not exist.

No Disclaimers

To the extent that anything in the Information Disclosure Statement or the listed references could be construed as a disclaimer of any subject matter supported by the present application, Applicant hereby rescinds and retracts such disclaimer.

Timing of Disclosure

This Information Disclosure Statement is being filed within three months of the filing date or date of national phase entry, and no fee is believed to be required.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: August 27, 2019

By: /Scott Cromar/_____
Scott A. Cromar
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Registered Practitioner
Customer No. 64735
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31216818

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/544,713	08/19/2019	2688	2120	MASCER.002C13	1	1

CONFIRMATION NO. 9381

64735
KNOBBE, MARTENS, OLSON & BEAR, LLP
MASIMO CORPORATION (MASIMO)
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

FILING RECEIPT

OC000000110732545

Date Mailed: 08/29/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Jeroen Poeze, Rancho Santa Margarita, CA;
Marcelo Lamego, Cupertino, CA;
Sean Merritt, Lake Forest, CA;
Cristiano Dalvi, Lake Forest, CA;
Hung Vo, Fountain Valley, CA;
Johannes Bruinsma, Opeinde, NETHERLANDS;
Ferdyan Lesmana, Irvine, CA;
Massi Joe E. Kiani, Laguna Niguel, CA;
Greg Olsen, Lake Forest, CA;

Applicant(s)

Masimo Corporation, Irvine, CA;

Power of Attorney: The patent practitioners associated with Customer Number 64735

Domestic Priority data as claimed by applicant

This application is a CON of 16/534,949 08/07/2019
which is a CON of 16/409,515 05/10/2019 PAT 10376191
which is a CON of 16/261,326 01/29/2019 PAT 10292628
which is a CON of 16/212,537 12/06/2018 PAT 10258266
which is a CON of 14/981,290 12/28/2015 PAT 10335068
which is a CON of 12/829,352 07/01/2010 PAT 9277880
which is a CON of 12/534,827 08/03/2009 ABN
which claims benefit of 61/086,060 08/04/2008

and claims benefit of 61/086,108 08/04/2008
and claims benefit of 61/086,063 08/04/2008
and claims benefit of 61/086,057 08/04/2008
and claims benefit of 61/091,732 08/25/2008
and said 12/829,352 07/01/2010
is a CIP of 12/497,528 07/02/2009 PAT 8577431
which claims benefit of 61/086,060 08/04/2008
and claims benefit of 61/086,108 08/04/2008
and claims benefit of 61/086,063 08/04/2008
and claims benefit of 61/086,057 08/04/2008
and claims benefit of 61/078,228 07/03/2008
and claims benefit of 61/078,207 07/03/2008
and claims benefit of 61/091,732 08/25/2008
and is a CIP of 29/323,408 08/25/2008 PAT D606659
and is a CIP of 29/323,409 08/25/2008 PAT D621516
and said 12/829,352 07/01/2010
is a CIP of 12/497,523 07/02/2009 PAT 8437825
which claims benefit of 61/086,060 08/04/2008
and claims benefit of 61/086,108 08/04/2008
and claims benefit of 61/086,063 08/04/2008
and claims benefit of 61/086,057 08/04/2008
and claims benefit of 61/078,228 07/03/2008
and claims benefit of 61/078,207 07/03/2008
and claims benefit of 61/091,732 08/25/2008
and is a CIP of 29/323,408 08/25/2008 PAT D606659
and is a CIP of 29/323,409 08/25/2008 PAT D621516

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 08/28/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/544,713**

Projected Publication Date: 12/05/2019

Non-Publication Request: No

Early Publication Request: No

Title

MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Preliminary Class

369

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/544,713

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	1 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 460 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						400
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2120

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L 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".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/544,713	08/19/2019	Jeroen Poeze	MASCER.002C13	9381

64735 7590 09/10/2019

KNOBBE, MARTENS, OLSON & BEAR, LLP
MASIMO CORPORATION (MASIMO)
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

EXAMINER	

ART UNIT	PAPER NUMBER
3791	

NOTIFICATION DATE	DELIVERY MODE
09/10/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

efiling@knobbe.com
jayna.cartee@knobbe.com

Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 16/544,713	**Applicant(s)** Poeze et al.	
	Examiner CHERYL P GIBSON BAYLOR	**Art Unit** OPET	**AIA (FITF) Status** No

1. THE REQUEST FILED 19 August 2019 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination

A. ☑ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;

B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;

C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to CHERYL GIBSON BAYLOR at (571)272-3213. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/CHERYL GIBSON BAYLOR/ Paralegal Specialist, OPET	

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/544,713	08/19/2019	Jeroen Poeze	MASCER.002C13	9381

64735 7590 09/11/2019

KNOBBE, MARTENS, OLSON & BEAR, LLP
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EXAMINER	

ART UNIT	PAPER NUMBER
3791	

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09/11/2019	ELECTRONIC

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Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 16/544,713	**Applicant(s)** Poeze et al.	
	Examiner CHERYL P GIBSON BAYLOR	**Art Unit** OPET	**AIA (FITF) Status** No

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C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to CHERYL GIBSON BAYLOR at (571)272-3213. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/CHERYL GIBSON BAYLOR/ Paralegal Specialist, OPET	

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/544,713	08/19/2019	Jeroen Poeze	MASCER.002C13	9381

64735 7590 09/23/2019

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IRVINE, CA 92614

EXAMINER	
LIU, CHU CHUAN	

ART UNIT	PAPER NUMBER
3791	

NOTIFICATION DATE	DELIVERY MODE
09/23/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

efiling@knobbe.com
jayna.cartee@knobbe.com

Office Action Summary	Application No. 16/544,713	Applicant(s) Poeze et al.	
	Examiner CHU CHUAN LIU	Art Unit 3791	AIA (FITF) Status No

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

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 08/19/2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 08/19/2019 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

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)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

Notice of Pre-AIA or AIA Status

1. The present application is being examined under the pre-AIA first to invent provisions.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claim 1 is rejected under pre-AIA 35 U.S.C. 102(b) as being anticipated by Clarke et al. (USPN 5,222,496 – applicant cited). In regard to claim 1, Clarke discloses a noninvasive device capable of producing a signal responsive to light attenuated by tissue at a measurement site (Figs. 1-4 and associated descriptions), the device comprising: an optical source (laser diode elements 12a-12f , Fig. 2 and associated descriptions) configured to emit optical radiation at least at wavelengths between about 1600 nm and about 1700 nm (about 1600nm; 1630-1660nm, Col 5 lines 34-48); and a plurality of photodetectors (elements 14a-14f, Fig. 2 and associated descriptions) each configured to detect the optical radiation from said optical source after attenuation by said tissue of said measurement site (Fig. 2 and associated descriptions; Col 3 lines 18-40; Col 5 line 49 – Col 6 line 9) and each output a respective signal stream responsive to said detected optical radiation (Fig. 2 and associated descriptions; Col 3 lines 18-40; Col 5 line 49 – Col 6 line 9).

Double Patenting

4. Claim 1 of this application is patentably indistinct from claim 1 of Application Nos. **16/541,987** and **16/544,755**. Pursuant to 37 CFR 1.78(f), when two or more applications filed by the same applicant or assignee contain patentably indistinct claims, elimination of such claims from all but one application may be required in the absence of good and sufficient reason for their retention during pendency in more than one application. Applicant is required to either cancel the patentably indistinct claims from all but one application or maintain a clear line of demarcation between the applications. See MPEP § 822.

5. A rejection based on double patenting of the "same invention" type finds its support in the language of 35 U.S.C. 101 which states that "whoever invents or discovers any new and useful process... may obtain a patent therefor..." (Emphasis added). Thus, the term "same invention," in this context, means an invention drawn to identical subject matter. See *Miller v. Eagle Mfg. Co.*, 151 U.S. 186 (1894); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Ockert*, 245 F.2d 467, 114 USPQ 330 (CCPA 1957).

A statutory type (35 U.S.C. 101) double patenting rejection can be overcome by canceling or amending the claims that are directed to the same invention so they are no longer coextensive in scope. The filing of a terminal disclaimer cannot overcome a double patenting rejection based upon 35 U.S.C. 101.

6. Claim 1 provisionally rejected under 35 U.S.C. 101 as claiming the same invention as that of claim 1 of copending Application No. **16/541,987** (reference application). This is a provisional statutory double patenting rejection since the claims directed to the same invention have not in fact been patented.

7. Claim 1 provisionally rejected under 35 U.S.C. 101 as claiming the same invention as that of claim 1 of copending Application No. **16/544,755** (reference application). This is a provisional statutory double patenting rejection since the claims directed to the same invention have not in fact been patented.

8. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory

double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

9. Claim 1 is rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1, 9-10 and 17 of U.S. Patent No. **9,277,880** in view of Clarke. In regard to claim 1 of present application, Claims 1, 9-10 and 17 of ‘880 recites a noninvasive device capable of producing a signal responsive to light attenuated by tissue at a measurement site (claims 1 and 10), the device comprising: an optical source (claims 1 and 10) configured to emit optical radiation at least at wavelengths

between about 1600 nm and about 1700 nm (claims 9 and 17); and a plurality of photodetectors (claims 1 and 10) each configured to detect the optical radiation from said optical source after attenuation by said tissue of said measurement site (claims 1 and 10) but does not specifically disclose each output a respective signal stream responsive to said detected optical radiation.

Clarke teaches each detector outputs a respective signal stream responsive to said detected optical radiation (convert these light waves into a series of electrical signals, Col 5 lines 49-60).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the sensor (Claims 1, 9-10 and 17 of '880) to incorporate outputting a respective signal stream responsive to said detected optical radiation from each detector as taught by Clarke, since both devices are noninvasive optical sensing systems and one of ordinary skill in the art would have recognized that the detected optical signals should be sent to an analyzer for calculation (see Clarke). The rationale would have been to obtain physiological information of the tissue from the detected optical signals.

10. Claim 1 is rejected on the ground of nonstatutory double patenting as being unpatentable over claims 7 and 16 of U.S. Patent No. **10,292,628** in view of Clarke. In regard to claim 1 of present application, Claims 7 and 16 of '628 recite a noninvasive device capable of producing a signal responsive to light attenuated by tissue at a measurement site (claims 7 and 16), the device comprising: an optical source configured to emit optical radiation (claim 7); and a plurality of photodetectors (claim 7)

each configured to detect the optical radiation from said optical source after attenuation by said tissue of said measurement site (claim 7) and the device is configured data for determining measurements of glucose (claim 16) but does not specifically disclose the emission of at least at wavelengths between about 1600 nm and about 1700 nm each output a respective signal stream responsive to said detected optical radiation.

Clarke teaches the use of emission of at least at wavelengths between about 1600 nm and about 1700 nm and each detector outputs a respective signal stream responsive to said detected optical radiation (about 1600nm; 1630-1660nm, Col 5 lines 34-48; and convert these light waves into a series of electrical signals, Col 5 lines 49-60).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the sensor (Claims 7 and 16 of '628) to incorporate using of emission of at least at wavelengths between about 1600 nm and about 1700 nm outputting a respective signal stream responsive to said detected optical radiation from each detector as taught by Clarke, since both devices are noninvasive optical sensing systems for glucose detection and one of ordinary skill in the art would have recognized that the use of at wavelengths between about 1600 nm and about 1700 nm facilitate detecting glucose information and the detected optical signals should be sent to an analyzer for glucose calculation (see Clarke). The rationale would have been to incorporate suitable wavelengths for obtaining glucose information of the tissue from the detected optical signals.

11. Claim 1 is rejected on the ground of nonstatutory double patenting as being unpatentable over claims 19 and 23 of U.S. Patent No. **10,299,708** in view of Clarke. In regard to claim 1 of present application, claims 19 and 23 of '708 recite a noninvasive device capable of producing a signal responsive to light attenuated by tissue at a measurement site (claims 19 and 23), the device comprising: an optical source configured to emit optical radiation (claim 19); and a plurality of photodetectors (claim 19) each configured to detect the optical radiation from said optical source after attenuation by said tissue of said measurement site (claim 19) and the device is configured data for determining measurements of glucose (claim 23) but does not specifically disclose the emission of at least at wavelengths between about 1600 nm and about 1700 nm each output a respective signal stream responsive to said detected optical radiation.

Clarke teaches the use of emission of at least at wavelengths between about 1600 nm and about 1700 nm and each detector outputs a respective signal stream responsive to said detected optical radiation (about 1600nm; 1630-1660nm, Col 5 lines 34-48; and convert these light waves into a series of electrical signals, Col 5 lines 49-60).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the sensor (Claims 19 and 23 of '708) to incorporate using of emission of at least at wavelengths between about 1600 nm and about 1700 nm outputting a respective signal stream responsive to said detected optical radiation from each detector as taught by Clarke, since both devices are noninvasive optical sensing systems for glucose detection and one of ordinary skill in the art would have

recognized that the use of at wavelengths between about 1600 nm and about 1700 nm facilitate detecting glucose information and the detected optical signals should be sent to an analyzer for glucose calculation (see Clarke). The rationale would have been to incorporate suitable wavelengths for obtaining glucose information of the tissue from the detected optical signals.

12. Claim 1 is rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1, 18, 26-27, and 30 of U.S. Patent No. **10,376,190** in view of Clarke. In regard to claim 1 of present application, claims 1, 18, 26-27, and 30 of '190 recite a noninvasive device capable of producing a signal responsive to light attenuated by tissue at a measurement site (claims 1, 18, 26-27, and 30), the device comprising: an optical source configured to emit optical radiation (claims 1 and 26); and a plurality of photodetectors (claims 1 and 26) each configured to detect the optical radiation from said optical source after attenuation by said tissue of said measurement site (claims 1 and 26) and the device is configured data for determining measurements of glucose (claims 18 and 30) but does not specifically disclose the emission of at least at wavelengths between about 1600 nm and about 1700 nm each output a respective signal stream responsive to said detected optical radiation.

Clarke teaches the use of emission of at least at wavelengths between about 1600 nm and about 1700 nm and each detector outputs a respective signal stream responsive to said detected optical radiation (about 1600nm; 1630-1660nm, Col 5 lines 34-48; and convert these light waves into a series of electrical signals, Col 5 lines 49-60).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the sensor (Claims 1, 18, 26-27, and 30 of '190) to incorporate using of emission of at least at wavelengths between about 1600 nm and about 1700 nm outputting a respective signal stream responsive to said detected optical radiation from each detector as taught by Clarke, since both devices are noninvasive optical sensing systems for glucose detection and one of ordinary skill in the art would have recognized that the use of at wavelengths between about 1600 nm and about 1700 nm facilitate detecting glucose information and the detected optical signals should be sent to an analyzer for glucose calculation (see Clarke). The rationale would have been to incorporate suitable wavelengths for obtaining glucose information of the tissue from the detected optical signals.

Conclusion

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to CHU CHUAN LIU whose telephone number is (571)270-5507. The examiner can normally be reached on M-Th (8am-6pm).

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jacqueline Cheng can be reached on (571) 272-5596. The fax phone

number for the organization where this application or proceeding is assigned is 571-273-8300.

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). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/CHU CHUAN LIU/
Examiner, Art Unit 3791

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/544,713	Poeze et al.
	Examiner	**Art Unit**
	CHU CHUAN LIU	3791

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant						☐ CPA		☐ T.D.		☐ R.1.47
CLAIM		**DATE**								
Final	Original	09/17/2019								
	1	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/544,713	Poeze et al.
	Examiner	Art Unit
	CHU CHUAN LIU	3791

CPC - Searched*		
Symbol	Date	Examiner
A61B5/1455,14551,14552,14532,6829,6838,6816,6843,14546,6826	09/17/2019	CCL

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor Name Search (PALM and EAST)	09/17/2019	CCL
EAST Search (TEXT, USPGPUB, USPAT, CPC) See SEarch History	09/17/2019	CCL
Google NPL Search	09/17/2019	CCL

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/CHU CHUAN LIU/ Examiner, Art Unit 3791	

References for Examiner Consideration

Applicant wishes to draw the Examiner's attention to, and encourages the Examiner to review, the following co-owned patents and/or applications and their existing and ongoing prosecution history, including without limitation Office Actions, Amendments, Remarks, and any other potentially relevant documents:

Docket No.	Patent No.	Title	Issued
MASCER.002C1	9,277,880	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	03/08/2016
MASCER.002C2	10,335,068	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	07/02/2019
MASCER.002C3	10,258,265	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	04/16/2019
MASCER.002C4	10,258,266	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	04/16/2019
MASCER.002C5	10,299,708	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	05/28/2019
MASCER.002C6	10,292,628	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	05/21/2019
MASCER.002C7	10,376,190	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/13/2019
MASCER.002C8	10,376,191	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/13/2019
MASCER.003A	8,630,691	MULTI-STREAM SENSOR FRONT ENDS FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	01/14/2014
MASCER.003D1	8,909,310	MULTI-STREAM SENSOR FRONT ENDS FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	12/09/2014
MASCER.004A	8,203,704	MULTI-STREAM SENSOR FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	06/19/2012
MASCER.004C1	8,570,503	HEAT SINK FOR NONINVASIVE MEDICAL SENSOR	10/29/2013
CERCA.005A	8,515,509	MULTI-STREAM EMITTER FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/20/2013
MASCER.006A	8,577,431	NOISE SHIELDING FOR A NONINVASIVE DEVICE	11/05/2013

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.L/

Docket No.	Patent No.	Title	Issued
MASCER.006C1	9,717,425	NOISE SHIELDING FOR A NONINVASIVE DEVICE	08/01/2017
MASCER.007A	8,437,825	CONTOURED PROTRUSION FOR IMPROVING SPECTROSCOPIC MEASUREMENT OF BLOOD CONSTITUENTS	05/07/2013
MASCER.007C1	9,591,975	CONTOURED PROTRUSION FOR IMPROVING SPECTROSCOPIC MEASUREMENT OF BLOOD CONSTITUENTS	03/14/2017
MASCER.008A	8,688,183	EMITTER DRIVER FOR NONINVASIVE PATIENT MONITOR	04/01/2014
MASCER.008C1	9,186,102	EMITTER DRIVER FOR NONINVASIVE PATIENT MONITOR	11/17/2015
MASCER.008C2	9,668,680	EMITTER DRIVER FOR NONINVASIVE PATIENT MONITOR	06/06/2017
MASCER.009DA	D621516	PATIENT MONITORING SENSOR	08/10/2010
MASCER.010DA	D606659	PATIENT MONITOR	12/22/2009

Docket No.	Serial No.	Title	Filed
MASCER.002A	12/534827	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/03/2009
MASCER.002C9	16/449143	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	06/21/2019
MASCER.002C10	16/534956	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/07/2019
MASCER.002C11	16/534949	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/07/2019
MASCER.002C12	16/541987	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/15/2019
MASCER.002C14	16/544755	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/19/2019
MASCER.004C3	14/064055	MULTI-STREAM SENSOR FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	10/25/2013
MASCER.006C2	15/660743	NOISE SHIELDING FOR A NONINVASIVE DEVICE	07/26/2017
MASCER.011A	12/497506	HEAT SINK FOR NONINVASIVE MEDICAL SENSOR	07/02/2009
MAS.1007A	15/195199	ADVANCED PULSE OXIMETRY SENSOR	06/28/2016
MAS.1007C1	16/226249	ADVANCED PULSE OXIMETRY SENSOR	12/19/2018
MAS.1007C2	16/532061	ADVANCED PULSE OXIMETRY SENSOR	08/05/2019

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Docket No.	Serial No.	Title	Filed
MAS.1007C3	16/532065	ADVANCED PULSE OXIMETRY SENSOR	08/05/2019

Applicant notes that cited references, office actions, responses and notices of allowance currently exist or will exist with reference to the above-referenced matters. Applicant also understands that the Examiner has access to sophisticated online Patent Office computing systems that provide ready access to the full file histories of these matters including, for example, specifications, drawings, pending claims, cited art, office actions, responses, declarations, and notices of allowance. Rather than submit copies of these file histories, Applicant respectfully requests that the Examiner continue to review these file histories online for past, current, and future information about these matters that may be relevant to examination of the present application. Also, if the Examiner cannot readily access these file histories, Applicant would be pleased to provide any portion of any of the file histories at any time upon specific Examiner request.

No Disclaimers

To the extent that anything in the Information Disclosure Statement or the listed references could be construed as a disclaimer of any subject matter supported by the present application, Applicant hereby rescinds and retracts such disclaimer.

Timing of Disclosure

This Information Disclosure Statement is being filed within three months of the filing date or date of national phase entry, and no fee is believed to be required.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: August 23, 2019

By: /Scott Cromar/_____
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Customer No. 64735
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31175893

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 1 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	3,910,701	10-07-1975	Henderson et al.	
	2	4,114,604	09-19-1978	Shaw et al.	
	3	4,258,719	03-31-1981	Lewyn	
	4	4,267,844	05-19-1981	Yamanishi	
	5	4,438,338	03-20-1984	Stitt	
	6	4,444,471	04-24-1984	Ford et al.	
	7	4,653,498	03-31-1987	New, Jr. et al.	
	8	4,655,225	04-07-1987	Dahne et al.	
	9	4,684,245	08-04-1987	Goldring	
	10	4,709,413	11-24-1987	Forrest	
	11	4,755,676	07-05-1988	Gaalema et al.	
	12	4,781,195	11-01-1988	Martin	
	13	4,805,623	02-21-1989	Jöbsis	
	14	4,880,304	11-14-1989	Jaeb et al.	
	15	4,960,128	10-02-1990	Gordon et al.	
	16	4,964,408	10-23-1990	Hink et al.	
	17	5,028,787	07-02-1991	Rosenthal, et al.	
	18	5,035,243	07-30-1991	Muz, Edwin	
	19	5,041,187	08-20-1991	Hink et al.	
	20	5,043,820	08-27-1991	Wyles et al.	
	21	5,069,213	12-03-1991	Polczynski	
	22	5,069,214	12-03-1991	Samaras et al.	
	23	5,077,476	12-31-1991	Rosenthal	
	24	5,086,229	02-04-1992	Rosenthal et al.	
	25	5,099,842	03-31-1992	Mannheimer et al.	
	26	5,122,925	06-16-1992	Inpyn	
	27	5,131,391	07-21-1992	Sakai et al.	
	28	5,137,023	08-11-1992	Mendelson, et al.	
	29	5,159,929	11-03-1992	McMillen et al.	

Examiner Signature	Date Considered
***Examiner:** Initial if reference 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.	

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SHEET 2 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	30	5,163,438	11-17-1992	Gordon et al.	
	31	5,222,295	06-29-1993	Dorris, Jr.	
	32	5,222,495	06-29-1993	Clarke et al.	
	33	5,222,496	06-29-1993	Clarke et al.	
	34	5,249,576	10-05-1993	Goldberger et al.	
	35	5,250,342	10-05-1993	Lang	
	36	5,278,627	01-11-1994	Aoyagi et al.	
	37	5,297,548	03-29-1994	Pologe, Jonas A.	
	38	5,319,355	06-07-1994	Russek	
	39	5,337,744	08-16-1994	Branigan	
	40	5,337,745	08-16-1994	Benaron	
	41	5,341,805	08-30-1994	Stavridi, et al.	
	42	5,362,966	11-08-1994	Rosenthal et al.	
	43	5,377,676	01-03-1995	Vari, et al.	
	44	5,427,093	06-27-1995	Ogawa et al.	
	45	5,431,170	07-11-1995	Mathews	
	46	5,437,275	08-01-1995	Amundsen et al.	
	47	5,441,054	08-15-1995	Tsuchiya	
	48	5,452,717	09-26-1995	Branigan et al.	
	49	5,456,252	10-10-1995	Vari, et al.	
	50	5,479,934	01-02-1996	Imran	
	51	5,482,034	01-09-1996	Lewis et al.	
	52	5,482,036	01-09-1996	Diab et al.	
	53	5,490,505	02-13-1996	Diab et al.	
	54	5,490,506	02-13-1996	Takatani et al.	
	55	5,494,043	02-27-1996	O'Sullivan et al.	
	56	5,497,771	03-12-1996	Rosenheimer	
	57	5,511,546	04-30-1996	Hon	
	58	5,533,511	07-09-1996	Kaspari et al.	

Examiner Signature	Date Considered
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	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 3 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	59	5,534,851	07-09-1996	Russek	
	60	5,551,422	09-03-1996	Simonsen et al.	
	61	5,553,615	09-10-1996	Carim et al.	
	62	5,553,616	09-09-1996	Ham et al.	
	63	5,561,275	10-01-1996	Savage, et al.	
	64	5,562,002	10-08-1996	Lalin	
	65	5,584,296	12-17-1997	Cui et al.	
	66	5,590,649	01-07-1997	Caro et al.	
	67	5,601,079	02-11-1997	Wong et al.	
	68	5,602,924	02-11-1997	Durand et al.	
	69	5,623,925	04-29-1997	Swenson et al.	
	70	5,625,458	04-29-1997	Alfano et al.	
	71	5,632,272	05-27-1997	Diab et al.	
	72	5,638,816	06-17-1997	Kiani-Azarbayjany et al.	
	73	5,638,818	06-17-1997	Diab et al.	
	74	5,645,440	07-08-1997	Tobler et al.	
	75	5,676,143	10-14-1997	Simonsen, et al.	
	76	5,685,299	11-11-1997	Diab et al.	
	77	5,743,262	04-28-1998	Lepper, Jr. et al.	
	78	5,750,927	05-12-1998	Baltazar, Osni	
	79	5,752,914	05-19-1998	Delonzor et al.	
	80	5,758,644	06-02-1998	Diab et al.	
	81	5,760,910	06-02-1998	Lepper, Jr. et al.	
	82	5,766,131	06-16-1998	Kondo et al.	
	83	5,769,785	06-23-1998	Diab et al.	
	84	5,782,757	07-21-1998	Diab et al.	
	85	5,785,659	07-28-1998	Caro et al.	
	86	5,791,347	08-11-1998	Flaherty et al.	
	87	5,792,052	08-11-1998	Isaacson et al.	

Examiner Signature	Date Considered
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(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 4 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	88	5,810,734	09-22-1998	Caro et al.	
	89	5,823,950	10-20-1998	Diab et al.	
	90	5,826,885	10-27-1998	Helgeland	
	91	5,830,131	11-03-1998	Caro et al.	
	92	5,830,137	11-03-1998	Scharf	
	93	5,833,618	11-10-1998	Caro et al.	
	94	5,851,178	12-22-1998	Aronow	
	95	5,860,919	01-19-1999	Kiani-Azarbayjany et al.	
	96	5,890,929	04-06-1999	Mills et al.	
	97	5,902,235	05-11-1999	Lewis et al.	
	98	5,903,357	05-11-1999	Colak	
	99	5,904,654	05-18-1999	Wohltmann et al.	
	100	5,919,134	07-06-1999	Diab	
	101	5,934,925	08-10-1999	Tobler et al.	
	102	5,940,182	08-17-1999	Lepper, Jr. et al.	
	103	5,957,840	09-28-1999	Terasawa et al.	
	104	5,987,343	11-16-1999	Kinast	
	105	5,995,855	11-30-1999	Kiani et al.	
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	111	6,045,509	04-04-2000	Caro et al.	
	112	6,049,727	04-11-2000	Crothall, Katherine D.	
	113	6,067,462	05-23-2000	Diab et al.	
	114	6,081,735	06-27-2000	Diab et al.	
	115	6,088,607	07-11-2000	Diab et al.	
	116	6,110,522	08-29-2000	Lepper, Jr. et al.	

Examiner Signature	Date Considered
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PTO/SB/08 Equivalent

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SHEET 5 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	117	6,124,597	09-26-2000	Shehada	
	118	6,128,521	10-03-2000	Marro et al.	
	119	6,129,675	10-10-2000	Jay	
	120	6,144,866	11-07-2000	Miesel et al.	
	121	6,144,868	11-07-2000	Parker	
	122	6,151,516	11-21-2000	Kiani-Azarbayjany et al.	
	123	6,152,754	11-28-2000	Gerhardt et al.	
	124	6,157,850	12-05-2000	Diab et al.	
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	126	6,172,743	01-09-2001	Kley, et al.	
	127	6,181,958	01-30-2001	Steuer et al.	
	128	6,184,521	02-06-2001	Coffin, IV et al.	
	129	6,206,830	03-27-2001	Diab et al.	
	130	6,223,063	04-24-2001	Chaiken et al.	
	131	6,229,856	05-08-2001	Diab et al.	
	132	6,232,609	05-15-2001	Snyder, et al.	
	133	6,236,872	05-22-2001	Diab et al.	
	134	6,241,683	06-05-2001	Macklem, et al.	
	135	6,253,097	06-26-2001	Aronow et al.	
	136	6,256,523	07-03-2001	Diab et al.	
	137	6,263,222	07-17-2001	Diab et al.	
	138	6,278,522	08-21-2001	Lepper, Jr. et al.	
	139	6,278,889	08-21-2001	Robinson	
	140	6,280,213	08-28-2001	Tobler et al.	
	141	6,285,896	09-04-2001	Tobler et al.	
	142	6,301,493	10-09-2001	Marro et al.	
	143	6,308,089	10-23-2001	von der Ruhr et al.	
	144	6,317,627	11-13-2001	Ennen et al.	
	145	6,321,100	11-20-2001	Parker	

Examiner Signature	Date Considered

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U.S. PATENT DOCUMENTS					
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	146	6,325,761	12-04-2001	Jay	
	147	6,334,065	12-25-2001	Al-Ali et al.	
	148	6,343,223	01-29-2002	Chin et al.	
	149	6,343,224	01-29-2002	Parker	
	150	6,345,194	02-05-2002	Robert Nelson, et al.	
	151	6,349,228	02-19-2002	Kiani et al.	
	152	6,353,750	03-05-2002	Kimura et al.	
	153	6,360,113	03-09-2002	Dettling, Allen	
	154	6,360,114	03-09-2002	Diab et al.	
	155	6,360,115	03-19-2002	Roger Greenwald, et al.	
	156	6,368,283	04-09-2002	Xu, et al.	
	157	6,371,921	04-16-2002	Caro et al.	
	158	6,377,829	04-23-2002	Al-Ali	
	159	6,388,240	05-14-2002	Schulz et al.	
	160	6,397,091	05-28-2002	Diab et al.	
	161	6,430,437	08-06-2002	Marro	
	162	6,430,525	08-06-2002	Weber et al.	
	163	6,463,311	10-08-2002	Diab	
	164	6,470,199	10-22-2002	Kopotic et al.	
	165	6,501,975	12-31-2002	Diab et al.	
	166	6,505,059	01-07-2003	Kollias, et al.	
	167	6,515,273	02-04-2003	Al-Ali	
	168	6,519,487	02-11-2003	Parker	
	169	6,522,521	02-18-2003	Mizuno et al.	
	170	6,525,386	02-25-2003	Mills et al.	
	171	6,526,300	02-25-2003	Kiani et al.	
	172	6,541,756	04-01-2003	Schulz et al.	
	173	6,542,764	04-01-2003	Al-Ali et al.	
	174	6,580,086	06-17-2003	Schulz et al.	

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U.S. PATENT DOCUMENTS					
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	175	6,584,336	06-24-2003	Ali et al.	
	176	6,595,316	07-22-2003	Cybulski et al.	
	177	6,597,932	07-22-2003	Tian et al.	
	178	6,597,933	07-22-2003	Kiani et al.	
	179	6,606,509	08-12-2003	Schmitt, Joseph M.	
	180	6,606,511	08-12-2003	Ali et al.	
	181	6,632,181	10-14-2003	Flaherty et al.	
	182	6,636,759	10-21-2003	Robinson	
	183	6,639,668	10-28-2003	Trepagnier, Pierre	
	184	6,639,867	10-28-2003	Shim	
	185	6,640,116	10-28-2003	Diab	
	186	6,643,530	11-04-2003	Diab et al.	
	187	6,650,917	11-18-2003	Diab et al.	
	188	6,654,624	11-25-2003	Diab et al.	
	189	6,658,276	12-02-2003	Kiani et al.	
	190	6,661,161	12-09-2003	Lanzo et al.	
	191	6,668,185	12-23-2003	Toida	
	192	6,671,526	12-30-2003	Aoyagi et al.	
	193	6,671,531	12-30-2003	Al-Ali et al.	
	194	6,678,543	01-13-2004	Diab et al.	
	195	6,681,133	01-20-2004	Chaiken et al.	
	196	6,684,090	01-27-2004	Ali et al.	
	197	6,684,091	01-27-2004	Parker	
	198	6,697,656	02-24-2004	Al-Ali	
	199	6,697,657	02-24-2004	Shehada, et al.	
	200	6,697,658	02-24-2004	Al-Ali	
	201	6,699,194	03-02-2004	Diab et al.	
	202	6,714,804	03-30-2004	Al-Ali et al.	
	203	6,721,582	04-13-2004	Trepagnier, et al.	

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	204	6,721,585	04-13-2004	Parker	
	205	6,725,075	04-20-2004	Al-Ali	
	206	6,728,560	04-27-2004	Kollias, et al.	
	207	6,735,459	05-11-2004	Parker	
	208	6,745,060	06-01-2004	Diab et al.	
	209	6,748,254	06-08-2004	O'Neil et al.	
	210	6,760,607	07-06-2004	Al-Ali	
	211	6,770,028	08-03-2004	Ali et al.	
	212	6,771,994	08-03-2004	Kiani et al.	
	213	6,792,300	09-14-2004	Diab et al.	
	214	6,801,799	10-05-2004	Mendelson	
	215	6,813,511	11-02-2004	Diab et al.	
	216	6,816,010	11-09-2004	Seetharaman et al.	
	217	6,816,241	11-09-2004	Grubisic, et al.	
	218	6,816,741	11-09-2004	Diab	
	219	6,822,564	11-23-2004	Al-Ali	
	220	6,826,419	11-30-2004	Diab et al.	
	221	6,830,711	12-14-2004	Mills et al.	
	222	6,850,787	02-01-2005	Weber et al.	
	223	6,850,788	02-01-2005	Al-Ali	
	224	6,852,083	02-08-2005	Caro et al.	
	225	6,861,639	03-01-2005	Al-Ali	
	226	6,898,452	05-24-2005	Al-Ali et al.	
	227	6,912,413	06-28-2005	Rantala et al.	
	228	6,920,345	07-19-2005	Al-Ali et al.	
	229	6,931,268	08-16-2005	Kiani-Azarbayjany et al.	
	230	6,934,570	08-23-2005	Kiani et al.	
	231	6,939,305	09-06-2005	Flaherty et al.	
	232	6,943,348	09-13-2005	Coffin IV	

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	233	6,950,687	09-27-2005	Al-Ali	
	234	6,961,598	11-01-2005	Diab	
	235	6,970,792	11-29-2005	Diab	
	236	6,979,812	12-27-2005	Al-Ali	
	237	6,985,764	01-10-2006	Mason et al.	
	238	6,993,371	01-31-2006	Kiani et al.	
	239	6,995,400	02-07-2006	Mizuyoshi	
	240	6,996,427	02-07-2006	Ali et al.	
	241	6,999,904	02-14-2006	Weber et al.	
	242	7,003,338	02-21-2006	Weber et al.	
	243	7,003,339	02-21-2006	Diab et al.	
	244	7,015,451	03-21-2006	Dalke et al.	
	245	7,024,233	04-04-2006	Ali et al.	
	246	7,026,619	04-11-2006	Cranford	
	247	7,027,849	04-11-2006	Al-Ali	
	248	7,030,749	04-18-2006	Al-Ali	
	249	7,039,449	05-02-2006	Al-Ali	
	250	7,041,060	05-09-2006	Flaherty et al	
	251	7,044,918	05-16-2006	Diab	
	252	7,047,054	05-16-2006	Benni	
	253	7,048,687	05-23-2006	Reuss et al.	
	254	7,067,893	06-27-2006	Mills et al.	
	255	7,092,757	08-15-2006	Larson et al.	
	256	7,096,052	08-22-2006	Mason et al.	
	257	7,096,054	08-22-2006	Abdul-Hafiz et al.	
	258	7,113,815	09-26-2006	O'Neil et al.	
	259	7,132,641	11-07-2006	Schulz et al.	
	260	7,142,901	11-28-2006	Kiani et al.	
	261	7,149,561	12-12-2006	Diab	

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	262	7,186,966	03-06-2007	Al-Ali	
	263	7,190,261	03-13-2007	Al-Ali	
	264	7,215,984	05-08-2007	Diab	
	265	7,215,986	05-08-2007	Diab	
	266	7,221,971	05-22-2007	Diab	
	267	7,225,006	05-29-2007	Al-Ali et al.	
	268	7,225,007	05-29-2007	Al-Ali	
	269	7,230,227	06-12-2007	Wilcken et al.	
	270	7,239,905	07-03-2007	Kiani-Azarbayjany et al.	
	271	7,245,953	07-17-2007	Parker	
	272	7,254,429	08-07-2007	Schurman et al.	
	273	7,254,431	08-07-2007	Al-Ali	
	274	7,254,433	08-07-2007	Diab et al.	
	275	7,254,434	08-07-2007	Schulz et al.	
	276	7,272,425	09-18-2007	Al-Ali	
	277	7,274,955	09-25-2007	Kiani et al.	
	278	7,280,858	10-09-2007	Al-Ali et al.	
	279	7,289,835	10-30-2007	Mansfield et al.	
	280	7,292,883	11-06-2007	De Felice et al.	
	281	7,295,866	11-13-2007	Al-Ali	
	282	7,328,053	02-05-2008	Diab et al.	
	283	7,332,784	02-19-2008	Mills, et al.	
	284	7,340,287	03-04-2008	Mason et al.	
	285	7,341,559	03-11-2008	Schulz et al.	
	286	7,343,186	03-11-2008	Lamego et al.	
	287	7,355,512	04-08-2008	Al-Ali	
	288	7,356,365	04-08-2008	Schurman	
	289	7,365,923	04-29-2008	Hargis et al.	
	290	7,371,981	05-13-2008	Abdul-Hafiz	

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	291	7,373,193	05-13-2008	Al-Ali et al.	
	292	7,373,194	05-13-2008	Weber et al.	
	293	7,376,453	05-20-2008	Diab et al.	
	294	7,377,794	05-27-2008	Al Ali et al.	
	295	7,377,899	05-27-2008	Weber et al.	
	296	7,383,070	06-03-2008	Diab et al.	
	297	7,395,189	07-01-2008	Qing et al.	
	298	7,415,297	08-19-2008	Al-Ali et al.	
	299	7,428,432	09-23-2008	Ali et al.	
	300	7,438,683	10-21-2008	Al-Ali et al.	
	301	7,440,787	10-21-2008	Diab	
	302	7,454,240	11-18-2008	Diab et al.	
	303	7,467,002	12-16-2008	Weber et al.	
	304	7,469,157	12-23-2008	Diab et al.	
	305	7,471,969	12-30-2008	Diab et al.	
	306	7,471,971	12-30-2008	Diab et al.	
	307	7,483,729	01-27-2009	Al-Ali et al.	
	308	7,483,730	01-27-2009	Diab et al.	
	309	7,489,958	02-10-2009	Diab et al.	
	310	7,496,391	02-24-2009	Diab et al.	
	311	7,496,393	02-24-2009	Diab et al.	
	312	7,499,741	03-03-2009	Diab et al.	
	313	7,499,835	03-03-2009	Weber et al.	
	314	7,500,950	03-10-2009	Al-Ali et al.	
	315	7,509,153	03-24-2009	Blank et al.	
	316	7,509,154	03-24-2009	Diab et al.	
	317	7,509,494	03-24-2009	Al-Ali	
	318	7,510,849	03-31-2009	Schurman et al.	
	319	7,519,327	04-14-2009	White	

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	320	7,526,328	04-28-2009	Diab et al.	
	321	7,530,942	05-12-2009	Diab	
	322	7,530,949	05-12-2009	Al Ali et al.	
	323	7,530,955	05-12-2009	Diab et al.	
	324	7,563,110	07-21-2009	Al-Ali et al.	
	325	7,596,398	09-29-2009	Al-Ali et al.	
	326	7,601,123	10-13-2009	Tweed, et al.	
	327	7,606,606	10-20-2009	Laakkonen	
	328	7,618,375	11-17-2009	Flaherty	
	329	7,647,083	01-12-2010	Al-Ali et al.	
	330	7,657,294	02-02-2010	Eghbal et al.	
	331	7,657,295	02-02-2010	Coakley et al.	
	332	7,657,296	02-02-2010	Raridan et al.	
	333	7,726,209	06-01-2010	Ruotoistenmäki	
	334	7,729,733	06-01-2010	Al-Ali et al.	
	335	7,734,320	06-08-2010	Al-Ali	
	336	7,761,127	07-20-2010	Al-Ali et al.	
	337	7,761,128	07-20-2010	Al-Ali et al.	
	338	7,764,982	07-27-2010	Dalke et al.	
	339	7,791,155	09-07-2010	Diab	
	340	7,801,581	09-21-2010	Diab	
	341	7,809,418	10-05-2010	Xu	
	342	7,822,452	10-26-2010	Schurman et al.	
	343	7,844,313	11-30-2010	Kiani et al.	
	344	7,844,314	11-30-2010	Al-Ali	
	345	7,844,315	11-30-2010	Al-Ali	
	346	7,862,523	01-04-2011	Ruotoistenmaki	
	347	7,865,222	01-04-2011	Weber et al.	
	348	7,873,497	01-18-2011	Weber et al.	

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	349	7,880,606	02-01-2011	Al-Ali	
	350	7,880,626	02-01-2011	Al-Ali et al.	
	351	7,891,355	02-22-2011	Al-Ali et al.	
	352	7,894,868	02-22-2011	Al-Ali et al.	
	353	7,899,506	03-01-2011	Xu et al.	
	354	7,899,507	03-01-2011	Al-Ali et al.	
	355	7,899,518	03-01-2011	Trepagnier et al.	
	356	7,904,132	03-08-2011	Weber et al.	
	357	7,909,772	03-22-2011	Popov et al.	
	358	7,910,875	03-22-2011	Al-Ali	
	359	7,919,713	04-05-2011	Al-Ali et al.	
	360	7,937,128	05-03-2011	Al-Ali	
	361	7,937,129	05-03-2011	Mason et al.	
	362	7,937,130	05-03-2011	Diab et al.	
	363	7,941,199	05-10-2011	Kiani	
	364	7,951,086	05-31-2011	Flaherty et al.	
	365	7,957,780	06-07-2011	Lamego et al.	
	366	7,962,188	06-14-2011	Kiani et al.	
	367	7,962,190	06-14-2011	Diab et al.	
	368	7,976,472	07-12-2011	Kiani	
	369	7,988,637	08-02-2011	Diab	
	370	7,990,382	08-02-2011	Kiani	
	371	7,991,446	08-02-2011	Ali et al.	
	372	8,000,761	08-16-2011	Al-Ali	
	373	8,008,088	08-08-2011	Bellott et al.	
	374	8,019,400	09-13-2011	Diab et al.	
	375	8,028,701	10-04-2011	Al-Ali et al.	
	376	8,029,765	10-04-2011	Bellott et al.	
	377	8,036,727	10-11-2011	Schurman et al.	

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	378	8,036,728	10-11-2011	Diab et al.	
	379	8,044,998	10-25-2011	Heenan	
	380	8,046,040	10-25-2011	Ali et al.	
	381	8,046,041	10-25-2011	Diab et al.	
	382	8,046,042	10-25-2011	Diab et al.	
	383	8,048,040	11-01-2011	Kiani	
	384	8,050,728	11-01-2011	Al-Ali et al.	
	385	8,118,620	02-21-2012	Al-Ali et al.	
	386	8,126,528	02-28-2012	Diab et al.	
	387	8,126,531	02-28-2012	Crowley	
	388	8,128,572	03-06-2012	Diab et al.	
	389	8,130,105	03-06-2012	Al-Ali et al.	
	390	8,145,287	03-27-2012	Diab et al.	
	391	8,150,487	04-03-2012	Diab et al.	
	392	8,175,672	05-08-2012	Parker	
	393	8,180,420	05-15-2012	Diab et al.	
	394	8,182,443	05-22-2012	Kiani	
	395	8,185,180	05-22-2012	Diab et al.	
	396	8,190,223	05-29-2012	Al-Ali et al.	
	397	8,190,227	05-29-2012	Diab et al.	
	398	8,203,438	06-19-2012	Kiani et al.	
	399	8,203,704	06-19-2012	Merritt et al.	
	400	8,204,566	06-19-2012	Schurman et al.	
	401	8,219,172	07-10-2012	Schurman et al.	
	402	8,219,170	07-10-2012	Hausmann et al.	
	403	8,224,411	07-17-2012	Al-Ali et al.	
	404	8,228,181	07-24-2012	Al-Ali	
	405	8,229,532	07-24-2012	Davis	
	406	8,229,533	07-24-2012	Diab et al.	

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	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	407	8,233,955	07-31-2012	Al-Ali et al.	
	408	8,244,325	08-14-2012	Al-Ali et al.	
	409	8,255,026	08-28-2012	Al-Ali	
	410	8,255,027	08-28-2012	Al-Ali et al.	
	411	8,255,028	08-28-2012	Al-Ali et al.	
	412	8,260,577	09-04-2012	Weber et al.	
	413	8,265,723	09-11-2012	McHale et al.	
	414	8,274,360	09-25-2012	Sampath et al.	
	415	8,280,473	10-02-2012	Al-Ali	
	416	8,289,130	10-16-2012	Nakajima et al.	
	417	8,301,217	10-30-2012	Al-Ali et al.	
	418	8,306,596	11-06-2012	Schurman et al.	
	419	8,310,336	11-13-2012	Muhsin et al.	
	420	8,315,683	11-20-2012	Al-Ali et al.	
	421	8,332,006	12-11-2012	Naganuma et al.	
	422	8,337,403	12-25-2012	Al-Ali et al.	
	423	8,346,330	01-01-2013	Lamego	
	424	8,353,842	01-15-2013	Al-Ali et al.	
	425	8,355,766	01-15-2013	MacNeish, III et al.	
	426	8,359,080	01-22-2013	Diab et al.	
	427	8,364,223	01-29-2013	Al-Ali et al.	
	428	8,364,226	01-29-2013	Diab et al.	
	429	8,364,389	01-29-2013	Dorogusker et al.	
	430	8,374,665	02-12-2013	Lamego	
	431	8,380,272	02-19-2013	Barrett et al.	
	432	8,385,995	02-26-2013	Al-ali et al.	
	433	8,385,996	02-26-2013	Smith et al.	
	434	8,388,353	03-05-2013	Kiani et al.	
	435	8,399,822	03-19-2013	Al-Ali	

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	436	8,401,602	03-19-2013	Kiani	
	437	8,405,608	03-26-2013	Al-Ali et al.	
	438	8,414,499	04-09-2013	Al-Ali et al.	
	439	8,418,524	04-16-2013	Al-Ali	
	440	8,421,022	04-16-2013	Rozenfeld	
	441	8,423,106	04-16-2013	Lamego et al.	
	442	8,428,674	04-23-2013	Duffy et al.	
	443	8,428,967	04-23-2013	Olsen et al.	
	444	8,430,817	04-30-2013	Al-Ali et al.	
	445	8,437,825	05-07-2013	Dalvi et al.	
	446	8,452,364	05-28-2013	Hannula et al.	
	447	8,455,290	06-04-2013	Siskavich	
	448	8,457,703	06-04-2013	Al-Ali	
	449	8,457,707	06-04-2013	Kiani	
	450	8,463,349	06-11-2013	Diab et al.	
	451	8,466,286	06-18-2013	Bellot et al.	
	452	8,471,713	06-25-2013	Poeze et al.	
	453	8,473,020	06-25-2013	Kiani et al.	
	454	8,483,787	07-09-2013	Al-Ali et al.	
	455	8,489,364	07-16-2013	Weber et al.	
	456	8,498,684	07-30-2013	Weber et al.	
	457	8,504,128	08-06-2013	Blank et al.	
	458	8,509,867	08-13-2013	Workman et al.	
	459	8,515,509	08-20-2013	Bruinsma et al.	
	460	8,523,781	09-03-2013	Al-Ali	
	461	8,529,301	09-10-2013	Al-Ali et al.	
	462	8,532,727	09-10-2013	Ali et al.	
	463	8,532,728	09-10-2013	Diab et al.	
	464	8,547,209	10-01-2013	Kiani et al.	

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	465	8,548,548	10-01-2013	Al-Ali	
	466	8,548,549	10-01-2013	Schurman et al.	
	467	8,548,550	10-01-2013	Al-Ali et al.	
	468	8,560,032	10-15-2013	Al-Ali et al.	
	469	8,560,034	10-15-2013	Diab et al.	
	470	8,570,167	10-29-2013	Al-Ali	
	471	8,570,503	10-29-2013	Hung Vo	
	472	8,571,617	10-29-2013	Reichgott et al.	
	473	8,571,618	10-29-2013	Lamego et al.	
	474	8,571,619	10-29-2013	Al-Ali et al.	
	475	8,577,431	11-05-2013	Lamego et al.	
	476	8,581,732	11-12-2013	Al-Ali et al.	
	477	8,584,345	11-19-2013	Al-Ali et al.	
	478	8,588,880	11-19-2013	Abdul-Hafiz et al.	
	479	8,600,467	12-03-2013	Al-Ali et al.	
	480	8,602,971	12-10-2013	Farr	
	481	8,606,342	12-10-2013	Diab	
	482	8,615,290	12-24-2013	Lin et al.	
	483	8,626,255	01-07-2014	Al-Ali et al.	
	484	8,630,691	01-14-2014	Lamego et al.	
	485	8,634,889	01-21-2014	Al-Ali et al.	
	486	8,641,631	02-04-2014	Sierra et al.	
	487	8,652,060	02-18-2014	Al-Ali	
	488	8,655,004	02-18-2014	Prest et al.	
	489	8,663,107	03-04-2014	Kiani	
	490	8,666,468	03-04-2014	Al-Ali	
	491	8,667,967	03-11-2014	Al-Ali et al.	
	492	8,670,811	03-11-2014	O'Reilly	
	493	8,670,814	03-11-2014	Diab et al.	

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	494	8,676,286	03-18-2014	Weber et al.	
	495	8,682,407	03-25-2014	Al-Ali	
	496	8,688,183	04-01-2014	Bruinsma et al.	
	497	8,690,799	04-08-2014	Telfort et al.	
	498	8,700,111	04-15-2014	LeBoeuf et al.	
	499	8,700,112	04-15-2014	Kiani	
	500	8,702,627	04-22-2014	Telfort et al.	
	501	8,706,179	04-22-2014	Parker	
	502	8,712,494	04-29-2014	MacNeish, III et al.	
	503	8,715,206	05-06-2014	Telfort et al.	
	504	8,718,735	05-06-2014	Lamego et al.	
	505	8,718,737	05-06-2014	Diab et al.	
	506	8,718,738	05-01-2014	Blank et al.	
	507	8,720,249	05-13-2014	Al-Ali	
	508	8,721,541	05-13-2014	Al-Ali et al.	
	509	8,721,542	05-13-2014	Al-Ali et al.	
	510	8,723,677	05-13-2014	Kiani	
	511	8,740,792	06-03-2014	Kiani et al.	
	512	8,754,776	06-17-2014	Poeze et al.	
	513	8,755,535	06-17-2014	Telfort et al.	
	514	8,755,856	06-17-2014	Diab et al.	
	515	8,755,872	06-17-2014	Marinow	
	516	8,760,517	06-24-2014	Sarwar et al.	
	517	8,761,850	06-24-2014	Lamego	
	518	8,764,671	07-01-2014	Kiani	
	519	8,768,423	07-01-2014	Shakespeare et al.	
	520	8,771,204	07-08-2014	Telfort et al.	
	521	8,777,634	07-15-2014	Kiani et al.	
	522	8,781,543	07-15-2014	Diab et al.	

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	523	8,781,544	07-15-2014	Al-Ali et al.	
	524	8,781,549	07-15-2014	Al-Ali et al.	
	525	8,788,003	07-22-2014	Schurman et al.	
	526	8,790,268	07-29-2014	Al-Ali	
	527	8,801,613	08-12-2014	Al-Ali et al.	
	528	8,821,397	09-02-2014	Al-Ali et al.	
	529	8,821,415	09-02-2014	Al-Ali et al.	
	530	8,830,449	09-09-2014	Lamego et al.	
	531	8,831,700	09-09-2014	Schurman et al.	
	532	8,840,549	09-23-2014	Al-Ali et al.	
	533	8,845,543	09-30-2014	Diab et al.	
	534	8,847,740	09-30-2014	Kiani et al.	
	535	8,849,365	09-30-2014	Smith et al.	
	536	8,852,094	10-07-2014	Al-Ali et al.	
	537	8,852,994	10-07-2014	Wojtczuk et al.	
	538	8,868,147	10-21-2014	Stippick et al.	
	539	8,868,150	10-21-2014	Al-Ali et al.	
	540	8,870,792	10-28-2014	Al-Ali et al.	
	541	8,886,271	11-11-2014	Kiani et al.	
	542	8,888,539	11-18-2014	Al-Ali et al.	
	543	8,888,708	11-18-2014	Diab et al.	
	544	8,892,180	11-18-2014	Weber et al.	
	545	8,897,847	11-25-2014	Al-Ali	
	546	8,909,310	12-09-2014	Lamego et al.	
	547	8,911,377	12-16-2014	Al-Ali	
	548	8,912,909	12-16-2014	Al-Ali et al.	
	549	8,920,317	12-30-2014	Al-Ali et al.	
	550	8,921,699	12-30-2014	Al-Ali et al	
	551	8,922,382	12-30-2014	Al-Ali et al.	

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	552	8,929,964	01-06-2015	Al-Ali et al.	
	553	8,942,777	01-27-2015	Diab et al.	
	554	8,948,834	02-03-2015	Diab et al.	
	555	8,948,835	02-03-2015	Diab	
	556	8,965,471	02-24-2015	Lamego	
	557	8,983,564	03-17-2015	Al-Ali	
	558	8,989,831	03-24-2015	Al-Ali et al.	
	559	8,996,085	03-31-2015	Kiani et al.	
	560	8,998,809	04-07-2015	Kiani	
	561	9,028,429	05-12-2015	Telfort et al.	
	562	9,037,207	05-19-2015	Al-Ali et al.	
	563	9,060,721	06-23-2015	Reichgott et al.	
	564	9,066,666	06-30-2015	Kiani	
	565	9,066,680	06-30-2015	Al-Ali et al.	
	566	9,072,437	07-07-2015	Paalasmaa	
	567	9,072,474	07-07-2015	Al-Ali et al.	
	568	9,078,560	07-14-2015	Schurman et al.	
	569	9,081,889	07-14-2015	Ingrassia, Jr. et al.	
	570	9,084,569	07-21-2015	Weber et al.	
	571	9,095,316	08-04-2015	Welch et al.	
	572	9,106,038	08-11-2015	Telfort et al.	
	573	9,107,625	08-18-2015	Telfort et al.	
	574	9,107,626	08-18-2015	Al-Ali et al.	
	575	9,113,831	08-25-2015	Al-Ali	
	576	9,113,832	08-25-2015	Al-Ali	
	577	9,119,595	09-01-2015	Lamego	
	578	9,131,881	09-15-2015	Diab et al.	
	579	9,131,882	09-15-2015	Al-Ali et al.	
	580	9,131,883	09-15-2015	Al-Ali	

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	581	9,131,917	09-15-2015	Telfort et al.	
	582	9,138,180	09-22-2015	Coverston et al.	
	583	9,138,182	09-22-2015	Al-Ali et al.	
	584	9,138,192	09-22-2015	Weber et al.	
	585	9,142,117	09-22-2015	Muhsin et al.	
	586	9,153,112	10-06-2015	Kiani et al.	
	587	9,153,121	10-06-2015	Kiani et al.	
	588	9,161,696	10-20-2015	Al-Ali et al.	
	589	9,161,713	10-20-2015	Al-Ali et al.	
	590	9,167,995	10-27-2015	Lamego et al.	
	591	9,176,141	11-03-2015	Al-Ali et al.	
	592	9,186,102	11-17-2015	Bruinsma et al.	
	593	9,192,312	11-24-2015	Al-Ali	
	594	9,192,329	11-24-2015	Al-Ali	
	595	9,192,351	11-24-2015	Telfort et al.	
	596	9,195,385	11-24-2015	Al-Ali et al.	
	597	9,210,566	12-08-2015	Ziemianska et al.	
	598	9,211,072	12-15-2015	Kiani	
	599	9,211,095	12-15-2015	Al-Ali	
	600	9,218,454	12-22-2015	Kiani et al.	
	601	9,226,696	01-05-2016	Kiani	
	602	9,241,662	01-26-2016	Al-Ali et al.	
	603	9,245,668	01-26-2016	Vo et al.	
	604	9,259,185	02-16-2016	Abdul-Hafiz et al.	
	605	9,267,572	02-23-2016	Barker et al.	
	606	9,277,880	03-08-2016	Poeze et al.	
	607	9,289,167	03-22-2016	Diab et al.	
	608	9,295,421	03-29-2016	Kiani et al.	
	609	9,307,928	04-12-2016	Al-Ali et al.	

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	610	9,311,382	04-12-2016	Varoglu et al.	
	611	9,323,894	04-26-2016	Kiani	
	612	9,326,712	05-03-2016	Kiani	
	613	9,333,316	05-10-2016	Kiani	
	614	9,339,220	05-17-2016	Lamego et al.	
	615	9,341,565	05-17-2016	Lamego et al.	
	616	9,351,673	05-31-2016	Diab et al.	
	617	9,351,675	05-31-2016	Al-Ali et al.	
	618	9,357,665	05-31-2016	Myers et al.	
	619	9,364,181	06-14-2016	Kiani et al.	
	620	9,368,671	06-14-2016	Wojtczuk et al.	
	621	9,370,325	06-21-2016	Al-Ali et al.	
	622	9,370,326	06-21-2016	McHale et al.	
	623	9,370,335	06-21-2016	Al-ali et al.	
	624	9,375,185	06-28-2016	Ali et al.	
	625	9,386,953	07-12-2016	Al-Ali	
	626	9,386,961	07-12-2016	Al-Ali et al.	
	627	9,392,945	07-19-2016	Al-Ali et al.	
	628	9,397,448	07-19-2016	Al-Ali et al.	
	629	9,408,542	08-09-2016	Kinast et al.	
	630	9,436,645	09-06-2016	Al-Ali et al.	
	631	9,466,919	10-11-2016	Kiani et al.	
	632	9,445,759	09-20-2016	Lamego et al.	
	633	9,474,474	10-25-2016	Lamego et al.	
	634	9,480,422	11-01-2016	Al-Ali	
	635	9,480,435	11-01-2016	Olsen	
	636	9,489,081	11-08-2016	Anzures et al.	
	637	9,492,110	11-15-2016	Al-Ali et al.	
	638	9,497,534	11-15-2016	Prest et al.	

Examiner Signature	Date Considered
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
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	First Named Inventor	Jeroen Poeze
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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	639	9,510,779	12-06-2016	Poeze et al.	
	640	9,517,024	12-13-2016	Kiani et al.	
	641	9,526,430	12-27-2016	Srinivas et al.	
	642	9,532,722	01-03-2017	Lamego et al.	
	643	9,538,949	01-10-2017	Al-Ali et al.	
	644	9,538,980	01-10-2017	Telfort et al.	
	645	9,549,696	01-24-2017	Lamego et al.	
	646	9,553,625	01-24-2017	Hatanaka et al.	
	647	9,554,737	01-31-2017	Schurman et al.	
	648	9,560,996	02-07-2017	Kiani	
	649	9,560,998	02-07-2017	Al-Ali et al.	
	650	9,566,019	02-14-2017	Al-Ali et al.	
	651	9,579,039	02-28-2017	Jansen et al.	
	652	9,591,975	03-14-2017	Dalvi et al.	
	653	9,593,969	03-14-2017	King	
	654	9,622,692	04-18-2017	Lamego et al.	
	655	9,622,693	04-18-2017	Diab	
	656	9,636,055	05-02-2017	Al-Ali et al.	
	657	9,636,056	05-02-2017	Al-Ali	
	658	9,649,054	05-16-2017	Lamego et al.	
	659	9,651,405	05-16-2017	Gowreesunker et al.	
	660	9,662,052	05-30-2017	Al-Ali et al.	
	661	9,668,676	06-06-2017	Culbert	
	662	9,668,679	06-06-2017	Schurman et al	
	663	9,668,680	06-06-2017	Bruinsma et al.	
	664	9,668,703	06-06-2017	Al-Ali	
	665	9,675,286	06-13-2017	Diab	
	666	9,687,160	06-27-2017	Kiani	
	667	9,693,719	07-04-2017	Al-Ali et al.	

Examiner Signature	Date Considered

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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	668	9,693,737	07-04-2017	Al-Ali	
	669	9,697,928	07-04-2017	Al-Ali et al.	
	670	9,699,546	07-04-2017	Qian et al.	
	671	9,716,937	07-25-2017	Qian et al.	
	672	9,717,425	08-01-2017	Kiani et al.	
	673	9,717,458	08-01-2017	Lamego et al.	
	674	9,723,997	08-08-2017	Lamego	
	675	9,724,016	08-08-2017	Al-Ali et al.	
	676	9,724,024	08-08-2017	Al-Ali	
	677	9,724,025	08-08-2017	Kiani et al.	
	678	9,743,887	08-29-2017	Al-Ali et al.	
	679	9,749,232	08-29-2017	Sampath et al.	
	680	9,750,461	09-05-2017	Telfort	
	681	9,750,442	09-05-2017	Olsen	
	682	9,781,984	10-10-2017	Baranski et al.	
	683	9,782,077	10-10-2017	Lamego et al.	
	684	9,782,110	10-10-2017	Kiani	
	685	9,787,568	10-10-2017	Lamego et al.	
	686	9,775,545	10-03-2017	Al-Ali et al.	
	687	9,730,640	08-15-2017	Diab et al.	
	688	9,750,443	09-05-2017	Smith et al.	
	689	9,775,546	10-03-2017	Diab et al.	
	690	9,775,570	10-03-2017	Al-Ali	
	691	9,778,079	10-03-2017	Al-Ali et al.	
	692	9,788,735	10-17-2017	Al-Ali	
	693	9,788,768	10-17-2017	Al-Ali et al.	
	694	9,795,300	10-24-2017	Al-Ali	
	695	9,795,310	10-24-2017	Al-Ali	
	696	9,795,358	10-24-2017	Telfort et al.	

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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	697	9,795,739	10-24-2017	Al-Ali et al.	
	698	9,801,556	10-31-2017	Kiani	
	699	9,801,588	10-31-2017	Weber et al.	
	700	9,808,188	11-07-2017	Perea et al.	
	701	9,814,418	11-14-2017	Weber et al.	
	702	9,820,691	11-21-2017	Kiani	
	703	9,833,152	12-05-2017	Kiani et al.	
	704	9,833,180	12-05-2017	Shakespeare et al.	
	705	9,838,775	12-05-2017	Qian et al.	
	706	9,839,379	12-12-2017	Al-Ali et al.	
	707	9,839,381	12-12-2017	Weber et al.	
	708	9,847,002	12-19-2017	Kiani et al.	
	709	9,847,749	12-19-2017	Kiani et al.	
	710	9,848,800	12-26-2017	Lee et al.	
	711	9,848,806	12-26-2017	Al-Ali et al.	
	712	9,848,807	12-26-2017	Lamego	
	713	9,848,823	12-26-2017	Raghuram et al.	
	714	9,861,298	01-09-2018	Eckerbom et al.	
	715	9,861,304	01-09-2018	Al-Ali et al.	
	716	9,861,305	01-09-2018	Weber et al.	
	717	9,866,671	01-09-2018	Thompson et al.	
	718	9,867,575	01-16-2018	Maani et al.	
	719	9,867,578	01-16-2018	Al-Ali et al.	
	720	9,872,623	01-23-2018	Al-Ali	
	721	9,876,320	01-23-2018	Coverston et al.	
	722	9,877,650	01-30-2018	Muhsin et al.	
	723	9,877,686	01-30-2018	Al-Ali et al.	
	724	9,891,079	02-13-2018	Dalvi	
	725	9,895,107	02-20-2018	Al-Ali et al.	

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U.S. PATENT DOCUMENTS					
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	726	9,898,049	02-20-2018	Myers et al.	
	727	9,918,646	03-20-2018	Singh Alvarado et al.	
	728	9,924,893	03-27-2018	Schurman et al.	
	729	9,924,897	03-27-2018	Abdul-Hafiz	
	730	9,913,617	03-13-2018	Al-Ali et al.	
	731	9,936,917	04-10-2018	Poeze et al.	
	732	9,943,269	04-17-2018	Muhsin et al.	
	733	9,949,676	04-24-2018	Al-Ali	
	734	9,952,095	04-24-2018	Hotelling et al.	
	735	9,955,937	05-01-2018	Telfort	
	736	9,965,946	05-08-2018	Al-Ali	
	737	9,980,667	05-29-2018	Kiani et al.	
	738	9,986,919	06-05-2018	Lamego et al.	
	739	9,986,952	06-05-2018	Dalvi et al.	
	740	9,989,560	06-05-2018	Poeze et al.	
	741	9,993,207	06-12-2018	Al-Ali et al.	
	742	10,007,758	06-26-2018	Al-Ali et al.	
	743	10,010,276	07-03-2018	Al-Ali et al.	
	744	10,032,002	07-24-2018	Kiani et al.	
	745	10,039,080	07-31-2018	Miller et al.	
	746	10,039,482	08-07-2018	Al-Ali et al.	
	747	10,052,037	08-21-2018	Kinast et al.	
	748	10,055,121	08-21-2018	Chaudhri et al.	
	749	10,058,275	08-28-2018	Al-Ali et al.	
	750	10,064,562	09-04-2018	Al-Ali	
	751	10,066,970	09-04-2018	Gowreesunker et al.	
	752	10,076,257	09-18-2018	Lin et al.	
	753	10,078,052	09-18-2018	Ness et al.	
	754	10,086,138	10-02-2018	Novak, Jr.	

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U.S. PATENT DOCUMENTS					
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	755	10,092,200	10-09-2018	Al-Ali et al.	
	756	10,092,249	10-09-2018	Kiani et al.	
	757	10,098,550	10-16-2018	Al-Ali et al.	
	758	10,098,591	10-16-2018	Al-Ali et al.	
	759	10,098,610	10-16-2018	Al-Ali et al.	
	760	10,123,726	11-13-2018	Al-Ali et al.	
	761	10,130,289	11-20-2018	Al-Ali et al.	
	762	10,130,291	11-20-2018	Schurman et al.	
	763	10,149,616	12-11-2018	Al-Ali et al.	
	764	10,154,815	12-18-2018	Al-Ali et al.	
	765	10,159,412	12-25-2018	Lamego et al.	
	766	10,188,296	01-29-2019	Al-Ali et al.	
	767	10,188,331	01-29-2019	Al-Ali et al.	
	768	10,188,348	01-29-2019	Kiani et al.	
	769	10,194,847	02-05-2019	Al-Ali	
	770	10,194,848	02-05-2019	Kiani et al.	
	771	10,201,298	02-12-2019	Al-Ali et al.	
	772	10,205,272	02-12-2019	Kiani et al.	
	773	10,205,291	02-12-2019	Scruggs et al.	
	774	10,213,108	02-26-2019	Al-Ali	
	775	10,219,706	03-05-2019	Al-Ali	
	776	10,219,746	03-05-2019	McHale et al.	
	777	10,226,187	03-12-2019	Al-Ali et al	
	778	10,226,576	03-12-2019	Kiani	
	779	10,231,657	03-19-2019	Al-Ali et al	
	780	10,231,670	03-19-2019	Blank et al.	
	781	10,231,676	03-19-2019	Al-Ali et al	
	782	10,255,994	04-09-2019	Sampath et al.	
	783	10,251,585	04-09-2019	Al-Ali et al.	

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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	784	10,251,586	04-09-2019	Lamego	
	785	10,258,265	04-16-2019	Poeze et al.	
	786	10,258,266	04-16-2019	Poeze et al.	
	787	10,271,748	04-30-2019	Al-Ali	
	788	10,278,626	05-07-2019	Schurman et al.	
	789	10,278,648	05-07-2019	Al-Ali et al.	
	790	10,279,247	05-07-2019	Kiani	
	791	10,292,628	05-21-2019	Poeze et al.	
	792	10,292,657	05-21-2019	Abdul-Hafiz et al.	
	793	10,292,664	05-21-2019	Al-Ali	
	794	10,299,708	05-28-2019	Poeze et al.	
	795	10,299,709	05-28-2019	Perea et al.	
	796	10,305,775	05-28-2019	Lamego et al.	
	797	10,307,111	06-04-2019	Muhsin et al.	
	798	10,325,681	06-18-2019	Sampath et al.	
	799	10,327,337	06-18-2019	Triman et al.	
	800	10,332,630	06-25-2019	Al-Ali	
	801	10,327,713	06-25-2019	Barker et al.	
	802	10,335,033	07-02-2019	Al-Ali	
	803	10,335,068	07-02-2019	Poeze et al.	
	804	10,335,072	07-02-2019	Al-Ali et al.	
	805	10,342,470	07-09-2019	Al-Ali et al.	
	806	10,342,487	07-09-2019	Al-Ali et al.	
	807	10,342,497	07-09-2019	Al-Ali et al.	
	808	10,349,898	07-16-2019	Al-Ali et al.	
	809	10,349,895	07-16-2019	Telfort et al.	
	810	10,354,504	07-16-2019	Kiani et al.	
	811	10,357,206	07-23-2019	Weber et al.	
	812	10,357,209	07-23-2019	Al-Ali	

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Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	813	10,366,787	07-30-2019	Sampath et al.	
	814	10,368,787	08-06-2019	Reichgott et al.	
	815	10,376,190	08-13-2019	Poeze et al.	
	816	10,376,191	08-13-2019	Poeze et al.	
	817	2002/0099279	07-25-2002	Pfeiffer et al.	
	818	2003/0036690	02-20-2003	Geddes et al.	
	819	2004/0054290	03-18-2004	Chance	
	820	2004/0114783	06-17-2004	Spycher et al.	
	821	2006/0005944	01-12-2006	Wang et al.	
	822	2006/0025659	02-02-2006	Kiguchi et al.	
	823	2006/0161054	07-20-2006	Reuss et al.	
	824	2007/0149864	06-28-2007	Laakkonen	
	825	2007/0238955	10-11-2007	Tearney et al.	
	826	2007/0293792	12-20-2007	Sliwa et al.	
	827	2008/0130232	06-05-2008	Yamamoto	
	828	2008/0139908	06-12-2008	Kurth	
	829	2009/0030327	01-29-2009	Chance, Britton	
	830	2009/0043180	02-12-2009	Tschautscher et al.	
	831	2009/0129102	05-21-2009	Xiao et al.	
	832	2009/0247984	10-01-2009	Lamego et al.	
	833	2009/0259114	10-15-2009	Johnson et al.	
	834	2009/0275813	11-05-2009	Davis	
	835	2009/0275844	11-05-2009	Al-Ali	
	836	2009/0306487	12-10-2009	Crowe et al.	
	837	2010/0004518	01-07-2010	Vo et al.	
	838	2010/0030040	02-04-2010	Poeze et al.	
	839	2011/0001605	01-06-2011	Kiani et al.	
	840	2011/0004106	01-06-2011	Iwamiya et al.	
	841	2011/0082711	04-07-2011	Poeze et al.	

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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	842	2011/0085721	04-14-2011	Guyon et al.	
	843	2011/0105854	05-05-2011	Kiani et al.	
	844	2011/0105865	05-05-2011	Yu et al.	
	845	2011/0125060	05-26-2011	Telfort et al.	
	846	2012/0165629	06-28-2012	Merritt et al.	
	847	2011/0208015	08-25-2011	Welch et al.	
	848	2011/0213212	09-01-2011	Al-Ali	
	849	2011/0230733	09-22-2011	Al-Ali	
	850	2011/0237911	09-29-2011	Lamego et al.	
	851	2012/0059267	03-08-2012	Lamego et al.	
	852	2012/0179006	07-12-2012	Jansen et al.	
	853	2012/0209084	08-16-2012	Olsen et al.	
	854	2012/0227739	09-13-2012	Kiani	
	855	2012/0283524	11-08-2012	Kiani et al.	
	856	2012/0296178	11-22-2012	Lamego et al.	
	857	2012/0319816	12-20-2012	Al-Ali	
	858	2012/0330112	12-27-2012	Lamego et al.	
	859	2013/0023775	01-24-2013	Lamego et al.	
	860	2013/0041591	02-14-2013	Lamego	
	861	2013/0045685	02-21-2013	Kiani	
	862	2013/0046204	02-21-2013	Lamego et al.	
	863	2013/0060147	03-07-2013	Welch et al.	
	864	2013/0096405	04-18-2013	Garfio	
	865	2013/0096936	04-18-2013	Sampath et al.	
	866	2013/0190581	07-25-2013	Al-Ali et al.	
	867	2013/0197328	08-01-2013	Diab et al.	
	868	2013/0211214	08-15-2013	Olsen	
	869	2013/0243021	09-19-2013	Siskavich	
	870	2013/0296672	11-07-2013	O'Neil et al.	

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Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	871	2013/0324808	12-05-2013	Al-Ali et al.	
	872	2013/0331660	12-12-2013	Al-Ali et al.	
	873	2013/0331670	12-12-2013	Kiani	
	874	2013/0338461	12-19-2013	Lamego et al.	
	875	2014/0012100	01-09-2014	Al-Ali et al.	
	876	2014/0034353	02-06-2014	Al-Ali et al.	
	877	2014/0051953	02-20-2014	Lamego et al.	
	878	2014/0058230	02-27-2014	Abdul-Hafiz et al.	
	879	2014/0077956	03-20-2014	Sampath et al.	
	880	2014/0081100	03-20-2014	Muhsin et al.	
	881	2014/0081175	03-20-2014	Telfort	
	882	2014/0094667	04-03-2014	Schurman et al.	
	883	2014/0100434	04-10-2014	Diab et al.	
	884	2014/0114199	04-24-2014	Lamego et al.	
	885	2014/0120564	05-01-2014	Workman et al.	
	886	2014/0121482	05-01-2014	Merritt et al.	
	887	2014/0121483	05-01-2014	Kiani	
	888	2014/0127137	05-08-2014	Bellott et al.	
	889	2014/0129702	05-08-2014	Lamego et al.	
	890	2014/0135588	05-15-2014	Al-Ali et al.	
	891	2014/0142401	05-22-2014	Al-Ali et al.	
	892	2014/0163344	06-12-2014	Al-Ali	
	893	2014/0163402	06-12-2014	Lamego et al.	
	894	2014/0166076	06-19-2014	Kiani et al.	
	895	2014/0171146	06-19-2014	Ma et al.	
	896	2014/0171763	06-19-2014	Diab	
	897	2014/0180154	06-26-2014	Sierra et al.	
	898	2014/0180160	06-26-2014	Brown et al.	
	899	2014/0187973	07-03-2014	Brown et al.	

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	900	2014/0194709	07-10-2014	Al-Ali et al.	
	901	2014/0194711	07-10-2014	Al-Ali	
	902	2014/0194766	07-10-2014	Al-Ali et al.	
	903	2014/0206963	07-24-2014	Al-Ali	
	904	2014/0213864	07-31-2014	Abdul-Hafiz et al.	
	905	2014/0243627	08-28-2014	Diab et al.	
	906	2014/0266790	09-18-2014	Al-Ali et al.	
	907	2014/0275808	09-18-2014	Poeze et al.	
	908	2014/0275835	09-18-2014	Lamego et al.	
	909	2014/0275871	09-18-2014	Lamego et al.	
	910	2014/0275872	09-18-2014	Merritt et al.	
	911	2014/0275881	09-18-2014	Lamego et al.	
	912	2014/0288400	09-25-2014	Diab et al.	
	913	2014/0296664	10-27-2014	Bruinsma et al.	
	914	2014/0303520	10-09-2014	Telfort et al.	
	915	2014/0316217	10-23-2014	Purdon et al.	
	916	2014/0316218	10-23-2014	Purdon et al.	
	917	2014/0316228	10-23-2014	Blank et al.	
	918	2014/0323825	10-30-2014	Al-Ali et al.	
	919	2014/0323897	10-30-2014	Brown et al.	
	920	2014/0323898	10-30-2014	Purdon et al.	
	921	2014/0330098	11-06-2014	Merritt et al.	
	922	2014/0330099	11-06-2014	Al-Ali et al.	
	923	2014/0333440	11-13-2014	Kiani	
	924	2014/0336481	11-13-2014	Shakespeare et al.	
	925	2014/0343436	11-20-2014	Kiani	
	926	2014/0357966	12-04-2014	Al-Ali et al.	
	927	2015/0005600	01-01-2015	Blank et al.	
	928	2015/0011907	01-08-2015	Purdon et al.	

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	929	2015/0018650	01-15-2015	Al-Ali et al.	
	930	2015/0032029	01-29-2015	Al-Ali et al.	
	931	2015/0038859	02-05-2015	Dalvi et al.	
	932	2015/0080754	03-19-2015	Purdon et al.	
	933	2015/0087936	03-26-2015	Al-Ali et al.	
	934	2015/0094546	04-02-2015	Al-Ali	
	935	2015/0099950	04-09-2015	Al-Ali et al.	
	936	2015/0101844	04-16-2015	Al-Ali et al.	
	937	2015/0106121	04-16-2015	Muhsin et al.	
	938	2015/0173671	06-25-2015	Paalasmaa et al.	
	939	2015/0196249	07-16-2015	Brown et al.	
	940	2015/0216459	08-06-2015	Al-Ali et al.	
	941	2015/0238722	08-27-2015	Al-Ali	
	942	2015/0255001	09-10-2015	Haughav et al.	
	943	2015/0257689	09-17-2015	Al-Ali et al.	
	944	2015/0281424	10-01-2015	Vock et al.	
	945	2015/0318100	11-05-2015	Rothkopf et al.	
	946	2015/0351697	11-05-2015	Weber et al.	
	947	2015/0351704	12-20-2015	Kiani et al.	
	948	2015/0366472	12-24-2015	Kiani	
	949	2015/0366507	12-24-2015	Blank	
	950	2015/0374298	12-31-2015	Al-Ali et al.	
	951	2015/0380875	12-31-2015	Coverston et al.	
	952	2016/0000362	01-07-2016	Diab et al.	
	953	2016/0007930	01-14-2016	Weber et al.	
	954	2016/0019360	01-21-2016	Pahwa et al.	
	955	2016/0023245	01-28-2016	Zadesky et al.	
	956	2016/0029932	02-04-2016	Al-Ali	
	957	2016/0029933	02-04-2016	Al-Ali et al.	

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	958	2016/0038045	02-11-2016	Shapiro	
	959	2016/0045118	02-18-2016	Kiani	
	960	2016/0051157	02-25-2016	Waydo	
	961	2016/0051158	02-25-2016	Silva	
	962	2016/0051205	02-25-2016	Al-Ali et al.	
	963	2016/0058302	03-03-2016	Raghuram et al.	
	964	2016/0058309	03-03-2016	Han	
	965	2016/0058312	03-03-2016	Han et al.	
	966	2016/0058338	03-03-2016	Schurman et al.	
	967	2016/0058356	03-03-2016	Raghuram et al.	
	968	2016/0058370	03-03-2016	Raghuram et al.	
	969	2016/0066823	03-10-2016	Al-Ali et al.	
	970	2016/0066824	03-10-2016	Al-Ali et al.	
	971	2016/0066879	03-10-2016	Telfort et al.	
	972	2016/0071392	03-10-2016	Hankey et al.	
	973	2016/0072429	03-10-2016	Kiani et al.	
	974	2016/0073967	03-17-2016	Lamego et al.	
	975	2016/0081552	03-24-2016	Wojtczuk et al.	
	976	2016/0095543	04-07-2016	Telfort et al.	
	977	2016/0103598	04-14-2016	Al-Ali et al.	
	978	2016/0113527	04-28-2016	Al-Ali et al.	
	979	2016/0143548	05-26-2016	Al-Ali	
	980	2016/0154950	06-02-2016	Nakajima et al.	
	981	2016/0157780	06-09-2016	Rimminen et al.	
	982	2016/0166210	06-16-2016	Al-Ali	
	983	2016/0192869	07-07-2016	Kiani et al.	
	984	2016/0196388	07-07-2016	Lamego	
	985	2016/0197436	07-07-2016	Barker et al.	
	986	2016/0213281	07-28-2016	Eckerbom, et al.	

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	987	2016/0213309	07-28-2016	Sannholm et al.	
	988	2016/0228043	08-11-2016	O'Neil et al.	
	989	2016/0256058	09-08-2016	Pham et al.	
	990	2016/0256082	09-08-2016	Ely et al.	
	991	2016/0267238	09-15-2016	Nag	
	992	2016/0270735	09-22-2016	Diab et al.	
	993	2016/0283665	09-29-2016	Sampath et al.	
	994	2016/0287181	10-06-2016	Han et al.	
	995	2016/0287786	10-06-2016	Kiani	
	996	2016/0296173	10-13-2016	Culbert	
	997	2016/0296174	10-13-2016	Isikman et al.	
	998	2016/0310027	10-27-2016	Han	
	999	2016/0314260	10-27-2016	Kiani	
	1000	2016/0324488	11-10-2016	Olsen	
	1001	2016/0327984	11-10-2016	Al-Ali et al.	
	1002	2016/0367173	12-22-2016	Dalvi et al.	
	1003	2016/0378069	12-29-2016	Rothkopf	
	1004	2016/0378071	12-29-2016	Rothkopf	
	1005	2017/0000394	01-05-2017	Al-Ali et al.	
	1006	2017/0007183	01-12-2017	Dusan et al.	
	1007	2017/0010858	01-12-2017	Prest et al.	
	1008	2017/0014083	01-19-2017	Diab et al.	
	1009	2017/0024748	01-26-2017	Haider	
	1010	2017/0042488	02-16-2017	Muhsin	
	1011	2017/0055882	03-02-2017	Al-Ali et al.	
	1012	2017/0055887	03-02-2017	Al-Ali	
	1013	2017/0055896	03-02-2017	Al-Ali et al.	
	1014	2017/0074897	03-16-2017	Mermel et al.	
	1015	2017/0084133	03-23-2017	Cardinali et al.	

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	1016	2017/0086689	03-30-2017	Shui et al.	
	1017	2017/0086723	03-30-2017	Al-Ali et al.	
	1018	2017/0086742	03-30-2017	Harrison-Noonan et al.	
	1019	2017/0086743	03-30-2017	Bushnell et al.	
	1020	2017/0094450	03-30-2017	Tu et al.	
	1021	2017/0143281	05-25-2017	Olsen	
	1022	2017/0147774	05-25-2017	Kiani	
	1023	2017/0156620	06-08-2017	Al-Ali et al.	
	1024	2017/0164884	06-15-2017	Culbert et al.	
	1025	2017/0173632	06-22-2017	Al-Ali	
	1026	2017/0196464	07-13-2017	Jansen et al.	
	1027	2017/0196470	07-13-2017	Lamego et al.	
	1028	2017/0228516	08-10-2017	Sampath et al.	
	1029	2017/0245790	08-31-2017	Al-Ali et al.	
	1030	2017/0248446	08-31-2017	Gowreesunker et al.	
	1031	2017/0251974	09-07-2017	Shreim et al.	
	1032	2017/0251975	09-07-2017	Shreim et al.	
	1033	2017/0273619	09-28-2017	Alvarado et al.	
	1034	2017/0281024	10-05-2017	Narasimhan et al.	
	1035	2017/0293727	10-12-2017	Klaassen et al.	
	1036	2017/0311891	11-02-2017	Kiani et al.	
	1037	2017/0325698	11-16-2017	Allec et al.	
	1038	2017/0325744	11-16-2017	Allec et al.	
	1039	2017/0332976	11-23-2017	Al-Ali et al.	
	1040	2017/0340209	11-30-2017	Klaassen et al.	
	1041	2017/0340219	11-30-2017	Sullivan et al.	
	1042	2017/0340293	11-30-2017	Al-Ali et al.	
	1043	2017/0347885	12-07-2017	Tan et al.	
	1044	2017/0354332	12-14-2017	Lamego	

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	1045	2017/0354795	12-14-2017	Blahnik et al.	
	1046	2017/0358239	12-14-2017	Arney et al.	
	1047	2017/0358240	12-14-2017	Blahnik et al.	
	1048	2017/0358242	12-14-2017	Thompson et al.	
	1049	2017/0360306	12-14-2017	Narasimhan et al.	
	1050	2017/0360310	12-21-2017	Kiani et al.	
	1051	2017/0366657	12-21-2017	Thompson et al.	
	1052	2018/0008146	01-11-2018	Al-Ali et al.	
	1053	2018/0013562	01-11-2018	Haider et al.	
	1054	2018/0014752	01-18-2018	Al-Ali et al.	
	1055	2018/0014781	01-18-2018	Clavelle et al.	
	1056	2018/0025287	01-25-2018	Mathew et al.	
	1057	2018/0028124	02-01-2018	Al-Ali et al.	
	1058	2018/0042556	02-15-2018	Shahparnia et al.	
	1059	2018/0049694	02-22-2018	Singh Alvarado et al.	
	1060	2018/0050235	02-22-2018	Tan et al.	
	1061	2018/0055375	03-01-2018	Martinez et al.	
	1062	2018/0055390	03-01-2018	Kiani	
	1063	2018/0055430	03-01-2018	Diab et al.	
	1064	2018/0055439	03-01-2018	Pham et al.	
	1065	2018/0056129	03-01-2018	Narasimha Rao et al.	
	1066	2018/0064381	03-08-2018	Shakespeare et al.	
	1067	2018/0070867	03-15-2018	Smith et al.	
	1068	2018/0078151	03-22-2018	Allec et al.	
	1069	2018/0078182	03-22-2018	Chen et al.	
	1070	2018/0082767	03-22-2018	Al-Ali et al.	
	1071	2018/0085068	03-29-2018	Telfort	
	1072	2018/0087937	03-29-2018	Al-Ali et al.	
	1073	2018/0103874	04-19-2018	Lee et al.	

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	1074	2018/0103905	04-19-2018	Kiani	
	1075	2018/0110469	04-26-2018	Maani et al.	
	1076	2018/0125368	05-10-2018	Lamego et al.	
	1077	2018/0125430	05-10-2018	Al-Ali et al.	
	1078	2018/0125445	05-10-2018	Telfort et al.	
	1079	2018/0132769	05-17-2018	Weber et al.	
	1080	2018/0146901	05-31-2018	Al-Ali et al.	
	1081	2018/0146902	05-31-2018	Kiani et al.	
	1082	2018/0153418	06-07-2018	Sullivan et al.	
	1083	2018/0153442	06-07-2018	Eckerbom, et al.	
	1084	2018/0153446	06-07-2018	Kiani	
	1085	2018/0153447	06-07-2018	Al-Ali et al.	
	1086	2018/0153448	06-07-2018	Weber et al.	
	1087	2018/0161499	06-14-2018	Al-Ali et al.	
	1088	2018/0164853	06-14-2018	Myers et al.	
	1089	2018/0168491	06-21-2018	Al-Ali et al.	
	1090	2018/0184917	07-05-2018	Kiani	
	1091	2018/0192924	07-12-2018	Al-Ali	
	1092	2018/0192953	07-12-2018	Shreim et al.	
	1093	2018/0196514	07-12-2018	Allec et al.	
	1094	2018/0199871	07-19-2018	Pauley et al.	
	1095	2018/0206795	07-26-2018	Al-Ali	
	1096	2018/0206815	07-26-2018	Telfort	
	1097	2018/0213583	07-26-2018	Al-Ali	
	1098	2018/0214031	08-02-2018	Kiani et al.	
	1099	2018/0214090	08-02-2018	Al-Ali et al.	
	1100	2018/0218792	08-02-2018	Muhsin et al.	
	1101	2018/0225960	08-09-2018	Al-Ali et al.	
	1102	2018/0228414	08-16-2018	Shao et al.	

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	1103	2018/0238718	08-23-2018	Dalvi	
	1104	2018/0238734	08-23-2018	Hotelling et al.	
	1105	2018/0242853	08-30-2018	Al-Ali	
	1106	2018/0242921	08-30-2018	Muhsin et al.	
	1107	2018/0242923	08-30-2018	Al-Ali et al.	
	1108	2018/0242926	08-30-2018	Muhsin et al.	
	1109	2018/0247353	08-30-2018	Al-Ali et al.	
	1110	2018/0247712	08-30-2018	Muhsin et al.	
	1111	2018/0253947	09-06-2018	Muhsin et al.	
	1112	2018/0256087	09-13-2018	Al-Ali et al.	
	1113	2018/0279956	10-04-2018	Waydo et al.	
	1114	2018/0285094	10-04-2018	Housel et al.	
	1115	2018/0289325	10-11-2018	Poeze et al.	
	1116	2018/0296161	10-18-2018	Shreim et al.	
	1117	2018/0300919	10-18-2018	Muhsin et al.	
	1118	2018/0310822	11-01-2018	Indorf et al.	
	1119	2018/0310823	11-01-2018	Al-Ali et al.	
	1120	2018/0317826	11-08-2018	Muhsin	
	1121	2018/0317841	11-08-2018	Novak, Jr.	
	1122	2018/0333055	11-22-2018	Lamego et al.	
	1123	2018/0333087	11-22-2019	Al-Ali	
	1124	2019/0000317	01-03-2019	Muhsin et al.	
	1125	2019/0000362	01-03-2019	Kiani et al.	
	1126	2019/0015023	01-17-2019	Monfre	
	1127	2019/0029574	01-31-2019	Schurman et al.	
	1128	2019/0029578	01-31-2019	Al-Ali et al.	
	1129	2019/0058280	02-21-2019	Al-Ali et al.	
	1130	2019/0058281	02-21-2019	Al-Ali et al.	
	1131	2019/0069813	03-07-2019	Al-Ali	

Examiner Signature	Date Considered

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PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 40 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1132	2019/0069814	03-07-2019	Al-Ali	
	1133	2019/0076028	03-14-2019	Al-Ali et al.	
	1134	2019/0082979	03-21-2019	Al-Ali et al.	
	1135	2019/0090760	03-28-2019	Kinast et al.	
	1136	2019/0090764	03-28-2019	Al-Ali	
	1137	2019/0117070	04-25-2019	Muhsin et al.	
	1138	2019/0117139	04-25-2019	Al-Ali et al.	
	1139	2019/0117140	04-25-2019	Al-Ali et al.	
	1140	2019/0117141	04-25-2019	Al-Ali	
	1141	2019/0117930	04-25-2019	Al-Ali	
	1142	2019/0122763	04-25-2019	Sampath et al.	
	1143	2019/0133525	05-09-2019	Al-Ali et al.	
	1144	2019/0142283	05-16-2019	Lamego et al.	
	1145	2019/0142344	05-16-2019	Telfort et al.	
	1146	2019/0150856	05-23-2019	Kiani et al.	
	1147	2019/0167161	06-06-2019	Al-Ali et al.	
	1148	2019/0175019	06-13-2019	Al-Ali et al.	
	1149	2019/0192076	06-27-2010	McHale et al.	
	1150	2019/0200941	07-04-2019	Chandran et al.	
	1151	2019/0201623	07-04-2019	Kiani	
	1152	2019/0214778	07-11-2019	Scruggs et al.	
	1153	2019/0209025	07-11-2019	Al-Ali	
	1154	2019/0216319	07-18-2019	Poeze et al.	
	1155	2018/0216370	07-18-2019	Schurman et al.	
	1156	2019/0216379	07-18-2019	Al-Ali et al.	
	1157	2019/0221966	07-18-2019	Kiani et al.	
	1158	2019/0223804	07-25-2019	Blank et al	
	1159	2019/0231199	08-01-2019	Al-Ali et al.	
	1160	2019/0231241	08-01-2019	Al-Ali et al.	

Examiner Signature	Date Considered

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	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 41 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1161	2019/0231270	08-01-2019	Abdul-Hafiz et al.	
	1162	2019/0239787	08-08-2019	Pauley et al.	
	1163	2019/0239824	08-08-2019	Muhsin et al.	
	1164	D326,715	06-02-1992	Schmidt, Michael	
	1165	D353,195	12-06-1994	Savage et al.	
	1166	D353,196	12-06-1994	Savage et al.	
	1167	D356,870	03-28-1995	Ivers et al.	
	1168	D359,546	06-20-1995	Savage, et al.	
	1169	D361,840	08-29-1995	Savage et al.	
	1170	D362,063	09-05-1995	Savage et al.	
	1171	D363,120	10-10-1995	Savage et al.	
	1172	D378,414	03-11-1997	Allen et al.	
	1173	D390,666	02-01-1998	Lagerlof, Ingemar	
	1174	D393,830	04-28-1998	Tobler et al.	
	1175	D403,070	12-22-1998	Maeda et al.	
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	1177	D452,012	12-11-2001	Phillips, Barney L.	
	1178	D455,834	04-16-2002	Donars et al.	
	1179	D463,561	09-24-2002	Fukatsu et al.	
	1180	D481,459	10-28-2003	Nahm, Werner	
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	1182	D508,862	08-30-2005	Behar et al.	
	1183	D510,625	10-11-2005	Widener et al.	
	1184	D514,461	02-07-2006	Harju, Jonne	
	1185	D535,031	01-09-2007	Barrett et al.	
	1186	D537,164	02-20-2007	Shigemori et al.	
	1187	D547,454	07-24-2007	Hsieh, Chin-Chih	
	1188	D549,830	08-28-2007	Behar et al.	
	1189	D550,364	09-04-2007	Glover et al.	

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PTO/SB/08 Equivalent

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	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 42 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1190	D551,350	09-18-2007	Lorimer et al.	
	1191	D553,248	10-16-2007	Nguyen	
	1192	D554,263	10-30-2007	Al-Ali	
	1193	D562,985	02-26-2008	Brefka et al.	
	1194	D566,282	04-08-2008	Al-Ali et al.	
	1195	D567,125	04-22-2008	Okabe et al.	
	1196	D569,001	05-13-2008	Omaki	
	1197	D569,521	05-20-2008	Omaki	
	1198	D587,657	03-03-2009	Al-Ali et al.	
	1199	D603,966	11-10-2009	Jones et al.	
	1200	D606,659	12-22-2009	Kiani et al.	
	1201	D609,193	02-02-2010	Al-Ali et al.	
	1202	D614,305	04-20-2010	Al-Ali et al.	
	1203	D621,516	08-10-2010	Kiani et al.	
	1204	D692,145	10-22-2013	Al-Ali et al.	
	1205	D755,392	05-03-2016	Hwang et al.	
	1206	D788,312	05-30-2017	Al-Ali et al.	
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	1210	D833,624	11-13-2018	DeJong et al.	
	1211	D835,282	12-04-2018	Barker et al.	
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	1216	RE 38,476	03-01-2004	Diab et al.	
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	1218	RE 39,672	06-05-2007	Shehada et al.	

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	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 43 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1219	RE 41,317	05-04-2010	Parker	
	1220	RE 41,912	11-02-2010	Parker	
	1221	RE 42,753	09-27-2011	Kiani-Azarbayjany et al.	
	1222	RE 43,169	02-07-2012	Parker	
	1223	RE 43,860	12-11-2012	Parker	
	1224	RE 44,823	04-01-2014	Parker	
	1225	RE 44,875	04-29-2014	Kiani et al.	
	1226	RE47,218	02-05-2019	Ali-Ali	
	1227	RE47,244	02-19-2019	Kiani et al.	
	1228	RE47,249	02-19-2019	Kiani et al.	
	1229	RE47,353	04-16-2019	Kiani et al.	

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	1230	EP 419223	03-27-1991	Minnesota Mining and Manufacturing Company		
	1231	EP 0 781 527	07-02-1997	Instrumentarium Oy		
	1232	EP 1 518 494	03-30-2005	Hitachi, Ltd.		
	1233	EP 2 277 440	01-26-2011	Pioneer Corp		
	1234	JP 08-185864	07-16-1996	Matsushita Electric Ind Co Ltd		Abs
	1235	JP 2002-500908 A	01-15-2002	Lightouch Medical Inc.		Abs
	1236	JP 2007-389463 A	11-08-2007	Konica Minolta Sensing Inc.		Abs
	1237	JP 2003-265444 A	09-24-2003	Shimadzu Corp.		Abs
	1238	JP 2003-508104 A	09-24-2003	Shimadzu Corp.		Abs
	1239	JP 08-185864	07-16-1996	Matsushita Electric Ind Co Ltd		Abs
	1240	JP 2001-66990	03-16-2001	Sumitomo Bakelite Co Ltd		Abs
	1241	JP 05-325705 A	12-10-1993	Fuji Porimatetsuku KK		Abs

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SHEET 44 OF 46	Attorney Docket No.	MASCER.002C13

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	1242	JP 2001-087250 A	04-03-2001	Cas Medical Systems Inc.		Abs
	1243	JP 2006-177837 A	07-06-2006	Hitachi Ltd.		Abs
	1244	JP 2003-024276 A	01-28-2003	Pentax Corp.		Abs
	1245	JP 2008-099222 A	04-24-2008	Konica Minolta Holdings Inc.		Abs
	1246	JP 2006-198321 A	08-03-2006	Hitachi Ltd.		Abs
	1247	JP 2003-508104 A	03-04-2003	Quantum Vision Inc.		Abs
	1248	JP 5756752	06-05-2015	Masimo Laboratories, Inc.		Abs
	1249	WO 1993/12712	07-08-1993	Vivascan Corp		
	1250	WO 1996/27325	09-12-1996	Huch et al.		X
	1251	WO 1999/000053	01-07-1999	TOA Medical Electronics		
	1252	WO 2000/25112	05-04-2000	Rolfe		
	1253	WO 2001/09589	02-08-2001	Abbott Laboratories		
	1254	WO 2010/003134	01-07-2010	Masimo Laboratories, Inc.		
	1255	WO 2014/149781	09-25-2014	Cercacor Laboratories, Inc.		
	1256	WO 2014/158820	10-02-2014	Cercacor Laboratories, Inc.		
	1257	WO 1999/01704	07-29-1999	General Electric Company		

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
	1258	PCT International Search Report, App. No. PCT/US2010/047899, Date of Actual Completion of Search: 01/26/2011, 4 pages.	
	1259	International Search Report and Written Opinion for PCT/US2009/049638, mailed January 7, 2010.	
	1260	International Search Report issued in Application No. PCT/US2009/052756, mailed February 10, 2009 in 14 pages.	
	1261	International Preliminary Report on Patentability and Written Opinion of the International Searching Authority issued in Application No. PCT US2009/049638, mailed January 5, 2011 in 9 pages.	
	1262	International Preliminary Report on Patentability and Written Opinion of the International Searching Authority issued in Application No. PCT/US2009/052756, mailed February 8, 2011 in 8 pages.	

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	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 45 OF 46	Attorney Docket No.	MASCER.002C13

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
	1263	International Preliminary Report on Patentability and Written Opinion for International Application No. PCT/US2016/040190, dated January 2, 2018, in 7 pages.	
	1264	Burritt, Mary F.; Current Analytical Approaches to Measuring Blood Analytes; Vol. 36; No. 8(B); 1990	
	1265	Hall, et al., Jeffrey W.; Near-Infrared Spectrophotometry: A New Dimension in Clinical Chemistry; Vol. 38; No. 9; 1992	
	1266	Kuenstner, et al., J. Todd; Measurement of Hemoglobin in Unlysed Blood by Near-Infrared Spectroscopy; Vol. 48; Number 4, 1994	
	1267	Manzke, et al., B., Multi Wavelength Pulse Oximetry in the Measurement of Hemoglobin Fractions; SPIE, Vol. 2676, April 24, 1996	
	1268	Naumenko, E. K.; Choice of Wavelengths for Stable Determination of Concentrations of Hemoglobin Derivatives from Absorption Spectra of Erythrocytes; Vol. 63; No. 1; pp. 60-66 January – February 1996; Original article submitted November 3, 1994	
	1269	Schmitt, Joseph M.; Simple Photon Diffusion Anaylsis of the Effects of Multiple Scattering on Pulse Oximetry; March 14, 1991; revised August 30, 1991	
	1270	Schmitt, et al., Joseph M.; Measurement of Blood Hematocrit by Dual-Wavelength near-IR Photoplethysmography; Vol. 1641; 1992	
	1271	Schnapp, et al., L.M.; Pulse Oximetry. Uses and Abuses.; Chest 1990; 98; 1244-1250 DOI 10.1378/Chest.98.5.1244	
	1272	http://www.masimo.com/rainbow/pronto.htm Noninvasive & Immediate Hemoglobin Testing, printed on August 20, 2009	
	1273	http://www.masimo.com/pulseOximeter/Rad5.htm; Signal Extraction Pulse Oximeter, printed on August 20, 2009	
	1274	http://blogderoliveira.blogspot.com/2008_02_01_archive.html; Ricardo Oliveira, printed on August 20, 2009	
	1275	http://www.masimo.com/rad-57/; Noninvasive Measurement of Methemoglobin, Carboxyhemoglobin and Oxyhemoglobin in the blood. Printed on August 20, 2009	
	1276	http://amivital.ugr.es/blog/?tag+spo2; Monitorizacion de la hemoglobina...y mucho mas, printed on August 20, 2009	
	1277	http://www.masimo.com/spco/; Carboxyhemoglobin Noninvasive > Continuous > Immediate, printed on August 20, 2009	
	1278	http://www.masimo.com/PARTNERS/WELCHALLYN.htm; Welch Allyn Expands Patient Monitor Capabilities with Masimo Pulse Oximetry Technology, printed on August 20, 2009	
	1279	http://www.masimo.com/pulseOximeter/PPO.htm; Masimo Personal Pulse Oximeter, printed on August 20, 2009	
	1280	http://www.masimo.com/generalFloor/system.htm; Masimo Patient SafetyNet System at a Glance, printed on August 20, 2009	
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SHEET 46 OF 46	Attorney Docket No.	MASCER.002C13

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	1282	Japanese Office Action, re JP Application No. 2011-516895, mailed September 2, 2014, with translation. (CERCA.007JP).	
	1283	Japanese Notice of Allowance, re JP Application No. 2011-516895, issued on May 12, 2015, no translation. (CERCA/MASCER.007JP).	
	1284	European Office Action issued in application no. 10763901.5 on 01/11/2013. (CERCA.008EP).	
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	1287	European Office Action issued in Application No. 09791157.2, dated June 20, 2016. (MASCER.002EP).	
	1288	KANUKURTHY et al., "Data Acquisition Unit for an Implantable Multi-Channel Optical Glucose Sensor", Electro/Information Technology Conference, Chicago, IL, USA, May 17-20, 2007, pp. 1-6	
	1289	KONIG et al., "Reflectance Pulse Oximetry - Principles and Obstetric Application in the Zurich System", Journal of Clinical Monitoring and Computing, Vol. 14, No. 6, August 1998, pp. 403-412.	
	1290	SMITH, "The Pursuit of Noninvasive Glucose: 'Hunting the Deceitful Turkey'", 2006	
	1291	SMALL et al., "Data Handling Issues for Near-Infrared Glucose Measurements", http://www.ieee.org/organizations/pubs/newsletters/leos/apr98/datahandling.htm, accessed 11/27/2007	

Examiner Signature	/CHU CHUAN LIU/	Date Considered	09/17/2019

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L7	439	glucose and "16"{d2} adj nm and A61B5/1455,14551,14552,14532,6829,6838,6816,6843,14546,6826.cpc.	US-PGPUB; USPAT	OR	ON	2019/09/17 18:39
L8	0	"16544713"	US-PGPUB; USPAT	OR	ON	2019/09/17 18:40
L9	22	7 and masimo.as.	US-PGPUB; USPAT	OR	ON	2019/09/17 18:51
S1	0	"16541987"	US-PGPUB; USPAT	OR	ON	2019/09/17 15:27
S2	423	(Poeze near2 Jeroen Lamego near2 Marcelo Merritt near2 Sean Dalvi near2 Cristiano Vo near2 Hung Bruinsma near2 Johannes Lesmana near2 Ferdyan Kiani near4 Massi with Joe Olsen near2 Greg).in.	US-PGPUB; USPAT	OR	ON	2019/09/17 15:29
S3	16	"12829352"	US-PGPUB; USPAT	OR	ON	2019/09/17 15:30
S4	1	("5638816").PN.	US-PGPUB; USPAT	OR	OFF	2019/09/17 15:31
S5	198	glucose and "16"{d2} adj nm and 600/310-344.ccls.	US-PGPUB; USPAT	OR	ON	2019/09/17 15:34
S6	45	S2 and "1600" adj nm	US-PGPUB; USPAT	OR	ON	2019/09/17 15:38
S7	4	S2 and "1600" adj nm.clm.	US-PGPUB; USPAT	OR	ON	2019/09/17 15:38
S8	21	"12497528"	US-PGPUB; USPAT	OR	ON	2019/09/17 15:40
S9	2	"12493523"	US-PGPUB; USPAT	OR	ON	2019/09/17 15:40
S10	17	"12534827"	US-PGPUB; USPAT	OR	ON	2019/09/17 15:40
S11	3	(S8 S9 S10) and "1600" adj nm.clm.	US-PGPUB; USPAT	OR	ON	2019/09/17 15:41
S12	0	"16534949"	US-PGPUB; USPAT	OR	ON	2019/09/17 15:42
S13	0	"16449143"	US-PGPUB; USPAT	OR	ON	2019/09/17 15:44
S14	2	"16409515"	US-PGPUB; USPAT	OR	ON	2019/09/17 15:45

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S31	266	diode adj detector same photodetector	US-PGPUB; USPAT	OR	ON	2019/09/17 17:00
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EAST Search History (Interference)

< This search history is empty>

9/17/2019 7:00:17 PM
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PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 1 OF 1	Attorney Docket No.	MASCER.002C13

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Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
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FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]

Examiner Signature	/CHU CHUAN LIU/	Date Considered	09/17/2019

***Examiner:** Initial if reference 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.

T[1] - Place a check mark in this area when an English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.L/

UNITED STATES PATENT AND TRADEMARK OFFICE
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KNOBBE, MARTENS, OLSON & BEAR, LLP
MASIMO CORPORATION (MASIMO)
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

Courtesy Reminder for
Application Serial No: 16/544,713

Attorney Docket No: MASCER.002C13
Customer Number: 64735
Date of Electronic Notification: 09/23/2019

This is a courtesy reminder that new correspondence is available for this application. If you have not done so already, please review the correspondence. The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

An email notification regarding the correspondence was sent to the following email address(es) associated with your customer number:
jayna.cartee@knobbe.com
efiling@knobbe.com

To view your correspondence online or update your email addresses, please visit us anytime at **https://ppair-my.uspto.gov/pair/PrivatePair.**
If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov or call 1-866-217-9197.

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/25 PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A PROVISIONAL DOUBLE PATENTING REJECTION OVER A PENDING "REFERENCE" APPLICATION AND TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	16544713
Filing Date	19-Aug-2019
First Named Inventor	Jeroen Poeze
Attorney Docket Number	MASCER.002C13
Title of Invention	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
Masimo Corporation	100 %

The owner(s) of percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of any patent granted on pending reference Application Number(s)

16534956 filed on 08/07/2019

16534949 filed on 08/07/2019

16541987 filed on 08/15/2019

as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and any patent granted on the reference application are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term of any patent granted on said reference application, "as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application," in the event that any such patent granted on the pending reference application: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims canceled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as shortened by any terminal disclaimer filed prior to its grant.

The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

10258265

10258266

10299708

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10376190

10376191

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○ I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.

Applicants claims the following fee status:

○ Small Entity

○ Micro Entity

◉ Regular Undiscounted

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.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

- (●) An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

  Registration Number 65066

- ( ) A sole inventor
- ( ) A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application
- ( ) A joint inventor; all of whom are signing this request

Signature	/Scott Cromar/
Name	Scott Cromar

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	16544713
Filing Date:	19-Aug-2019
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Filer:	Scott Cromar/Elizabeth Rutherford
Attorney Docket Number:	MASCER.002C13

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	1814	1	160	160
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**160**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 16544713

Filing Date: 19-Aug-2019

Applicant/Patent under Reexamination: Poeze

Electronic Terminal Disclaimer filed on October 7, 2019

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt	
EFS ID:	37387690
Application Number:	16544713
International Application Number:	
Confirmation Number:	9381
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Customer Number:	64735
Filer:	Scott Cromar/Elizabeth Rutherford
Filer Authorized By:	Scott Cromar
Attorney Docket Number:	MASCER.002C13
Receipt Date:	07-OCT-2019
Filing Date:	19-AUG-2019
Time Stamp:	19:20:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$160
RAM confirmation Number	E201907J20476524
Deposit Account	111410
Authorized User	Elizabeth Rutherford
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	39518 77fc856cf9ece80bbcd4af552c60b0f5dc49509f	no	3
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30749 3ecd284dad924667492764513ccfcbe3fba658e	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	70267		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Inventor	:	Jeroen Poeze
App. No.	:	16/544713
Filed	:	August 19, 2019
For	:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
Examiner	:	Chu Chuan Liu
Art Unit	:	3791
Conf. No.	:	9381

RESPONSE TO OFFICE ACTION DATED SEPTEMBER 23, 2019

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Prior to examination, please amend the application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Summary of Interview begins on page 7 of this paper.

Remarks begin on page 8 of this paper.

AMENDMENTS TO THE CLAIMS

1. (**Canceled**)

2. (**New**) A physiological measurement system comprising:

a physiological sensor device comprising:

a plurality of emitters configured to emit light into tissue of a user;

at least four detectors;

a wall that surrounds at least the at least four detectors; and

a cover that operably connects to the wall and that is configured to be located between tissue of the user and the at least four detectors when the physiological sensor device is worn by the user, wherein:

the cover comprises a single protruding convex surface, and

at least a portion of the cover is sufficiently rigid to cause tissue of the user to conform to at least a portion of a shape of the single protruding convex surface when the physiological sensor device is worn by the user; and

a handheld computing device in wireless communication with the physiological sensor device, wherein the handheld computing device comprises:

one or more processors configured to wirelessly receive one or more signals from the physiological sensor device, the one or more signals responsive to at least a physiological parameter of the user;

a touch-screen display configured to provide a user interface, wherein:

the user interface is configured to display indicia responsive to measurements of the physiological parameter, and

an orientation of the user interface is configurable responsive to a user input; and

a storage device configured to at least temporarily store at least the measurements of the physiological parameter.

3. (**New**) The physiological measurement system of Claim 2, wherein each of the at least four detectors has a corresponding window that allows light to pass through to the detector.

4. (**New**) The physiological measurement system of Claim 3, wherein the at least four detectors comprise at least eight detectors.

5. (**New**) The physiological measurement system of Claim 4, wherein at least part of the cover is light permeable to provide optical paths to the at least four detectors.

6. (**New**) The physiological measurement system of Claim 5, wherein the physiological sensor device further comprises:

an at least partially opaque layer blocking one or more optical paths to the at least four detectors, wherein the at least partially opaque layer comprises the windows that allow light to pass through to the corresponding detectors.

7. (**New**) The physiological measurement system of Claim 6, wherein the physiological sensor device further comprises:

a substrate having a first surface, wherein the at least four detectors are arranged on the first surface.

8. (**New**) The physiological measurement system of Claim 7, wherein:

the wall surrounds at least the at least four detectors on the first surface,

the wall operably connects to the substrate on one side of the wall, and

the wall operably connects to the cover on an opposing side of the wall.

9. (**New**) The physiological measurement system of Claim 8, wherein the wall creates one or more gaps between the first surface of the substrate and a surface of the cover that is interior to the physiological sensor device, and wherein the at least four detectors are positioned on the first surface of the substrate within the one or more gaps.

10. (**New**) The physiological measurement system of Claim 8, wherein the substrate, the wall, and the cover together hermetically seal the at least four detectors.

11. (**New**) The physiological measurement system of Claim 10, wherein a surface of the handheld computing device positions the touch-screen display.

12. (**New**) The physiological measurement system of Claim 11, wherein the physiological parameter comprises at least one of: pulse rate, glucose, oxygen, oxygen saturation, methemoglobin, total hemoglobin, carboxyhemoglobin, or carbon monoxide.

13. (**New**) The physiological measurement system of Claim 12, wherein the single protruding convex surface protrudes a height between 1 millimeter and 3 millimeters.

14. (**New**) The physiological measurement system of Claim 13, wherein at least one of the detectors is configured to detect light that has been attenuated by tissue of the user.

15. (**New**) The physiological measurement system of Claim 14, wherein the displayed indicia are further responsive to temperature.

16. (**New**) The physiological measurement system of Claim 15, wherein a portion of the physiological sensor device comprises one of at least two sizes, the two sizes intended to be appropriate for larger users and smaller users.

17. (**New**) The physiological measurement system of Claim 16, wherein the at least four detectors are arranged such that a first detector and a second detector of the least four detectors are arranged across from each other on opposite sides of a central point along a first axis, and a third detector and a fourth detector of the least four detectors are arranged across from each other on opposite sides of the central point along a second axis which is different from the first axis.

18. (**New**) The physiological measurement system of Claim 17, wherein the first axis is perpendicular to the second axis, and wherein the first, second, third and fourth detectors form a cross pattern about the central point.

19. (**New**) The physiological measurement system of Claim 18, wherein the single protruding convex surface protrudes a height greater than 2 millimeters and less than 3 millimeters.

20. (**New**) The physiological measurement system of Claim 19, wherein the attenuated light is reflected by the tissue.

21. (**New**) The physiological measurement system of Claim 11, wherein the physiological parameter comprises a state or trend of wellness of the user.

22. (**New**) A physiological measurement system comprising:

a physiological sensor device comprising:

a plurality of emitters configured to emit light into tissue of a user;

at least four detectors;

a wall that surrounds at least the at least four detectors; and

a tissue shaper that operably connects to the wall and that is configured to be located between tissue of the user and the at least four detectors when the physiological sensor device is worn by the user, wherein:

the tissue shaper comprises a single protruding convex surface, and

at least a portion of the tissue shaper is sufficiently rigid to cause tissue of the user to conform to at least a portion of a shape of the single

protruding convex surface when the physiological sensor device is worn by the user; and

a handheld computing device in wireless communication with the physiological sensor device.

23. (**New**) The physiological measurement system of Claim 22, wherein the handheld computing device comprises:

one or more processors configured to wirelessly receive one or more signals from the physiological sensor device, the one or more signals responsive to at least a physiological parameter of the user;

a touch-screen display configured to provide a user interface, wherein:

the user interface is configured to display indicia responsive to measurements of the physiological parameter, and

an orientation of the user interface is configurable responsive to a user input; and

a storage device configured to at least temporarily store at least the measurements of the physiological parameter.

24. (**New**) The physiological measurement system of Claim 23, wherein the at least four detectors comprise at least eight detectors.

25. (**New**) The physiological measurement system of Claim 24, wherein at least part of the tissue shaper is light permeable to provide optical paths to the at least four detectors.

26. (**New**) The physiological measurement system of Claim 25, wherein each of the at least four detectors has a corresponding window that allows light to pass through to the detector.

27. (**New**) The physiological measurement system of Claim 26, wherein the physiological sensor device further comprises:

an at least partially opaque layer blocking one or more optical paths to the at least four detectors, wherein the at least partially opaque layer comprises the windows that allow light to pass through to the corresponding detectors.

28. (**New**) The physiological measurement system of Claim 27, wherein the physiological sensor device further comprises:

a substrate having a first surface, wherein the at least four detectors are arranged on the first surface, and wherein the wall surrounds at least the at least four detectors on the first surface,

wherein:

the wall operably connects to the substrate on one side of the wall, and

the wall operably connects to the tissue shaper on an opposing side of the wall.

29. (**New**) The physiological measurement system of Claim 28, wherein a surface of the handheld computing device positions the touch-screen display.

30. (**New**) The physiological measurement system of Claim 29, wherein the physiological parameter comprises at least one of: pulse rate, glucose, oxygen, oxygen saturation, methemoglobin, total hemoglobin, carboxyhemoglobin, carbon monoxide, or a state or trend of wellness of the user.

31. (**New**) The physiological measurement system of Claim 30, wherein the single protruding convex surface protrudes a height greater than 2 millimeters and less than 3 millimeters.

SUMMARY OF INTERVIEW

Attendees, Date and Type of Interview

A telephone interview was conducted on October 3, 2019, and attended by Examiner Chiu Chuan Liu, and Applicant's representatives Scott Cromar and Jarom Kesler.

Exhibits and/or Demonstrations

None.

Identification of Claims Discussed

Proposed new claims 2-31.

Identification of Cited/Disclosed Art Discussed

References of record.

Proposed Amendments

Proposed new claims 2-31.

Substance and Results of Interview

Certain proposed new claims 2-31 were discussed. It was agreed that the proposed new claims would overcome the statutory double patenting rejections and the rejections under 35 U.S.C. § 102.

REMARKS

Applicant thanks Examiner Liu for the interview summarized above ("the interview"). Claim 1 was pending. By this response, and in view of the interview, Applicant has canceled Claim 1 without prejudice or disclaimer of subject matter, and added new Claims 2-31 that are similar to those discussed during the interview. Applicant reserves the right to pursue previously pending claims in this or another application (e.g., a continuing application). Accordingly, Claims 2-31 are pending for consideration.

Rejections under 35 U.S.C. § 102

Claim 1 was rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,222,496 to Clarke et al. ("Clarke"). Applicant respectfully traverses this rejection, but notes that Claim 1 has been canceled, rendering the rejection moot. Accordingly, Applicant requests withdrawal of the rejection under 35 U.S.C. § 102(b).

Double Patenting Rejections

Claim 1 was rejected on the ground of provisional statutory double patenting over Claim 1 of co-pending Application No. 16/541,987 and Claim 1 of co-pending Application No. 16/544,755. As noted above, Claim 1 has been canceled, rendering the rejection moot. Accordingly, Applicant requests withdrawal of the statutory double patenting rejection.

Claim 1 was rejected on the ground of nonstatutory double patenting over Claims 1, 9-10, and 17 of U.S. Patent No. 9,277,880 in view of Clarke; Claim 1 was rejected on the ground of nonstatutory double patenting over Claims 7 and 16 of U.S. Patent No. 10,292,628 in view of Clarke; Claim 1 was rejected on the ground of nonstatutory double patenting over Claims 19 and 23 of U.S. Patent No. 10,299,708 in view of Clarke; and Claim 1 was rejected on the ground of nonstatutory double patenting over Claims 1, 18, 26-27, and 30 of U.S. Patent No. 10,376,190 in view of Clarke. As noted above, Claim 1 has been canceled, rendering the rejections moot. Accordingly, Applicant requests withdrawal of the nonstatutory double patenting rejections.

However, in the interest of expediting allowance of the present application, Applicant is filing simultaneously herewith an electronic terminal disclaimer.

New Claims

Applicant has added new Claims 2-31 that are similar to those discussed during the interview.

No Disclaimers or Disavowals

Although the present communication may include alterations to the application or claims, or characterizations of claim scope or referenced art, Applicant is not conceding in this application that previously pending claims are not patentable over the cited references. Rather, any alterations or characterizations are being made to facilitate expeditious prosecution of this application. Applicant reserves the right to pursue at a later date any previously pending or other broader or narrower claims that capture any subject matter supported by the present disclosure, including subject matter found to be specifically disclaimed herein or by any prior prosecution. Accordingly, reviewers of this or any parent, child, or related prosecution history shall not reasonably infer that Applicant has made any disclaimers or disavowals of any subject matter supported by the present application.

Co-Pending Applications of Assignee

Applicant wishes to draw the Examiner's attention to the following co-pending applications of the present application's assignee.

Docket No.	Serial No.	Title	Filed
MASCER.002C9	16/449143	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	06/21/2019
MASCER.002C10	16/534956	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/07/2019
MASCER.002C11	16/534949	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/07/2019
MASCER.002C12	16/541987	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/15/2019

Docket No.	Serial No.	Title	Filed
MASCER.002C14	16/544755	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/19/2019
MASCER.002C15	16/594980	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	10/07/2019
MASCER.006C2	15/660743	NOISE SHIELDING FOR A NONINVASIVE DEVICE	07/26/2017

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: October 7, 2019

By: /Scott Cromar/_____
Scott A. Cromar
Registration No. 65,066
Registered Practitioner
Customer No. 64735
(949) 760-0404

31160688

Electronic Patent Application Fee Transmittal

Application Number:	16544713
Filing Date:	19-Aug-2019
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Filer:	Scott Cromar/Frances Tsai
Attorney Docket Number:	MASCER.002C13

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1202	10	100	1000
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1000**

Electronic Acknowledgement Receipt	
EFS ID:	37387635
Application Number:	16544713
International Application Number:	
Confirmation Number:	9381
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Customer Number:	64735
Filer:	Scott Cromar/Fabiola Esmerio
Filer Authorized By:	Scott Cromar
Attorney Docket Number:	MASCER.002C13
Receipt Date:	07-OCT-2019
Filing Date:	19-AUG-2019
Time Stamp:	19:07:33
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1000
RAM confirmation Number	E201907J07596397
Deposit Account	111410
Authorized User	Fabiola Esmerio
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Response_MASCER002C13.pdf	57999 100ae40ae9d4568a453d0e3a71727183be48966b	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	6
	Applicant summary of interview with examiner	7	7
	Applicant Arguments/Remarks Made in an Amendment	8	10

Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30345 2a8c4ca964e66efef9fc457072101873c9936c1a	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	88344		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/544,713	Filing Date 08/19/2019	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	10/07/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 30	Minus	** 20	= 10		x $100 =	1000
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	1000

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/SHARON M WEST/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. 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, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

References for Examiner Consideration

Applicant wishes to draw the Examiner's attention to, and encourages the Examiner to review, the following co-owned patents and/or applications and their existing and ongoing prosecution history, including without limitation Office Actions, Amendments, Remarks, and any other potentially relevant documents:

Docket No.	Serial No.	Title	Filed
MASCER.002C15	16/594980	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	10/07/2019

Applicant notes that cited references, office actions, responses and notices of allowance currently exist or will exist with reference to the above-referenced matters. Applicant also understands that the Examiner has access to sophisticated online Patent Office computing systems that provide ready access to the full file histories of these matters including, for example, specifications, drawings, pending claims, cited art, office actions, responses, declarations, and notices of allowance. Rather than submit copies of these file histories, Applicant respectfully requests that the Examiner continue to review these file histories online for past, current, and future information about these matters that may be relevant to examination of the present application. Also, if the Examiner cannot readily access these file histories, Applicant would be pleased to provide any portion of any of the file histories at any time upon specific Examiner request.

No Disclaimers

To the extent that anything in the Information Disclosure Statement or the listed references could be construed as a disclaimer of any subject matter supported by the present application, Applicant hereby rescinds and retracts such disclaimer.

Timing of Disclosure

This Information Disclosure Statement is being filed after receipt of a First Office Action, but before the mailing date of a Final Action and before the mailing date of a Notice of Allowance.

This Statement is accompanied by the fees set forth in 37 CFR 1.17(p). The Commissioner is hereby authorized to charge any additional fees which may be required or to credit any overpayment to Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: October 8, 2019

By: /Scott Cromar/_____
Scott A. Cromar
Registration No. 65,066
Registered Practitioner
Customer No. 64735
(949) 760-0404

31476585

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	3791
(Multiple sheets used when necessary)	Examiner	Liu, Chu Chuan
SHEET 1 OF 1	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	6,297,969	10-02-2001	Mottahed	
	2	10,383,520	08-20-2019	Wojtczuk et al.	
	3	10,383,527	08-20-2019	Al-Ali	
	4	10,388,120	08-20-2019	Muhsin et al.	
	5	10,398,320	09-03-2019	Kiani et al.	
	6	10,405,804	09-10-2019	Al-Ali	
	7	10,413,666	09-17-2019	Al-Ali et al.	
	8	10,420,493	09-24-2019	Al-Ali et al.	
	9	2002/0111546	08-15-2002	Cook et al.	
	10	2019/0254578	08-22-2019	Lamego	
	11	2019/0261857	08-29-2019	Al-Ali	
	12	2019/0269370	09-05-2019	Al-Ali et al.	
	13	2019/0274606	09-12-2019	Kiani et al.	
	14	2019/0274627	09-12-2019	Al-Ali et al.	
	15	2019/0274635	09-12-2019	Al-Ali et al.	
	16	2019/0290136	09-26-2019	Dalvi et al.	
	17	2019/0298270	10-03-2019	Al-Ali et al.	
	18	2019/0304601	10-03-2019	Sampath et al.	
	19	2019/0304605	10-03-2019	Al-Ali	

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T^1

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T^1

Examiner Signature	Date Considered
***Examiner:** Initial if reference 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.	

T^1 - Place a check mark in this area when an English language Translation is attached.

Electronic Patent Application Fee Transmittal

Application Number:	16544713
Filing Date:	19-Aug-2019
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Filer:	Scott Cromar/Frances Tsai
Attorney Docket Number:	MASCER.002C13

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
		Total in USD ($)		**240**

Electronic Acknowledgement Receipt	
EFS ID:	37399130
Application Number:	16544713
International Application Number:	
Confirmation Number:	9381
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Customer Number:	64735
Filer:	Scott Cromar/Frances Tsai
Filer Authorized By:	Scott Cromar
Attorney Docket Number:	MASCER.002C13
Receipt Date:	08-OCT-2019
Filing Date:	19-AUG-2019
Time Stamp:	17:10:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$240
RAM confirmation Number	E201908H11167934
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		IDS_002C13.pdf	52348 fb264a99822549c27c9b37261ca17ee0f6089df0	yes	4
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	1	
	Information Disclosure Statement (IDS) Form (SB08)		2	4	
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30535 99c2607ed8ed820079e45b67f2e7a22d074aae61	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	82883		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

INFORMATION DISCLOSURE STATEMENT

First Inventor	:	Jeroen Poeze
App. No.	:	16/544713
Filed	:	August 19, 2019
For	:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
Examiner	:	Liu, Chu Chuan
Art Unit	:	3791
Conf. No.	:	9381

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

References and Listing

Pursuant to 37 CFR 1.56, an Information Disclosure Statement listing references is provided herewith. Copies of any listed foreign and non-patent literature references are being submitted.

Pursuant to 37 CFR 1.97(g) and (h), Applicant makes no representation that the information is considered to be material to patentability. Additionally, inclusion on this list is not an admission that any of the cited documents are prior art in this application. Further, Applicant makes no representation regarding the completeness of this list, or that better art does not exist.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/544,713	08/19/2019	Jeroen Poeze	MASCER.002C13	9381

64735 7590 10/09/2019

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

EXAMINER	
LIU, CHU CHUAN	

ART UNIT	PAPER NUMBER
3791	

NOTIFICATION DATE	DELIVERY MODE
10/09/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

efiling@knobbe.com
jayna.cartee@knobbe.com

Applicant-Initiated Interview Summary	**Application No.** 16/544,713	**Applicant(s)** Poeze et al.	
	Examiner CHU CHUAN LIU	**Art Unit** 3791	**AIA (FITF) Status** No

All participants (applicant, applicants representative, PTO personnel):

(1) Chu Chuan Liu.

(2) Jarom Kesler.

(3) Scott Cromar.

(4) _____.

Date of Interview: 03 October 2019.

Type: ☑ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☑102 ☐103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 2.

Identification of prior art discussed: None.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

During the interview, proposed claim amendments were discussed. Attorney indicated that claim 1 would be canceled and proposed claims 2-31 would be submitted (see the attachment). Examiner indicated the cancellation of claim 1 would overcome the previous rejections. Examiner also indicated that an updated search is required when the formal response has been filed..

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☑ Attachment

/CHU CHUAN LIU/ Examiner, Art Unit 3791	

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiners responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicants correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,-
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicants record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiners version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, Interview Record OK on the paper recording the substance of the interview along with the date and the examiners initials.

1. (**Canceled**)

2. (**New**) A physiological measurement system comprising:

a physiological sensor device comprising:

a plurality of emitters configured to emit light into tissue of a user;

at least four detectors;

a wall that surrounds at least the at least four detectors;

a cover that operably connects to the wall and that is configured to be located between tissue of the user and the at least four detectors when the physiological sensor device is worn by the user, wherein:

the cover comprises a single protruding convex surface, and

at least a portion of the cover is sufficiently rigid to cause tissue of the user to conform to at least a portion of a shape of the single protruding convex surface when the physiological sensor device is worn by the user; and

a plurality of windows, wherein each of the plurality of windows allows light to pass through to at least a respective one of the at least four detectors; and

a handheld computing device in wireless communication with the physiological sensor device, wherein the handheld computing device comprises:

one or more processors configured to wirelessly receive one or more signals from the physiological sensor device, the one or more signals responsive to at least a physiological parameter of the user;

a touch-screen display configured to provide a user interface, wherein:

the user interface is configured to display indicia responsive to measurements of the physiological parameter, and

an orientation of the user interface is configurable responsive to a user input; and

a storage device configured to at least temporarily store at least the measurements of the physiological parameter.

3. (**New**) The physiological measurement system of Claim 2, wherein the at least four detectors comprise at least eight detectors.

4. (**New**) The physiological measurement system of Claim 3, wherein at least part of the cover is light permeable to provide optical paths to the at least four detectors.

5. (**New**) The physiological measurement system of Claim 4, wherein the physiological sensor device further comprises:

an at least partially opaque layer blocking one or more optical paths to the at least four detectors, wherein the at least partially opaque layer comprises the plurality of windows that allow light to pass through to at least the respective ones of the at least four detectors.

6. (**New**) The physiological measurement system of Claim 5, wherein the physiological sensor device further comprises:

a substrate having a first surface, wherein the at least four detectors are arranged on the first surface.

7. (**New**) The physiological measurement system of Claim 6, wherein the wall surrounds at least the at least four detectors on the first surface.

8. (**New**) The physiological measurement system of Claim 7, wherein:

the wall operably connects to the substrate on one side of the wall, and

the wall operably connects to the cover on an opposing side of the wall.

9. (**New**) The physiological measurement system of Claim 8, wherein the wall creates one or more gaps between the first surface of the substrate and a surface of the cover that is interior to the physiological sensor device, and wherein the at least four detectors are positioned on the first surface of the substrate within the one or more gaps.

10. (**New**) The physiological measurement system of Claim 8, wherein the substrate, the wall, and the cover together hermetically seal the at least four detectors.

11. (**New**) The physiological measurement system of Claim 10, wherein a surface of the handheld computing device positions the touch-screen display.

12. (**New**) The physiological measurement system of Claim 11, wherein the physiological parameter comprises at least one of: pulse rate, glucose, oxygen, oxygen saturation, methemoglobin, total hemoglobin, carboxyhemoglobin, or carbon monoxide.

13. (**New**) The physiological measurement system of Claim 12, wherein the single protruding convex surface protrudes a height between 1 millimeter and 3 millimeters.

14. (**New**) The physiological measurement system of Claim 13, wherein at least one of the detectors is configured to detect light that has been attenuated by tissue of the user.

15. (**New**) The physiological measurement system of Claim 14, wherein the displayed indicia are further responsive to temperature.

16. (**New**) The physiological measurement system of Claim 15, wherein a portion of the physiological sensor device comprises at least one of two sizes, the two sizes intended to be appropriate for larger users and smaller users.

17. (**New**) The physiological measurement system of Claim 16, wherein the at least four detectors are arranged such that a first detector and a second detector of the least four detectors are arranged across from each other on opposite sides of a central point along a first axis, and a third detector and a fourth detector of the least four detectors are arranged across from each other on opposite sides of the central point along a second axis which is different from the first axis.

18. (**New**) The physiological measurement system of Claim 17, wherein the first axis is perpendicular to the second axis, and wherein the first, second, third and fourth detectors form a cross pattern about the central point.

19. (**New**) The physiological measurement system of Claim 18, wherein the single protruding convex surface protrudes a height greater than 2 millimeters and less than 3 millimeters.

20. (**New**) The physiological measurement system of Claim 19, wherein the attenuated light is reflected by the tissue.

21. (**New**) The physiological measurement system of Claim 11, wherein the physiological parameter comprises a state or trend of wellness of the user.

22. (**New**) A physiological measurement system comprising:

a physiological sensor device comprising:

a plurality of emitters configured to emit light into tissue of a user;

at least four detectors;

a wall that surrounds at least the at least four detectors; and

a tissue shaper that operably connects to the wall and that is configured to be located between tissue of the user and the at least four detectors when the physiological sensor device is worn by the user, wherein:

the tissue shaper comprises a single protruding convex surface, and

at least a portion of the tissue shaper is sufficiently rigid to cause tissue of the user to conform to at least a portion of a shape of the single protruding convex surface when the physiological sensor device is worn by the user.

23. (**New**) The physiological measurement system of Claim 22 further comprising:

a handheld computing device in wireless communication with the physiological sensor device, wherein the handheld computing device comprises:

one or more processors configured to wirelessly receive one or more signals from the physiological sensor device, the one or more signals responsive to at least a physiological parameter of the user;

a touch-screen display configured to provide a user interface, wherein:

the user interface is configured to display indicia responsive to measurements of the physiological parameter, and

an orientation of the user interface is configurable responsive to a user input; and

a storage device configured to at least temporarily store at least the measurements of the physiological parameter.

24. (**New**) The physiological measurement system of Claim 23, wherein the at least four detectors comprise at least eight detectors.

25. (**New**) The physiological measurement system of Claim 24, wherein at least part of the tissue shaper is light permeable to provide optical paths to the at least four detectors.

26. (**New**) The physiological measurement system of Claim 25, wherein the physiological sensor device further comprises:

a plurality of windows, wherein each of the plurality of windows allows light to pass through to at least a respective one of the at least four detectors.

27. (**New**) The physiological measurement system of Claim 26, wherein the physiological sensor device further comprises:

an at least partially opaque layer blocking one or more optical paths to the at least four detectors, wherein the at least partially opaque layer comprises the plurality of windows that allow light to pass through to at least the respective ones of the at least four detectors.

28. (**New**) The physiological measurement system of Claim 27, wherein the physiological sensor device further comprises:

a substrate having a first surface, wherein the at least four detectors are arranged on the first surface, and wherein the wall surrounds at least the at least four detectors on the first surface,

wherein:

the wall operably connects to the substrate on one side of the wall, and

the wall operably connects to the tissue shaper on an opposing side of the wall.

29. (**New**) The physiological measurement system of Claim 28, wherein a surface of the handheld computing device positions the touch-screen display.

30. (**New**) The physiological measurement system of Claim 29, wherein the physiological parameter comprises at least one of: pulse rate, glucose, oxygen, oxygen

saturation, methemoglobin, total hemoglobin, carboxyhemoglobin, carbon monoxide, or a state or trend of wellness of the user.

31. (**New**) The physiological measurement system of Claim 30, wherein the single protruding convex surface protrudes a height greater than 2 millimeters and less than 3 millimeters.

Please Direct All Correspondence to Customer Number 64735

SUMMARY OF INTERVIEW

Inventor	:	Jeroen Poeze
App. No	:	16/544713
Filed	:	August 19, 2019
For	:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
Examiner	:	Liu, Chu Chuan
Art Unit	:	3791
Conf No.	:	9381

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Pursuant to the Examiner Interview of October 16, 2019, Applicant submits this Summary of Interview for recording in the official file.

Attendees, Date and Type of Interview

A telephone interview was conducted on October 16, 2019, and attended by Examiner Chu Chuan Liu, and Applicant's representative Scott Cromar.

Exhibits and/or Demonstrations

None.

Identification of Claims Discussed

Claims 2-31.

Identification of Cited/Disclosed Art Discussed

References of record.

Proposed Amendments

Certain proposed amendment to the claims, including cancelations of certain claims, were discussed.

Substance and Results of Interview

It was agreed that the proposed claim amendments and cancelations would place the claims in condition for allowance. Applicant authorized the examiner to enter the amendments by examiner's amendments.

Applicant notes that amendments to the claims are made for clarification purposes, to expedite allowance of the application, and not for patentability reasons. Applicant believes the previously pending claims, including the canceled claims, are patentable, and Applicant reserves the right to pursue previously pending claims in this or another application (e.g., a continuing application).

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: October 21, 2019

By: /Scott Cromar/_____
Scott A. Cromar
Registration No. 65,066
Registered Practitioner
Customer No. 64735
(949) 760-0404

31525016

Electronic Acknowledgement Receipt

EFS ID:	37517050
Application Number:	16544713
International Application Number:	
Confirmation Number:	9381
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Customer Number:	64735
Filer:	Scott Cromar/Gustavo Lopez
Filer Authorized By:	Scott Cromar
Attorney Docket Number:	MASCER.002C13
Receipt Date:	21-OCT-2019
Filing Date:	19-AUG-2019
Time Stamp:	19:05:16
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant summary of interview with examiner	IntSum_002C13.pdf	20441 e5c0783cf6fbf04309211c42149b225e4e70a5bb	no	2

Warnings:

Information:	
Total Files Size (in bytes):	20441

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

64735 7590 10/23/2019

KNOBBE, MARTENS, OLSON & BEAR, LLP
MASIMO CORPORATION (MASIMO)
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

EXAMINER
LIU, CHU CHUAN

ART UNIT	PAPER NUMBER
3791	

DATE MAILED: 10/23/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/544,713	08/19/2019	Jeroen Poeze	MASCER.002C13	9381

TITLE OF INVENTION: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	01/23/2020

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 DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). 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. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

64735 7590 10/23/2019
KNOBBE, MARTENS, OLSON & BEAR, LLP
MASIMO CORPORATION (MASIMO)
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/544,713	08/19/2019	Jeroen Poeze	MASCER.002C13	9381

TITLE OF INVENTION: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	01/23/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
LIU, CHU CHUAN	3791	600-310000

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 03-09 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. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). 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. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

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UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/544,713	08/19/2019	Jeroen Poeze	MASCER.002C13	9381

64735 7590 10/23/2019

KNOBBE, MARTENS, OLSON & BEAR, LLP
MASIMO CORPORATION (MASIMO)
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

EXAMINER	
LIU, CHU CHUAN	

ART UNIT	PAPER NUMBER
3791	

DATE MAILED: 10/23/2019

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

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B 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 30 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, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 16/544,713	Applicant(s) Poeze et al.	
	Examiner CHU CHUAN LIU	Art Unit 3791	AIA (FITF) Status No

-- 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 the response filed on 10/07/2019.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 2,4-25 and 27-31 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information , please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   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. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ 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).

6. ☐ 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. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 10/08/2019.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☑ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/ERIC F WINAKUR/ Primary Examiner, Art Unit 3791	/CHU CHUAN LIU/ Examiner, Art Unit 3791

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Scott Cromar on 10/16/2019. Amendments were made to better define over the art.

The application has been amended as follows:

Claim 2. A physiological measurement system comprising:

a physiological sensor device comprising:

a plurality of emitters configured to emit light into tissue of a user;

at least four detectors, wherein each of the at least four detectors has a corresponding window that allows light to pass through to the detector;

a wall that surrounds at least the at least four detectors; and

a cover that operably connects to the wall and that is configured to be located between tissue of the user and the at least four detectors when the physiological sensor device is worn by the user, wherein:

the cover comprises a single protruding convex surface, and

at least a portion of the cover is sufficiently rigid to cause tissue of the user to conform to at least a portion of a shape of the

single protruding convex surface when the physiological sensor device is worn by the user; and

a handheld computing device in wireless communication with the physiological sensor device, wherein the handheld computing device comprises:

one or more processors configured to wirelessly receive one or more signals from the physiological sensor device, the one or more signals responsive to at least a physiological parameter of the user;

a touch-screen display configured to provide a user interface, wherein:

the user interface is configured to display indicia responsive to measurements of the physiological parameter, and

an orientation of the user interface is configurable responsive to a user input; and

a storage device configured to at least temporarily store at least the measurements of the physiological parameter.

Claim 3 was canceled.

Claim 4. The physiological measurement system of Claim [[3]]2, wherein the at least four detectors comprise at least eight detectors.

Claim 22. A physiological measurement system comprising:

a physiological sensor device comprising:

a plurality of emitters configured to emit light into tissue of a user;

at least four detectors, wherein each of the at least four detectors has a corresponding window that allows light to pass through to the detector;

a wall that surrounds at least the at least four detectors; and

a tissue shaper that operably connects to the wall and that is configured to be located between tissue of the user and the at least four detectors when the physiological sensor device is worn by the user, wherein:

the tissue shaper comprises a single protruding convex surface, and

at least a portion of the tissue shaper is sufficiently rigid to cause tissue of the user to conform to at least a portion of a shape of the single protruding convex surface when the physiological sensor device is worn by the user; and

a handheld computing device in wireless communication with the physiological sensor device.

Claim 26 was canceled.

Claim 27. The physiological measurement system of Claim [[26]]25, wherein the physiological sensor device further comprises:

an at least partially opaque layer blocking one or more optical paths to the at least four detectors, wherein the at least partially opaque layer comprises the windows that allow light to pass through to the corresponding detectors.

2. The following is an examiner's statement of reasons for allowance: The terminal disclaimer for co-pending applications 16/534,956, 16/534,949 and 16/541,987 and patent Nos. 10,258,265, 10,258,266, 10,299,708, 10,292,628, 10,376,190, and 10,376,191 was approved on 10/07/2019 for resolving potential double patenting issues.

With regard to the prior art, Chaiken et al. (USPN 6,223,063 – applicant cited) teaches a physiological measurement device (Fig. 1), the physiological measurement device comprising: an emitter configured to emit light into tissue of a user (element 130 and finger, Figs. 1-2); at least four detectors (elements 160, Fig. 1) wherein each of the at least four detectors has a corresponding window that allows light to pass through to the detector (elements 150, Fig. 1); a cover is configured to be located between tissue of the user and the plurality of detectors (element 110, Fig. 1); the cover comprises multiple protruding convex surfaces (elements 150, Fig. 1), and at least a portion of the cover is sufficiently rigid to cause tissue of the user to conform to at least a portion of a shape of the single protruding convex surface when the physiological sensor device is worn by the user (element 110 with protruding elements 150, Fig. 1). Cook et al. (USPGPUB 2002/0111546 – applicant cited) teaches a physiological measurement

device (Fig. 7), the physiological measurement device comprising: a plurality of emitters configured to emit light into tissue of a user (element 702, Fig. 7; [0085]); a wall (the side wall(s) of the tubular section(s) connected to the base where the CCD is disposed on, Fig. 7) surrounds a plurality of detectors (CCD 760, Fig. 7); at least four detectors arranged in a grid pattern on the base (CCD 760, Fig. 7; pixels, [0099]); and a cover (window 724, Fig. 7) connects the wall and configured to be located between a tissue and the detectors (Fig. 7) and a computer for image correction, scene segmentation, and blood characteristic analysis ([0044]). Kimura et al. (USPN 6,353,750 – applicant cited) teaches a physiological measurement device (Fig. 27), the physiological measurement device comprising: a plurality of emitters configured to emit light into tissue of a user (elements 11, Fig. 27); at least four detectors positioned on a detector assembly (a lens with a CCD, a line sensor or a photodiode array of element 12, Fig. 27); a wall that surrounds the at least four detectors (element 151, Fig. 27); and a cover connects the wall and configured to be located between a tissue and the detectors (element 170 connects to element 150, Fig. 27); the cover comprises a single protruding convex surface (element 170, Fig. 27) and at least a portion of the cover is sufficiently rigid to cause tissue of the user to conform to at least a portion of a shape of the single protruding convex surface when the physiological measurement device is worn by the use (light-transmitting plate 170 made of acrylic resin, Fig. 27 and associated descriptions) and a personal computer (elements 2, Figs. 1 and 2). However, the prior art of record does not teach or suggest “at least four detectors, wherein each of the at least four detectors has a corresponding window that allows light to pass through to the detector; a wall that surrounds at least the at least four detectors; and a cover that

operably connects to the wall and that is configured to be located between tissue of the user and the at least four detectors when the physiological sensor device is worn by the user, wherein: the cover comprises a single protruding convex surface; and a handheld computing device in wireless communication with the physiological sensor device, wherein the handheld computing device comprises: one or more processors configured to wirelessly receive one or more signals from the physiological sensor device, the one or more signals responsive to at least a physiological parameter of the user; a touch-screen display configured to provide a user interface, wherein: the user interface is configured to display indicia responsive to measurements of the physiological parameter, and an orientation of the user interface is configurable responsive to a user input" and "at least four detectors, wherein each of the at least four detectors has a corresponding window that allows light to pass through to the detector; a wall that surrounds at least the at least four detectors; and a tissue shaper that operably connects to the wall and that is configured to be located between tissue of the user and the at least four detectors when the physiological sensor device is worn by the user, wherein: the tissue shaper comprises a single protruding convex surface; and a handheld computing device in wireless communication with the physiological sensor device", in combination with the other claimed elements/ steps.

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 CHU CHUAN LIU whose telephone number is (571)270-5507. The examiner can normally be reached on M-Th (8am-6pm).

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jacqueline Cheng can be reached on (571) 272-5596. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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). If you would like assistance from a

USPTO Customer Service Representative or access to the automated information

system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/ERIC F WINAKUR/
Primary Examiner, Art Unit 3791

/CHU CHUAN LIU/
Examiner, Art Unit 3791

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/544,713	Poeze et al.
	Examiner	Art Unit
	CHU CHUAN LIU	3791

CPC - Searched*		
Symbol	**Date**	**Examiner**
A61B5/1455,14551,14552,14532,6829,6838,6816,6843,14546,6826	09/17/2019	CCL
A61B5/1455,14551,14552,14532,14546,6826,6816,6829,6838 A61B2562/00,04,046,06,063,066	10/16/2019	CCL

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
Inventor Name Search (PALM and EAST)	09/17/2019	CCL
EAST Search (TEXT, USPGPUB, USPAT, CPC) See Search History	09/17/2019	CCL
Google NPL Search	09/17/2019	CCL
Updated EAST Search (TEXT, USPGPUB, USPAT, CPC) See Search History	10/16/2019	CCL
Google NPL Search	10/16/2019	CCL
Allowance consultation with Eric Winakur	10/09/2019	CCL

/CHU CHUAN LIU/ Examiner, Art Unit 3791	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/544,713	Poeze et al.
	Examiner	Art Unit
	CHU CHUAN LIU	3791

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
A61B5	1455,14551,14552,14532,14546,6826,6816,6829,6838	10/16/2019	CCL
A61B2562	00,04,046,06,063,066	10/16/2019	CCL

/CHU CHUAN LIU/ Examiner, Art Unit 3791	

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/544,713	Poeze et al.
	Examiner	**Art Unit**
	CHU CHUAN LIU	3791

CPC						
Symbol					**Type**	**Version**
A61B	/	5	/	1455	F	2013-01-01
A61B	/	5	/	6838	I	2013-01-01
A61B	/	5	/	14532	I	2013-01-01
A61B	/	5	/	6826	I	2013-01-01
A61B	/	5	/	6816	I	2013-01-01
A61B	/	5	/	14546	I	2013-01-01
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CPC Combination Sets								
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/CHU CHUAN LIU/ Examiner, Art Unit 3791	16 October 2019	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	28	
/ERIC F WINAKUR/ Primary Examiner, Art Unit 3791	17 October 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3C

U.S. Patent and Trademark Office — Part of Paper No.: 20191016

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/544,713	Poeze et al.
	Examiner	**Art Unit**
	CHU CHUAN LIU	3791

INTERNATIONAL CLASSIFICATION				
CLAIMED				
A61B	/	5	/	1455

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

/CHU CHUAN LIU/ Examiner, Art Unit 3791	16 October 2019	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	28	
/ERIC F WINAKUR/ Primary Examiner, Art Unit 3791	17 October 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3C

U.S. Patent and Trademark Office — Part of Paper No.: 20191016

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/544,713	Poeze et al.
	Examiner	**Art Unit**
	CHU CHUAN LIU	3791

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1	8	10	17	19	25	28								
1	2	9	11	18	20	26	29								
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/CHU CHUAN LIU/ Examiner, Art Unit 3791	16 October 2019	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	28	
/ERIC F WINAKUR/ Primary Examiner, Art Unit 3791	17 October 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3C

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S60	18	transparent with (window$1 grid permeable) same (photo$1detector photo$1diode detector receiver) same (respective$2 corresponding) same (lens$2 protru$5) same (tissue skin finger)	US-PGPUB; USPAT	OR	ON	2019/10/16 09:48
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S49	65	S47 and (smart mobile) with phone same display same wireless	US-PGPUB; USPAT	OR	ON	2019/10/16 09:38
S48	238	S47 and (handheld portable) same display same wireless	US-PGPUB; USPAT	OR	ON	2019/10/16 09:36
S47	1591	touch adj screen with display same user adj interface same orientation	US-PGPUB; USPAT	OR	ON	2019/10/16 09:35
S46	64	touch adj screen with display same user adj interface same orientation and "600".clas.	US-PGPUB; USPAT	OR	ON	2019/10/16 09:32
S45	48	kimura.in. and finger and "600".clas.	US-PGPUB; USPAT	OR	ON	2019/10/16 09:26
S44	1383	kimura.in. and finger	US-PGPUB; USPAT	OR	ON	2019/10/16 09:26
S43	22	kimura.in. and finger and oxygen with saturation	US-PGPUB; USPAT	OR	ON	2019/10/16 09:25
S42	19	("10383520" | "10383527" | "10388120" | "10398320" | "10405804" | "10413666" | "10420493" | "20020111546" | "20190254578" | "20190261857" | "20190269370" | "20190274606" | "20190274627" | "20190274635" | "20190290136" | "20190298270" | "20190304601" | "20190304605" | "6297969").PN.	US-PGPUB; USPAT	OR	ON	2019/10/16 09:24
S41	109	(CCD array with detect$3) and wall same housing same (lens cover protru$5) and (A61B5/1455,14551,14552,14532,14546,6826,6816,6829,6838 A61B2562/00,04,046,06,063,066).cpc.	US-PGPUB; USPAT	OR	ON	2019/10/16 09:23
S40	221	(CCD array beam$1splitter) and wall same housing same (lens cover protru$5) and (A61B5/1455,14551,14552,14532,14546,6826,6816,6829,6838 A61B2562/00,04,046,06,063,066).cpc.	US-PGPUB; USPAT	OR	ON	2019/10/16 09:23

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S58	64	touch adj screen with display same user adj interface same orientation and "600".clas.	US-PGPUB; USPAT	OR	ON	2019/10/16 09:32
S57	221	(CCD array) and wall same housing same (lens cover protru$5) and	US-PGPUB;	OR	ON	2019/10/16 09:30

		(A61B5/1455,14551,14552,14532,14546,6826,6816,6829,6838 A61B2562/00,04,046,06,063,066).cpc.	USPAT			
S56	221	(CCD array beam$1splitter) and wall same housing same (lens cover protru$5) and (A61B5/1455,14551,14552,14532,14546,6826,6816,6829,6838 A61B2562/00,04,046,06,063,066).cpc.	US-PGPUB; USPAT	OR	ON	2019/10/16 09:30

10/ 16/ 2019 2:37:15 PM
C:\ Users\ cliu\ Documents\ EAST\ Workspaces\ 16544713.wsp

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Applicant wishes to draw the Examiner's attention to, and encourages the Examiner to review, the following co-owned patents and/or applications and their existing and ongoing prosecution history, including without limitation Office Actions, Amendments, Remarks, and any other potentially relevant documents:

Docket No.	Serial No.	Title	Filed
MASCER.002C15	16/594980	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	10/07/2019

Applicant notes that cited references, office actions, responses and notices of allowance currently exist or will exist with reference to the above-referenced matters. Applicant also understands that the Examiner has access to sophisticated online Patent Office computing systems that provide ready access to the full file histories of these matters including, for example, specifications, drawings, pending claims, cited art, office actions, responses, declarations, and notices of allowance. Rather than submit copies of these file histories, Applicant respectfully requests that the Examiner continue to review these file histories online for past, current, and future information about these matters that may be relevant to examination of the present application. Also, if the Examiner cannot readily access these file histories, Applicant would be pleased to provide any portion of any of the file histories at any time upon specific Examiner request.

No Disclaimers

To the extent that anything in the Information Disclosure Statement or the listed references could be construed as a disclaimer of any subject matter supported by the present application, Applicant hereby rescinds and retracts such disclaimer.

Timing of Disclosure

This Information Disclosure Statement is being filed after receipt of a First Office Action, but before the mailing date of a Final Action and before the mailing date of a Notice of Allowance.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.L/

This Statement is accompanied by the fees set forth in 37 CFR 1.17(p). The Commissioner is hereby authorized to charge any additional fees which may be required or to credit any overpayment to Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: October 8, 2019

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31476585

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	3791
(Multiple sheets used when necessary)	Examiner	Liu, Chu Chuan
SHEET 1 OF 1	Attorney Docket No.	MASCER.002C13

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Examiner Signature	/CHU CHUAN LIU/	Date Considered	10/16/2019

***Examiner:** Initial if reference 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.

T[1] - Place a check mark in this area when an English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.L/

Bibliographic Data

Application No: 16/544,713

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /CHU CHUAN LIU/ Examiner's Signature | Initials

Title: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
08/19/2019	600	3791	MASCER.002C13
RULE			

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12534827 has PRO of 61086108 08/04/2008

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12497528 has PRO of 61086063 08/04/2008

12497523 has PRO of 61086108 08/04/2008

12497528 has PRO of 61086108 08/04/2008

12497528 has PRO of 61086060 08/04/2008

12534827 has PRO of 61086057 08/04/2008

12534827 has PRO of 61086060 08/04/2008

12534827 has PRO of 61086063 08/04/2008

12497523 has PRO of 61078228 07/03/2008

12497528 has PRO of 61078228 07/03/2008

12497528 has PRO of 61078207 07/03/2008

12497523 has PRO of 61078207 07/03/2008

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

08/28/2019

STATE OR COUNTRY

UNITED STATES

ADDRESS

KNOBBE, MARTENS, OLSON & BEAR, LLP
MASIMO CORPORATION (MASIMO)
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614
UNITED STATES

FILING FEE RECEIVED

$6,260

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

64735 7590 10/23/2019
KNOBBE, MARTENS, OLSON & BEAR, LLP
MASIMO CORPORATION (MASIMO)
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/544,713	08/19/2019	Jeroen Poeze	MASCER.002C13	9381

TITLE OF INVENTION: MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	01/23/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
LIU, CHU CHUAN	3791	600-310000

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 03-09 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 Knobbe Martens Olson & Bear LLP
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. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). 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): Irvine, CA

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge ~~the required fee(s),~~ any deficiency, or credit any overpayment to Deposit Account No. 11-1410

5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Scott Cromar/ Date 2019-10-24

Typed or printed name Scott Cromar Registration No. 65066

Please Direct All Correspondence to Customer Number 64735

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Inventor	:	Jeroen Poeze
App. No.	:	16/544713
Filed	:	August 19, 2019
For	:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
Examiner	:	Liu, Chu Chuan
Art Unit	:	3791
Conf. No.	:	9381

COMMENTS ON EXAMINER'S STATEMENT OF REASONS FOR ALLOWANCE

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In response to the Examiner's Statement of Reasons for Allowance mailed on October 23, 2019, Applicant respectfully submits the following comments.

Applicant acknowledges the Examiner's statement regarding Allowable Subject Matter and agrees that the claimed subject matter is patentable. To the extent that there is any implication that the patentability of the claims rests on the recitation of a single feature, Applicant respectfully disagrees with the Examiner's Statement because it is the combination of features that makes the claims patentable. Accordingly, Applicant submits that the claims of the present application are allowable because each of the claims recites a combination of features that are not taught or suggested by the prior art. Applicant takes no other positions regarding the Allowable Subject Matter presented by the Examiner other than the positions Applicant may have previously taken during prosecution. Therefore, the Examiner's statement regarding Allowable Subject Matter should not be attributed to Applicant as an indication of the basis for

Applicant's belief that the claims are patentable. Furthermore, Applicant respectfully asserts that there may also be additional reasons for patentability of the claimed subject matter not explicitly stated in this record and Applicant does not waive rights to such arguments by not further addressing such reasons herein.

To the extent that there is any implication that the patentability of dependent claims is only attributable to the limitations in the independent claim from which each depends or that the dependent claims have the same scope as the claims from which they depend, Applicant respectfully disagrees and notes that it is each claim, taken as a whole, that is patentable. For dependent claims, their additional limitations may also provide additional reasons for patentability. Accordingly, Applicant submits that each of the allowed claims is allowable because the prior art does not teach or suggest the combination of features.

Applicant reserves the right to pursue at a later date any previously pending or other broader or narrower claims that capture any subject matter supported by the application's disclosure. Accordingly, reviewers of this or any child or related prosecution history shall not reasonably infer that the Applicant has made any disclaimers, disavowals, or abandonments of any subject matter supported by the present application, and any prior or alleged disclaimers, disavowals, or abandonments are hereby rescinded.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: October 24, 2019

By: /Scott Cromar/_____
Scott A. Cromar
Registration No. 65,066
Registered Practitioner
Customer No. 64735
(949) 760-0404

31570854

Electronic Patent Application Fee Transmittal

Application Number:	16544713
Filing Date:	19-Aug-2019
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Filer:	Scott Cromar/Frances Tsai
Attorney Docket Number:	MASCER.002C13

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1000	1000

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1000**

Electronic Acknowledgement Receipt	
EFS ID:	37550916
Application Number:	16544713
International Application Number:	
Confirmation Number:	9381
Title of Invention:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
First Named Inventor/Applicant Name:	Jeroen Poeze
Customer Number:	64735
Filer:	Scott Cromar/Gustavo Lopez
Filer Authorized By:	Scott Cromar
Attorney Docket Number:	MASCER.002C13
Receipt Date:	24-OCT-2019
Filing Date:	19-AUG-2019
Time Stamp:	16:20:28
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1000
RAM confirmation Number	E20190NG21158227
Deposit Account	111410
Authorized User	Gustavo Lopez
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	IssueFee_002C13.pdf	183104 260ded82a78bf18ffe3039deb3ea00789de88728	no	1
Warnings:					
Information:					
2	Post Allowance Communication - Incoming	Comments_002C13.pdf	21532 badc3a182418c9bcd5c172085a5347197e72caaf	no	2
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30266 c97b5e4c95d2acc2f31abfc5a35624320827717d	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	234902		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Application No.: 16/544713
Filing Date: August 19, 2019

Change(s) applied to document, /N.W.S./ 11/12/2019

Docket No.	Patent No.	Title	Issued
MASCER.006C1	9,717,425	NOISE SHIELDING FOR A NONINVASIVE DEVICE Kiani, et al.	08/01/2017
MASCER.007A	8,437,825	CONTOURED PROTRUSION FOR IMPROVING SPECTROSCOPIC MEASUREMENT OF BLOOD CONSTITUENTS Dalvi, et al.	05/07/2013
MASCER.007C1	9,591,975	CONTOURED PROTRUSION FOR IMPROVING SPECTROSCOPIC MEASUREMENT OF BLOOD CONSTITUENTS Dalvi, et al.	03/14/2017
MASCER.008A	8,688,183	EMITTER DRIVER FOR NONINVASIVE PATIENT MONITOR Bruinsma, et al.	04/01/2014
MASCER.008C1	9,186,102	EMITTER DRIVER FOR NONINVASIVE PATIENT MONITOR Bruinsma, et al.	11/17/2015
MASCER.008C2	9,668,680	EMITTER DRIVER FOR NONINVASIVE PATIENT MONITOR Bruinsma, et al.	06/06/2017
MASCER.009DA	D621516	PATIENT MONITORING SENSOR Kiani, et al.	08/10/2010
MASCER.010DA	D606659	PATIENT MONITOR Kiani, et al.	12/22/2009

Docket No.	Serial No.	Title	Filed
MASCER.002A	12/534827	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/03/2009
MASCER.002C9	16/449143	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	06/21/2019
MASCER.002C10	16/534956	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/07/2019
MASCER.002C11	16/534949	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/07/2019
MASCER.002C12	16/541987	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/15/2019
MASCER.002C14	16/544755	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	08/19/2019
MASCER.004C3	14/064055	MULTI-STREAM SENSOR FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	10/25/2013
MASCER.006C2	15/660743	NOISE SHIELDING FOR A NONINVASIVE DEVICE	07/26/2017
MASCER.011A	12/497506	HEAT SINK FOR NONINVASIVE MEDICAL SENSOR	07/02/2009
MAS.1007A	15/195199	ADVANCED PULSE OXIMETRY SENSOR	06/28/2016
MAS.1007C1	16/226249	ADVANCED PULSE OXIMETRY SENSOR	12/19/2018
MAS.1007C2	16/532061	ADVANCED PULSE OXIMETRY SENSOR	08/05/2019

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.L/

References for Examiner Consideration

Applicant wishes to draw the Examiner's attention to, and encourages the Examiner to review, the following co-owned patents and/or applications and their existing and ongoing prosecution history, including without limitation Office Actions, Amendments, Remarks, and any other potentially relevant documents:

Change(s) applied to document.
/N.W.S./
11/12/2019

Docket No.	Patent No.	Title	Issued
MASCER.002C1	9,277,880	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS Poeze, et al.	03/08/2016
MASCER.002C2	10,335,068	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS Poeze, et al.	07/02/2019
MASCER.002C3	10,258,265	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS Poeze, et al.	04/16/2019
MASCER.002C4	10,258,266	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS Poeze, et al.	04/16/2019
MASCER.002C5	10,299,708	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS Poeze, et al.	05/28/2019
MASCER.002C6	10,292,628	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS Poeze, et al.	05/21/2019
MASCER.002C7	10,376,190	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS Poeze, et al.	08/13/2019
MASCER.002C8	10,376,191	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS Poeze, et al.	08/13/2019
MASCER.003A	8,630,691	MULTI-STREAM SENSOR FRONT ENDS FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS Lamego, et al.	01/14/2014
MASCER.003D1	8,909,310	MULTI-STREAM SENSOR FRONT ENDS FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS Lamego, et al.	12/09/2014
MASCER.004A	8,203,704	MULTI-STREAM SENSOR FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	Merritt, et al. 06/19/2012
MASCER.004C1	8,570,503	HEAT SINK FOR NONINVASIVE MEDICAL SENSOR Vo, et al.	10/29/2013
CERCA.005A	8,515,509	MULTI-STREAM EMITTER FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	Bruinsma, et al. 08/20/2013
MASCER.006A	8,577,431	NOISE SHIELDING FOR A NONINVASIVE DEVICE Lamego, et al.	11/05/2013

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.L/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	2688
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 40 OF 46	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1132	2019/0069814	03-07-2019	Al-Ali	
	1133	2019/0076028	03-14-2019	Al-Ali et al.	
	1134	2019/0082979	03-21-2019	Al-Ali et al.	
	1135	2019/0090760	03-28-2019	Kinast et al.	
	1136	2019/0090764	03-28-2019	Al-Ali	
	1137	2019/0117070	04-25-2019	Muhsin et al.	
	1138	2019/0117139	04-25-2019	Al-Ali et al.	
	1139	2019/0117140	04-25-2019	Al-Ali et al.	
	1140	2019/0117141	04-25-2019	Al-Ali	
	1141	2019/0117930	04-25-2019	Al-Ali	
	1142	2019/0122763	04-25-2019	Sampath et al.	
	1143	2019/0133525	05-09-2019	Al-Ali et al.	
	1144	2019/0142283	05-16-2019	Lamego et al.	
	1145	2019/0142344	05-16-2019	Telfort et al.	
	1146	2019/0150856	05-23-2019	Kiani et al.	
	1147	2019/0167161	06-06-2019	Al-Ali et al.	
	1148	2019/0175019	06-13-2019	Al-Ali et al.	
Change(s) applied to document, /N.W.S./ 11/13/2019	**1149**	2019/0192076	06-27-2019	McHale et al.	
	1150	2019/0200941	07-04-2019	Chandran et al.	
	1151	2019/0201623	07-04-2019	Kiani	
	1152	2019/0214778	07-11-2019	Scruggs et al.	
	1153	2019/0209025	07-11-2019	Al-Ali	
	1154	2019/0216319	07-18-2019	Poeze et al.	
Change(s) applied to document, /N.W.S./ 11/12/2019	**1155**	2018/0216370 08/2018	~~07-18-2019~~	~~Schurman et al.~~ Ishiguro et al.	
	1156	2019/0216379	07-18-2019	Al-Ali et al.	
	1157	2019/0221966	07-18-2019	Kiani et al.	
	1158	2019/0223804	07-25-2019	Blank et al	
	1159	2019/0231199	08-01-2019	Al-Ali et al.	
	1160	2019/0231241	08-01-2019	Al-Ali et al.	

Examiner Signature	Date Considered
***Examiner:** Initial if reference 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.	

T[1] - Place a check mark in this area when an English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.L/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/544,713	12/17/2019	10506958	MASCER.002C13	9381

64735 7590 11/26/2019

KNOBBE, MARTENS, OLSON & BEAR, LLP
MASIMO CORPORATION (MASIMO)
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

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

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

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) WEB site (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 (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Masimo Corporation, Irvine, CA;
Jeroen Poeze, Rancho Santa Margarita, CA;
Marcelo Lamego, Cupertino, CA;
Sean Merritt, Lake Forest, CA;
Cristiano Dalvi, Lake Forest, CA;
Hung Vo, Fountain Valley, CA;
Johannes Bruinsma, Opeinde, NETHERLANDS;
Ferdyan Lesmana, Irvine, CA;
Massi Joe E. Kiani, Laguna Niguel, CA;
Greg Olsen, Lake Forest, CA;

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/544,713	08/19/2019	Jeroen Poeze	MASCER.002C13

CONFIRMATION NO. 9381

64735
KNOBBE, MARTENS, OLSON & BEAR, LLP
MASIMO CORPORATION (MASIMO)
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

PUBLICATION NOTICE

Title:MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS

Publication No.US-2019-0365295-A1
Publication Date:12/05/2019

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Doc code: RCEX
Doc description: Request for Continued Examination (RCE)

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	16544713	Filing Date	2019-08-19	Docket Number (if applicable)	MASCER.002C13	Art Unit	3791
First Named Inventor	Jeroen Poeze			Examiner Name	Liu, Chu Chuan		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
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SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☐ Amendment/Reply
- ☒ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 111410

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Signature of Registered U.S. Patent Practitioner			
Signature	/Scott Cromar/	Date (YYYY-MM-DD)	2019-12-11
Name	Scott Cromar	Registration Number	65066

This collection of information is required by 37 CFR 1.114. 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 1.11 and 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, P.O. Box 1450, Alexandria, VA 22313-1450.

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application No.	16/544713
	Filing Date	August 19, 2019
	First Named Inventor	Jeroen Poeze
	Art Unit	3791
(Multiple sheets used when necessary)	Examiner	Liu, Chu Chuan
SHEET 1 OF 1	Attorney Docket No.	MASCER.002C13

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	6,463,187	10-08-2002	Baruch et al.	
	2	8,244,326	08-14-2012	Ninomiya et al.	
	3	9,700,249	07-11-2017	Johnson et al.	
	4	2005/0116820	06-02-2005	Goldreich	
	5	2009/0247885	10-01-2009	Suzuki et al.	
	6	2010/0305416	12-02-2010	Bedard et al.	

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	**T[1]**
	7	JP 2005160641 A	06-23-2005	Denso Corp		X
	8	JP 3741147 B2	02-01-2006	Denso Corp		X
	9	JP 3803351 B2	08-02-2006	Seiko Epson Corp; Seiko Instruments Inc.		X
	10	JP 2007319232 A	12-13-2007	Toshiba Corp		X
	11	WO 2007/004083 A1	01-11-2007	Koninklijke Philips NV		

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	**T[1]**
	12	D. C. Zheng and Y. T. Zhang, "A ring-type device for the noninvasive measurement of arterial blood pressure," Proceedings of the 25th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE Cat. No.03CH37439), 17-21 September, 2003, Cancun, pp. 3184-3187 Vol.4.	

Examiner Signature	Date Considered
***Examiner:** Initial if reference 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.	

T[1] - Place a check mark in this area when an English language Translation is attached.

INFORMATION DISCLOSURE STATEMENT

First Inventor	:	Jeroen Poeze
App. No.	:	16/544713
Filed	:	August 19, 2019
For	:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS
Examiner	:	Liu, Chu Chuan
Art Unit	:	3791
Conf. No.	:	9381

Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

References and Listing

Pursuant to 37 CFR 1.56, an Information Disclosure Statement listing references is provided herewith. Copies of any listed foreign and non-patent literature references are being submitted.

For certain cited non-English patent and/or non-patent references, machine translations of the references (and/or Abstracts) are included, and inclusion is indicated in the last column. Applicant makes no representation as to the accuracy of the English machine translations. If the Examiner would like additional information regarding these references or if anything is unclear, the Examiner is invited to request such information, and Applicant will attempt to comply with any such request.

Pursuant to 37 CFR 1.97(g) and (h), Applicant makes no representation that the information is considered to be material to patentability. Additionally, inclusion on this list is not an admission that any of the cited documents are prior art in this application. Further, Applicant makes no representation regarding the completeness of this list, or that better art does not exist.

No Disclaimers

To the extent that anything in the Information Disclosure Statement or the listed references could be construed as a disclaimer of any subject matter supported by the present application, Applicant hereby rescinds and retracts such disclaimer.

Timing of Disclosure

This Information Disclosure Statement is being filed with an RCE, and no fee is believed to be required.

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

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: December 11, 2019

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JP2005160641A
(Machine Translated Text)

Pulse wave detector

Abstract:
PROBLEM TO BE SOLVED: To provide a pulse wave detector highly precisely detecting a pulse wave by removing the effect of a sunlight.
SOLUTION: A pulse wave sensor 3 is used by being fixed to an arm or the like of a human body and, as shown in Fig. (a), provided with an infrared LED 21 and a green LED 23 as light emitting elements and a photodiode 25 as a light receiving element. A light shielding plate 31 is disposed to cover the end face of a light transmission plate. The light shielding plate 31 employs a material having such a flexible characteristic as being in contact with the skin without any clearance, when a pulse wave sensor 3 is fixed to the arm or the like of the human body. The surface in the side of the light shielding plate 31 being in contact with the skin, is painted with a light-absorbing color. Projecting parts 33 are disposed on the light shielding plate 31 (refer to Fig. (b)) surrounding the light transmission plate 29. It is sufficient that if only the projecting part 33 has a height of producing a depression on the skin, when fixing the pulse wave sensor on the arm or the like.

Description:
The present invention relates to a pulse wave detection device which detects a pulse wave of a living body by using a light emitting element and a light receiving element.

In recent years, for the purpose of prevention, such as lifestyle-related diseases, portable devices are used to help regular exercise, such as pedometer and calorie consumption meter. The momentum to be more accurately determined, it is effective to measure the pulse rate, for this, often the optical pulse wave sensor using the absorption characteristics of blood components is used. The optical pulse wave sensor comprises a light emitting element and the light receiving element is irradiated with light from the light emitting element toward a human body, it is configured to receive light reflected by the light receiving element, the change in the received light amount detecting a pulse wave by. Then, as the optical pulse wave sensor, for example, pulse wave sensor which is composed of a light emitting element and the light receiving element is fixed between the base of the human index finger by sensor fixing band to the second knuckle what is known (e.g., see Patent Document 1.).
Re-Table 97/037588 JP

However, in the case of using an optical pulse wave sensor outdoors, the sunlight noise is a big problem. That is, in the outdoor that sunlight enters the pulse wave sensor, there is a problem that pulse wave component to be detected originally can not be precisely detected pulse wave buried in sunlight noise.

The present invention has been made in view of the above problems, and an object thereof is to provide a pulse wave detection device to accurately detect the pulse wave by removing the influence of sunlight.

Pulse wave detection device according to claim 1 which has been made in order to achieve the object according is fixed in contact with the skin of a living body, it irradiates light to the light emitting means is a living body, the light receiving means, the reflected light of the light from the light emitting means, for detecting a pulse wave of a living body by receiving through the transparent plate. Then, the pulse wave detection device includes a light shielding plate for blocking light covers the end face of the transparent plate, the light shielding plate, the light irradiated from the outside of the pulse wave detection device through the skin of a living body Te prevents it from being received by the light receiving means.

Therefore, it is possible to accurately detect the pulse wave by removing the influence of the light irradiated from the outside.
Meanwhile, external light (hereinafter, referred to as external light) irradiated from the pulse wave detection device as the path is received by the light receiving means through the skin of

a living body, as shown in FIG. 6 (a), the skin surface and the skin inside the propagation thereof. What these, the skin surface propagation, the external light enters from the gap formed between the skin of the shielding plate and the biological, reaches the light receiving means while repeatedly reflected between the skin of the shielding plate and the biological it is.

In order to suppress the propagation of the skin surface, in the pulse wave detection device according to claim 1, may be as described in any one claims 2 to 5.
That is, in the pulse wave detection device according to claim 1, as claimed in claim 2, the material of the light shielding plate is better to have the property of absorbing light.

According to the thus configured pulse wave detecting apparatus, since the external light incident from the gap formed between the skin of the shielding plate and the living body strikes the light shielding plate, the external light is absorbed by the light shielding plate, can be suppressed external light is received by the light receiving means.

Further, the pulse wave detecting apparatus according to claim 1 or claim 2, as claimed in claim 3, wherein the outer surface of the light shielding plate may be so are painted with color that absorbs light.
According to the thus configured pulse-wave detecting device, external light incident from the formed gap strikes the light shielding plate, the external light is absorbed by the coated portion between the skin of the shielding plate and the biological Therefore, it is possible to suppress the external light is received by the light receiving means.

Further, the pulse wave detection device according to any one claims 1 to 3, as described in claim 4, wherein the material of the light shielding plate, upon fixing the pulse wave detection device to the skin of the living body to, may the outer surface of the shielding plate to have a flexible property to the extent that contact without a gap with the skin of the living body.

According to the thus configured pulse wave detecting apparatus, since the external light is not formed a gap that causes the incident, it is possible to suppress the external light is received by the light receiving means.
Further, the pulse wave detection device according to any one claims 1 to 4, as described in claim 5, on the outer surface of the light shielding plate, be regarded as the outer surface is not a mirror it may be as is the degree of unevenness formation capable.

According to the thus configured pulse wave detecting apparatus, in order external light incident from the gap formed between the skin of the shielding plate and the living body strikes the light shielding plate, external light is scattered in all directions, external light can be prevented from being received by the light receiving means.

On the other hand, the inner skin propagation, as shown in FIG. 6 (a), in which the external light reaches the light receiving means through the inside of the skin.
In order to suppress the internal skin propagation, in the pulse wave detecting apparatus according to any one of claims 1 to 5, as described in claim 6, the pulse wave detection device to the skin of the living body the shielding convex portions when a fixed cause a depression in the skin may be so provided on the outer surface of the light shielding plate.

According to the thus configured pulse wave detecting apparatus, by shielding convex portions to such an extent to cause a depression in the skin pushes the skin, since the light-shielding convex portions confronting the path of the external light propagating within the skin the external light that strikes the light-shielding protrusion is scattered in all directions, it is possible to suppress the external light is received by the light receiving means.

Further, the pulse wave detection device according to claim 6, further as described in claim 7, the material of the light shielding convex portions, upon fixing the pulse wave detection device to the skin of the living body, the shielding convex portions may be to have a flexible property to the extent that contact without a gap with the skin of the living body.

According to the thus configured pulse wave detection device, between the skin of the light-shielding protrusion and biological, since no gap is formed to cause the external light enters, the external light is received by the light receiving means further it can be suppressed.

Further, the pulse wave detection device according to claim 6 or claim 7, further as described in claim 8, wherein the light-shielding convex portions, may be configured to be disposed so as to surround the transparent plate .
According to the thus configured pulse-wave detecting device, since the external light propagating within the skin is arranged reliably shielding convex portions on the path to reach the light receiving means, receiving the external light to the light receiving means It is further possible to suppress.

Further, the pulse wave detection device according to claim 8, further as described in claim 9, or when the light-shielding protrusions are so are arranged.
According to the thus configured pulse-wave detecting device, will be the external light propagating within the skin is placed a number of light-shielding protrusions on the path to reach the light receiving unit, an external light receiving means It can be further suppressed from being received by the.

Incidentally, the arrangement interval between the light-shielding convex portions, when they coincide to an integral multiple of the frequency of the external light, be arranged shielding convex portions on the path of the external light, propagating inside the skin external sometimes the light passes through without impinging on the light-shielding protrusion.

Therefore, the pulse wave detection device according to claim 9, further, as set forth in claim 10, wherein the plurality of light-shielding protrusions, as arrangement interval of each other are arranged to be randomly Then good.

According to the thus configured pulse wave detecting apparatus, in the path of the external light propagating within the skin, the light blocking projections of arrangement interval does not coincide with an integral multiple of the frequency of the external light, it is securely positioned Runode, it is possible to suppress the external light is received by the light receiving means.

Further, the pulse wave detection device according to claim 8 according to claim 10, further as described in claim 11, wherein the light-shielding convex portion includes a projection having a starting end and a terminating portion better to so that.

According to the thus configured pulse-wave detecting device, through a gap formed between the ends of the ridges, and the air in the gap between the skin of the pulse-wave detecting device and the living body, pulse wave detection and air outside the apparatus, can be circulated through the gap formed between the ends of the ridges.

That can be suppressed stuffiness tends to occur in a portion where the the pulse-wave detecting device and the skin are in close contact.
Further, the pulse wave detection device according to claim 11, further claims as described in claim 12, wherein the plurality of the transparent plate shielding protrusion disposed farthest from within the shielding convex portion a gap formed between the ends of the ridges constituting the, on a straight line connecting the said transparent plate, may at least one of the light-shielding protrusions are so disposed.

According to the thus configured pulse wave detecting apparatus, in ridges constituting the light-shielding protrusions disposed farthest from the light transmitting plate, external light incident from the formed gap between its ends since the light-shielding protrusion on the path of are arranged, it can be suppressed that the external light is received by the light receiving means.

Incidentally, the pulse wave detection device according to claims 1 to 12, by suppressing the external light is received by the light receiving means, but is intended to accurately detect the pulse wave, in claim 14 as described, the external light detecting means for detecting an external light received in the light receiving means is irradiated from the outside of the pulse

wave detection apparatus, it outputs the external light receiving signal corresponding to the received light amount of the external light the an external light signal, the light emitting means based on said light receiving signals when irradiated with light, may be provided with a pulse wave detecting means for detecting a pulse wave of said living body.

According to the thus configured pulse-wave detecting device, an external light detecting means outputs an external light receiving signal corresponding to the received light amount of the external light by detecting external light received by the light receiving means, the pulse wave detection means, based an external light signal, the light receiving signal when the light emitting means is irradiated with light, detecting a pulse wave of a living body.

That is, among the light receiving signal when the light emitting means is irradiated with light, it is possible to detect a pulse wave of a living body in view of the portion due to the external light, to remove the influence of the light irradiated from the outside, precision it can be detected well pulse wave.

Incidentally, as described in claim 13, an external light detecting means and the pulse wave detecting means as claimed in claim 14, it may be included in the pulse wave detection device according to claim 1 to claim 12.
Further, the pulse wave detection device according to claim 13 or claim 14, as claim 15, wherein the pulse wave detecting means, based on the difference signal obtained by subtracting the external light signal from the light receiving signal it may be detected the pulse wave.

According to the thus configured pulse wave detecting apparatus, by a simple operation that the difference of the external light signal from the light receiving signal, it is possible to obtain a signal which the influence of external light is removed.
Further, the pulse wave detection device according to any one claims 13 15, light receiving means for receiving when the light emitting means is not irradiated with light, usually, since an external light, to claim 15 as described, the external light detecting means, said light emitting means may be adapted to detect the external light when stopping the light emission.

According to the thus configured pulse wave detecting apparatus, it is possible to detect the external light without being affected by the light emitted from the light emitting means.
Further, the pulse wave detection device according to claim 16, as claim 17, wherein the light emitting means intermittently emits light, the external light detecting means, each time said light emitting means to stop the emission , it may be adapted to detect the external light.

According to the thus configured pulse-wave detecting device, before the light emitting means emits light time since the last emission, and detects an external light entering the light-receiving unit, the light receiving means when the light emitting means emits light this time the influence of the incident external light can be accurately removed.

It will be described based on the drawings exemplary embodiments of the invention are described below.
First, the pulse wave measuring device 1 according to the pulse wave detecting apparatus of the present invention will be described with reference to FIG.
Pulse wave detection device 1 of this embodiment is an apparatus for detecting the number of human pulse, as shown in FIG. 1, provided with a infrared LED21 and green LED23 as a light emitting element, a photodiode as a light receiving element (PD) a pulse wave sensor 3 provided with 25, relative to the infrared LED21 and green LED 23, a drive circuit 5 for driving the pulse wave sensor 3 by outputting a driving signal for irradiating light at different timings, and a data processing unit 7 which controls the driving circuit 5 as well as processing signals from the pulse wave sensor 3. Incidentally, the driving circuit 5 and the data processing device 7 is accommodated in the housing of the pulse wave detection device body 9.

First, a description will be given of a configuration of a pulse wave sensor 3 in FIG. 2 (a) is a cross-sectional view showing the configuration of a pulse wave sensor 3, FIG. 2 (b) is a plan view from the side in contact with the skin of the pulse wave sensor 3. Incidentally, FIG. 2 (a) shows an A-A cross section of FIG. 2 (b).

Pulse wave sensor 3 is for use in fixing the body of the arm or the like, as shown in FIG. 2 (a), an infrared LED21 for irradiating infrared light having a wavelength of about 940 nm, green about 520nm green LED23 for irradiating light, an optical reflection sensor and a PD25 which receives light and outputs a signal (light-receiving signal) corresponding to the received light amount.

The infrared LED 21, green LED 23, PD 25 is the bottom 27 of each pulse wave sensor 3 of the housing 20, and the infrared LED 21 and the green LED 23 are arranged in parallel so as to be located on the left and right sides of the PD 25, transparent through a transparent plate 29, which is to be irradiated with infrared light or green light on the human body. Furthermore, the light shielding plate 31 for blocking light is arranged so as to cover an end face of the transparent plate 29. The light-shielding plate 31, when fixing the pulse wave sensor 3 to the body of the arm or the like, is used as a material shielding plate 31 with the flexible properties to the extent that contact without skin and gaps, for example, a silicon material it is preferred. The surface on the side in contact with the skin of the light shielding plate 31 is painted with a color (e.g., black) that absorbs light. Incidentally, show what the light shielding plate 31 and the housing 20 are separate in the figure may be configured to have the same function as the light shielding plate 31 by processing the housing 20.

Furthermore, on the light-shielding plate 31, the convex portion 33 is disposed so as to surround the transparent plate 29 in triplicate. This was a triple, singlet, it may be a double or quadruple or more. The height of the convex portion 33, when fixing the pulse wave sensor 3 to the body of the arm or the like may be a high enough to cause a depression in the skin, for example when about 0.3 mm. The convex portion 33, as will be described later, is for the light from the outside is prevented from being received by the PD 25. Further, the convex portion 33 is composed of a plurality of projections having a starting end and a terminal end, between the end of the projection, the gap 35 for preventing stuffiness is formed. Further, another arrangement interval of the convex portion 33 disposed in triplicate (e.g., see interval S1, S2 in FIG. 2 (b)) is not uniform becomes random. Incidentally, the convex portion 33, when fixing the pulse wave sensor 3 to the body of the arm or the like, those protrusions 33 is made of a material having flexible properties to the extent that contact without skin and a gap is used, for example, a silicon material it is preferred. Although shown what protrusion 33 and the light shielding plate 31 and the housing 20 in the figure is a separate may be configured to have the same function as protrusion 33 and the light shielding plate 31 by processing the housing 20.

Further, the void (e.g., voids 35a) formed in the convex portion 33 disposed farthest from the transparent plate 29, on the segment (e.g., segment B-B) connecting the transparent plate 29, at least one of the protrusions 33 is configured to be placed.

Thus, in the pulse wave sensor 3 configured, as shown in FIG. 1, the light shielding plate 31 and the transparent plate 29 for example by contact with the skin of the human arm to fix the pulse wave sensor 3. Thereafter, the infrared LED21 and green LED23, respectively irradiated with infrared light and green light alternately towards the human body, the reflected light of the light PD25 is received. Then, PD 25 outputs a change in the amount of received light to the data processing device 7 as a light reception signal (e.g. voltage signal).

Note that light emitted to the human body from the infrared LED21 and green LED 23, the carrying small-arterioles partially through the interior of the human body (hair arterioles), is absorbed by hemoglobin in the blood flowing through the capillary arteries, the remaining light is scattered and reflected by the hair arterioles. At this time, the amount of hemoglobin in the capillary arteries by pulsation of blood varies wave, the light is absorbed by hemoglobin also changes wave manner. That is, depending on the pulsation of the blood, the received light quantity detected by PD25 reflected by capillary arteries vary.

Thus, PD 25 is (corresponding to reflected light of light emitted from the infrared LED21 or green LED 23) outputted from the light receiving signal, information about the pulse wave is obtained.
The following describes the reason for using the infrared LED21 green LED23 to detect a pulse wave.

As shown in FIG. 5, the light reception signal PD25 is output, a signal indicating the pulse wave reflected against the capillary arteries (pulse wave component), the component of the reflected wave reflected by the outside surface of the skin or hair arterioles (reflected wave component) contains both components of the. When the receiving signal frequency analysis, is mainly separated, and pulse components synchronized with the heart beat, and body motion components synchronized with motion, in the (a reflected wave component excluding the body motion component) generally direct current component .

Among them, DC component, the amount of light changes with the blood flow change due to expansion contraction of blood vessels (hereinafter, referred to as noise A), the skin surface scattered light changes due to the shift of the pulse wave sensor 3 (hereinafter, referred to as noise B), It is due like light amount change of light incident from the outside of the pulse wave sensor 3 (such as sunlight), is cut by the method described later in the detection circuit 11.

And, for the pulse component and the body motion component, have different absorption characteristics in the infrared light and green light, the light reception signal PD25 is output when light is emitted green LED 23, both the pulse component and the body motion component whereas also obtained in extractable signal level, the received light signal PD25 is output when the light is emitted infrared LED 21, a very small pulse component compared to body motion component, only the body movement component extraction resulting in possible signal levels.

That is, the light reception signal output from PD25 when light is emitted green LED 23 (including the pulse component and the body motion component), a light receiving signal output by the PD25 when light is emitted infrared LED 21 (including only body motion components) by comparing is possible to extract only the pulse component.

However, light from the outside of the pulse wave sensor 3, such as sunlight (hereinafter, referred to as external light) is incident on PD25 and propagates inside the skin surface and the skin.
Among external light propagating through the skin surface, at the surface of the light shielding plate 31 painted in a color which absorbs light, as shown in FIG. 6 (b), a part is absorbed.

The light shielding plate 31 (in close contact with the skin), to prevent the gap to cause the external light incident is formed.
Furthermore, for the external light propagating within the skin, the convex portion 33 formed on the surface of the light shielding plate 31 presses the skin, as shown in FIG. 6 (c), the external light propagating within the skin to protrusions 33 confront on the path of the external light that hits the convex portion 33 is scattered.

These suppress the external light reaches the PD 25.
Next, the data processing device 7, a micro performing a detection circuit 11 for amplifying the light reception signal obtained from the pulse wave sensor 3, the various operations such as detection of processing the signal from the detection circuit 11 pulse wave computer (hereinafter, referred to as microcomputer) and a 13.

Then, the detection circuit 11, as shown in FIG. 3, an amplifier 41 for amplifying the light reception signal obtained from the pulse wave sensor 3, the correction unit for outputting a direct current component signal corresponding to the DC component to the amplification section 41 and a 43.

Among these, amplification section 41 is configured around the operational amplifier OP1. The non-inverting input terminal of the operational amplifier OP1 (+), together with the photodetection signal from the pulse wave sensor 3 is inputted through the resistor R2, and is grounded through a resistor R1. The inverting input terminal of the operational amplifier OP1 (-), together with the DC component signal is input from the correcting unit 43 through a resistor R4, is connected to the output terminal of the operational amplifier OP1 through a resistor R3. The output terminal of the operational amplifier OP1 is connected to the A / D port PAD1 of 10-bit A / D converter 13d to be described later. Further, the light receiving signal

from the pulse wave sensor 3 is also inputted to the A / D port PAD2 described later A / D converter 13d. The resistance value of the resistor R1 is equal to resistor R3, the resistance value of the resistor R2 is set to be equal to the resistor R4. Furthermore, the amplification degree of the operational amplifier OP1 is, for example, the resistance value of the resistor R1~R4 such that = 1000 {(resistance value R1) / (resistance value of R2)} is set.

In the amplifier unit 41 thus constructed, it amplifies and outputs the signal obtained by cutting the voltage value amount of the DC component signal from the voltage value of the light receiving signal.
That is, among the light emitted from the infrared LED21 and green LED 23, light absorbed by hemoglobin is small, thereby the change of the pulse component appearing on the light-receiving signal, the A / D converter 13d provided microcomputer 13 amplification is required in order to be detectable. In this embodiment it is necessary to amplify the approximately 1000-fold.

The change of the DC component, since several hundred times larger several times than the change in the pulse component, when amplified without subtracting the DC component from the received light signal, amplifies the signal available to the input of the A / D converter 13d It exceeds the upper limit of the voltage. Therefore, doing amplification after subtracting the DC component from the received light signal.

Next, the correction unit 43 is configured mainly of an operational amplifier OP2 and the voltage dividing resistors R9, R10. D / A port PDA2 below 10-bit D / A converter 13e is grounded through a voltage dividing resistors R9, R10. The non-inverting input terminal of the operational amplifier OP2 (+) via a resistor R6, together with the signal inputted from the D / A port PDA1 described later D / A converter 13e, is grounded via a resistor R5 ing. The inverting input terminal of the operational amplifier OP2 (-) via a resistor R8, is connected to a connection point between the voltage dividing resistors R9 and R10, are connected to the output terminal of the operational amplifier OP2 via the resistor R7 . The resistance value of the resistor R5 is equal to the resistance R7, the resistance value of the resistor R6 is set to be equal to the resistance R8. Furthermore, the amplification degree of the operational amplifier OP2 is, for example, {(resistance value R5) / (resistance value of R6)} = 1 and the resistance value of the resistor R5~R8 so is set. Furthermore, the resistance value of the voltage dividing resistors R9, R10 are, for example, is set to be "(the resistance value of the resistor R10) / (resistance value of the resistor R9) = 1024".

In the correction unit 43 thus configured, D / voltage value of the output analog signal from the A port PDA2 the (V2) (1/1024) multiplied by signal inverting input terminal of the operational amplifier OP2 - entered into () Rutotomoni, when the signal having a voltage value equal to the output analog signal from the D / a port PDA1 the (V1) is input to the non-inverting input terminal of the operational amplifier OP2 (+), the output terminal of the operational amplifier OP2 (V1 analog signal having a voltage value of -V2 / 1024) is output.

That is, the resolution of the voltage value of the analog signal output from the output terminal of the operational amplifier OP2 becomes 1024 times the resolution of the voltage value of the analog signal output from the D / A port PDA 2.

That is, by two using a 10-bit D / A port, thereby outputting an analog signal with a resolution of 20 bits. Then, the value of (V1-V2 / 1024) mentioned above, to match the voltage value of the DC component signal, D / analog signal from the A port PDA1 voltage value V1, D / from the A port PDA2 voltage value V2 analog signal is output.

Therefore, the D / A port PDA 2, the input voltage value of the output analog signal in the case of changing one bit of the minimum resolution, the signal exceeds the input voltage range of the A / D port PAD1 is the A / D port PAD1 it is possible to prevent that being. That is, for example, an input voltage range of 10-bit A / D port PAD1 is 3V, 10-bit D / A output voltage width of the port PDA1 is 3V, by using only D / A port PDA1, to the DC component signal assuming a case of outputting corresponding analog signals, the minimum voltage change of an analog signal outputted from the D / a port PDA1 is 3 mV, the amplification factor of the operational amplifier OP1 is a 1000-fold in the same manner as described above, the DC

component signal the change in the output of the operational amplifier OP1 by the voltage change of 3mV of the 3V. In other words, the number bits voltage change of the DC component signal outputted from the D / A port PDA 1, the output voltage of the operational amplifier OP1 is to exceed the input voltage range of the A / D port PAD1.

In contrast, in the present embodiment, since an analog signal with a resolution of 20 bits and is output as a direct current component signal, the minimum voltage change when the output voltage swing is to 3V is about 3MyuV, minimum voltage change the change in the output of the operational amplifier OP1 by is about 3mV. That is, the voltage change in the number bits of the DC component signal outputted from the D / A port PDA 1, PDA 2, does not output voltage of the operational amplifier OP1 is higher than the input voltage range of the A / D port PAD1.

In the detection circuit 11 configured as described above, in accordance with the analog signal from the D / A converter 13e, while adjusting the voltage value of the DC component signal, amplifies the received signal and the offset voltage value of the DC component signal and outputs to the A / D converter 13d.

Next, the microcomputer 13, as shown in FIG. 1, the CPU13a that executes processing in accordance with predetermined processing program, a ROM13b which various control programs are stored, various memory is provided for storing various data and RAM13c was, the a / D converter 13d for converting the voltage value of the analog signal into 10-bit digital value, a 10-bit digital data CPU13a is generated, a D / a converter 13e for converting the analog signal, It comprises a plurality of input ports which various digital signals are input, and an output port 13f and a plurality of output ports which various digital signals are output.

As shown in FIG. 1, A / D converter 13d is provided with an A / D port PAD1, PAD2 which an analog signal is input, D / A converter 13e, the D / A port for outputting an analog signal PDA1, has a PDA2. Furthermore, the input-output port 13f, as shown in FIG. 1, and an output port PO1, drive circuit 7 is connected to the output port PO1.

The microcomputer 13 thus configured, CPU 13a, of the DC component signal, and outputs and outputting a signal component corresponding to the noise A and the noise B, and signal components corresponding to the outside light and processing, each separately.

First, the process of outputting signal component corresponding to the noise A and the noise B.
The noise frequency of the voltage variation of the A and the light receiving signal due to the noise B is sufficiently low compared to the pulse component, voltage fluctuations due to such noise is small in a short time. Therefore, CPU 13a, for each predetermined time range (e.g., 10 seconds), by analyzing the voltage variation of the received light signal within the predetermined time period, the voltage change due to the noise A and the noise B, the current D / a port PDA 1, to adjust the output value of the PDA 2. Thus, the noise A and minute of the DC component signal corresponding to the noise B is output from the correction unit 43. In other words, adjusting the voltage value of the DC component signal for each of the predetermined time.

Then, the signal components corresponding to the external light (hereinafter, referred to as external light signal) will be described based on external light adjustment process for outputting a in FIG. Figure 4 is a flow chart representing the external light adjustment process. The external light adjustment process, while the CPU13a is activated (power supply ON), for example a process of infrared LED21 and green LED23 are repeatedly executed every time the irradiation.

The outside light adjustment process, CPU 13a, at first S10, acquires the data of the voltage of the signal input to the A / D port PAD2. Thereafter, in S20, the voltage value data acquired at S10 is to determine whether the same value as the voltage value data obtained from the A / D port PAD2 the previous. Here, if it is determined that the same value (S20: YES), the process proceeds to S50. On the other hand, if it is determined not to be the same value (S20: NO), the process proceeds to S30.

Then, shifting to S30, based on the difference voltage value between the voltage value acquired in the acquired voltage value data and the previous in S10, to calculate the variation of the voltage outputted from the D / A port PDA 1, PDA 2. Further, at S40, the voltage variation calculated in S30, adjusting the output value of the current of the D / A port PDA 1, PDA 2. Then, the process proceeds to S50.

Then, shifting to S50, the acquired data of the voltage value of the signal input to the A / D port PAD1 with it emits green LED 23.
Further, in S60, it acquires the data of the voltage of the signal input to the A / D port PAD1 with emit infrared LED 21, and ends the external light adjustment process.

That is, the external light adjustment process, infrared LED21 and green LED23 are regarded as external light signal a light reception signal from the PD25 when not emitting light, D / A port PDA1 in accordance with the voltage value of the received light signal, adjusting the voltage value of the analog signal output from the PDA 2.

In the pulse wave detecting apparatus 1 of the thus constructed embodiment, immediately before the green LED23 emits light, and detects the received light is PD25 as an external light receiving signal (S10), and outputs the external light reception signal (S20 to S40). Then, light is emitted in the order of green LED 23 ⟶ infrared LED 21, a light receiving signal PD25 is output when the green LED 23 or the infrared LED 21 emits light, and the difference in the amplification unit 41 and an external light receiving signal to obtain the difference signal (S50~S60) for detecting the pulse wave by.

Therefore, it is possible to detect the pulse wave of the human body in consideration of the portion of infrared LED21 or green LED23 is due to the external light within the photodetection signal when irradiated with light, accurately by removing the influence of external light it is possible to detect the pulse wave.

Moreover, by a simple operation that the difference of the external light signal from the light receiving signal, it is possible to obtain a signal which the influence of external light is removed.
Furthermore, since detecting an external light receiving signal when the infrared LED21 and green LED 23 has stopped emitting, it is possible to detect the external light without being affected by the light emitted from the infrared LED21 or green LED 23.

Furthermore, since detecting an external light receiving signal just before the green LED23 emits light, the influence of external light infrared LED21 and green LED23 is incident on PD25 when light emission can be accurately removed. At this time, the light-emitting order of the green LED23 and infrared LED21 good from either.

Further, the pulse wave detection device 1 of the present embodiment is used in a fixed state pulse wave sensor 3 to human skin, the surface on the side in contact with the skin of the light shielding plate 31 is painted in a color which absorbs light for that, the external light incident from the formed gap between the light shielding plate 31 and the skin hits the light shielding plate, prevent the external light is absorbed by the light shielding plate 31, the external light is received in PD25 it can.

Further, the light shielding plate 31, on the surface of the side in contact with skin, since the plurality of protrusions 33 are disposed so as to surround the transparent plate 29, protruding in the path of the external light propagating within the skin part 33 Tachihadakari, external light impinging on the convex portion 33 is scattered in all directions, it is possible to suppress the external light is received by the PD 25. Incidentally, as the number of the convex portion 33 is large, will be outside light propagating within the skin is placed a number of protrusions 33 on the path to reach the PD25, the external light is received by the PD25 it can be suppressed.

The plurality of protrusions 33, to arrangement interval of each other are arranged such that at random on a path of external light propagating within the skin, does not match an integer multiple of the frequency of the external light the convex portion 33 having the arrangement

interval is securely arranged, it is possible to suppress the external light is received by the PD 25.

Further, the convex portion 33, which is configured with projections having a starting end and a terminal end, through a gap 35 formed between the ends of the protrusions, between the pulse wave sensor 3 and the skin can be air in the gap, the air outside the pulse wave sensor 3 is circulated. That can be suppressed stuffiness tends to occur in a portion where the skin pulse wave sensor 3 is in close contact.

Further, the convex portion 33 disposed farthest from the transparent plate 29, and the gap 35a formed between its ends, on a line segment (a line segment B-B) connecting the transparent plate 29 , since it is configured such that at least one of the protrusions 33 are disposed, even when the external light enters from the gap 35a, it is possible to prevent the external light is received by the PD 25.

Further, as the material of the light shielding plate 31 and the protrusion 33, when fixing the pulse wave sensor 3 to human skin, silicon light shielding plate 31 and the convex portion 33 has a flexible property to the extent that contact without skin and a gap wood has been used. Therefore, no gap is formed to cause the external light is incident, it is possible to prevent the external light is received by the PD 25.

In the embodiment described above, the infrared LED 21, the green LED23 light emitting means in the present invention, PD 25 is a light receiving unit in the present invention, the light-shielding protrusions of the raised portion 33 according to the present invention, processing and correction of S10~S40 in FIG 43 is processing an amplifier 41 of S50~S60 external light detecting means, in FIG. 4 of the present invention is a pulse wave detecting means of the present invention.

Having described an embodiment of the present invention, the present invention is not limited to the above embodiments, it is possible to adopt various aspects.
For example, in the above embodiment, the surface on the side in contact with the skin of the light shielding plate 31, showed what is painted in a color which absorbs light. However, the material of the light shielding plate 31, having a property of absorbing light (e.g., a resin or rubber) may be. In this way, when the external light incident from the gap formed between the light shielding plate 31 and the skin hits the light shielding plate, since the external light is absorbed by the light shielding plate 31, the external light is received by the PD25 it can be suppressed.

Further, on the surface on the side in contact with the skin of the light shielding plate 31, this surface may be formed coarse unevenness to an extent which can be regarded as non-specular. In this way, when the external light incident from the formed gap between the light shielding plate 31 and the skin hits the light shielding plate 31, in order external light is scattered in all directions, the external light is received by the PD25 It can be suppressed.

Further, in the above embodiment, the solar as external light is shown for the case where the incident, if the light incident from the outside of the pulse wave sensor 3, be other than sunlight is applicable. For example, it may be a light emitted from the fluorescent lamp.

Further, in the above embodiment, as the material of the light shielding plate 31 and the convex portion 33, a silicon material. However, when fixing the pulse wave sensor 3 to the body of the arm or the like, as long as it has a flexible property to the extent that contact without skin and a gap may be a material other than silicon material. For example, rubber, fabric, may be used a gel-like solid.

Further, in the above embodiment, although the light shielding plate 31 and the protrusion 33 as a separate body from the housing 20, may be integrally formed with the same member to provide a similar effect.
In the embodiment described above, it showed that voids 35 are formed in the convex portion 33. However, the convex portion 33 is annular, that is, may be in the absence of voids 35 shape.

Diagram showing the main configuration of the pulse wave detection device 1. Explanatory view showing a configuration of a pulse wave sensor 3. Circuit diagram showing the configuration of a detection circuit 11. Flowchart illustrating a procedure of external light adjustment process. Explanatory view showing a light receiving signal obtained by the pulse wave sensor 3. Explanatory view showing an external light skin surface propagation and skin internal propagation.
DESCRIPTION OF SYMBOLS

1 ... pulse-wave detecting device, 3 ... pulse wave sensor, 5 ... driving circuit, 7 ... data processing unit, 9 ... pulse-wave detecting device main body, 11 ... detecting circuit, 13 ... microcomputer, 13a ... CPU, 13b ... ROM, 13c ... RAM, 13d ... A / D converter, 13e ... D / A converter, 13f ... input-output port, 20 ... housing, 21 ... infrared LED, 23 ... green LED, 25 ... PD, 27 ... bottom, 29 ... transparent plate, 31 ... light shielding plate, 33 ... protruding portion, 35 ... gap, 41 ... amplifier unit, 43 ... correction unit, OP1, OP2 ... operational amplifier, PAD1, PAD2 ... A / D port, PDA 1, PDA 2 ... D / A port, PO1 ... output port, R1~R10 ... resistance.

Claim(s):

1. Light emitting means for irradiating light to a living body, Light receiving means for at least receiving reflected light of light emitted from said light emitting means, is disposed on the irradiation side of the light of said light emitting means, a ransparent plate which transmits light, It covers the end face of the transparent plate, and a light shielding plate for blocking light, With a in the transparent plate and the light shielding plate, an outer surface on the side opposite to the side where the light mitting means and the light receiving means is positioned in contact with the skin of the living body by fixing the device, a pulse wave detecting apparatus for detecting a pulse wave of said living body, The light shielding plate, that the light irradiated from the outside of the pulse wave detection device is received by said light receiving means through the skin of the living body, configured to block, Pulse-wave detecting device, characterized in that.
2. The material of the light shielding plate, the pulse wave detection device according to claim 1, characterized in that it has a characteristic of absorbing light.
3. Wherein said outer surface of the light shielding plate pulse wave detecting apparatus according to claim 1 or claim 2, characterized in that it is coated with a color that absorbs light.
4. The material of the light shielding plate, the pulse wave detection device when secured to the skin of the living body, characterized in that the outer surface of the light shielding plate with the flexible properties to the extent that contact without a gap with the skin of the living body pulse wave detecting apparatus according to any claims 1 to 3,.
5. Pulse according to the on the outer surface of the light shielding plate is in any one of claims 1 to claim 4 in which the outer surface, characterized in that the unevenness of the degree that can be regarded as non-mirror surface is formed wave detection apparatus.
6. The shielding convex portion to cause a depression in the skin in any one of claims 1 to claim 5, characterized in that it comprises on said outer surface of said light shielding plate when the pulse wave detection device is fixed to the skin of the living body pulse wave detection device according to.
7. The material of the light shielding convex portions, the pulse wave detection device when secured to the skin of the living body, wherein the light-shielding protrusion has a flexible property to the extent that contact without a gap with the skin of the living body pulse wave detection device according to claim 6.
8. The shielding convex portions, the pulse wave detection device according to claim 6 or claim 7, characterized in that it is arranged so as to surround the transparent plate.
9. Pulse wave detecting apparatus according to claim 8, wherein the light-shielding protrusions are arranged.
10. Wherein the plurality of light shielding convex portions, the pulse wave detection device according to claim 9, characterized in that the arrangement interval of each other are arranged so as to be random.
11. The shielding convex portions, the pulse wave detection device according to claim 8 according to claim 10, characterized in that it is composed of a protrusion having a starting end and a terminal end.

12. A gap formed between the ends of the ridges constituting the light-shielding protrusions arranged farthest from said transparent plate among the plurality of light shielding convex portions, a straight line connecting the said transparent plate a pulse wave detection device according to claim 11, wherein at least one of the light-shielding protrusions are located.
13. It said light receiving means outputs a light receiving signal corresponding to the received light amount of the received light, And an external light detecting means for detecting an external light received in the light receiving means is irradiated from the outside of the pulse wave detection apparatus, it outputs the external light receiving signal corresponding to the received light amount of the external light, Wherein an external light signal, the light emitting means based on said light receiving signals when irradiated with light, and pulse wave detecting means for detecting a pulse wave of said living body, Equipped with a, Pulse wave detection device according to claim 1 to claim 12, characterized in that.
14. Light emitting means for irradiating light to a living body, Light receiving means for said at least receiving reflected light of light emitted from the light emitting means, and outputs a light receiving signal corresponding to the received light amount of the received light, And an external light detecting means for detecting an external light received in the light receiving means is irradiated from the outside of the pulse wave detection apparatus, it outputs the external light receiving signal corresponding to the received light amount of the external light, Wherein an external light signal, the light emitting means based on said light receiving signals when irradiated with light, and pulse wave detecting means for detecting a pulse wave of said living body, Pulse wave detecting apparatus comprising: a.
15. It said pulse wave detection means detects the pulse wave on the basis of a difference signal obtained by subtracting the external light signal from the light receiving signal,
16. Pulse wave detection device according to claim 13 or claim 14, characterized in that. It said external light detecting means, the pulse wave detection device according to claim 13 or any claim 15, characterized in that detecting the external light when said light emitting means is stopped emitting light.
17. The light emitting means intermittently emits light, Said external light detecting means, each time said light emitting means stops emitting light, detecting the external light, Pulse wave detection device according to claim 16, characterized in that.

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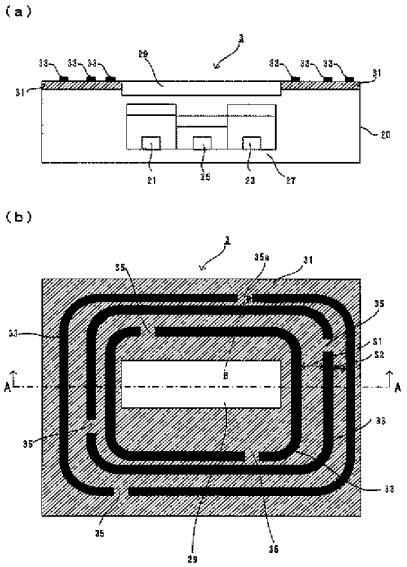
最終頁に続く

(54)【発明の名称】脈波検出装置

(57)【要約】
【課題】　太陽光の影響を除去して精度良く脈波を検出する脈波検出装置を提供。
【解決手段】　脈波センサ３は、人体の腕等に固定して利用するものであり、図（ａ）に示すように、発光素子としての赤外ＬＥＤ２１，緑色ＬＥＤ２３と、受光素子としてのフォトダイオード２５とを備える。そして、透光板２９の端面を覆うように遮光板３１が配置されている。尚、遮光板３１は、脈波センサ３を人体の腕等に固定した際に、遮光板３１が皮膚と隙間なく接触する程度に柔軟な特性を有する材質のものが用いられている。また、遮光板３１の皮膚と接触する側の表面は光を吸収する色で塗装されている。さらに、遮光板３１上には、凸部３３が透光板２９を取り巻くように配置されている（図（ｂ）参照）。凸部３３の高さは、脈波センサ３を腕等に固定した際に、皮膚に窪みを生じさせる程度の高さであればよい。
【選択図】図２



【特許請求の範囲】
【請求項1】
生体に対して光を照射する発光手段と、
　前記発光手段から照射された光の反射光を少なくとも受光する受光手段と、
　前記発光手段の光の照射側に配置され、光を透過する透光板と、
　前記透光板の端面を覆い、光を遮光する遮光板と、
　を備え、前記透光板及び前記遮光板における、前記発光手段及び前記受光手段が位置する側とは反対側となる外側表面を、前記生体の皮膚に接触させて当該装置を固定することにより、前記生体の脈波を検出する脈波検出装置であって、
　前記遮光板は、当該脈波検出装置の外部から照射された光が前記生体の皮膚を介して前記受光手段に受光されるのを、阻止するように構成される、
　ことを特徴とする脈波検出装置。
【請求項2】
前記遮光板の材質は、光を吸収する特性を有することを特徴とする請求項１に記載の脈波検出装置。
【請求項3】
前記遮光板の前記外側表面は光を吸収する色で塗装されていることを特徴とする請求項１または請求項２に記載の脈波検出装置。
【請求項4】
前記遮光板の材質は、当該脈波検出装置を前記生体の皮膚に固定した際に、前記遮光板の前記外側表面が前記生体の皮膚と隙間なく接触する程度に柔軟な特性を有することを特徴とする請求項１～請求項３何れかに記載の脈波検出装置。
【請求項5】
前記遮光板の前記外側表面上には、該外側表面が鏡面でないと見做すことができる程度の凹凸が形成されていることを特徴とする請求項１～請求項４何れかに記載の脈波検出装置。
【請求項6】
当該脈波検出装置を前記生体の皮膚に固定した際に該皮膚に窪みを生じさせる遮光凸部を前記遮光板の前記外側表面上に備えることを特徴とする請求項１～請求項５何れかに記載の脈波検出装置。
【請求項7】
前記遮光凸部の材質は、当該脈波検出装置を前記生体の皮膚に固定した際に、前記遮光凸部が前記生体の皮膚と隙間なく接触する程度に柔軟な特性を有することを特徴とする請求項６に記載の脈波検出装置。
【請求項8】
前記遮光凸部は、前記透光板を取り巻くように配置されることを特徴とする請求項６または請求項７に記載の脈波検出装置。
【請求項9】
前記遮光凸部が複数配置されていることを特徴とする請求項８に記載の脈波検出装置。
【請求項10】
前記複数の遮光凸部は、互いの配置間隔がランダムになるように配置されていることを特徴とする請求項９に記載の脈波検出装置。
【請求項11】
前記遮光凸部は、始端部と終端部とを有する突条で構成されることを特徴とする請求項８～請求項１０に記載の脈波検出装置。
【請求項12】
前記複数の遮光凸部の内で前記透光板から最も離れた位置に配置された遮光凸部を構成する突条の端部間に形成された空隙と、前記透光板とを結ぶ直線上に、少なくとも１つの遮光凸部が配置されていることを特徴とする請求項１１に記載の脈波検出装置。

【請求項13】
前記受光手段は、受光した光の受光量に応じた受光信号を出力し、
当該脈波検出装置の外部から照射されて前記受光手段に受光される外部光を検出して、前記外部光の受光量に応じた外部受光信号を出力する外部光検出手段と、
前記外部受光信号と、前記発光手段が光を照射した時の前記受光信号とに基づいて、前記生体の脈波を検出する脈波検出手段と、
を備える、
ことを特徴とする請求項１～請求項１２何れかに記載の脈波検出装置。
【請求項14】
生体に対して光を照射する発光手段と、
前記発光手段から照射された光の反射光を少なくとも受光し、受光した光の受光量に応じた受光信号を出力する受光手段と、
当該脈波検出装置の外部から照射されて前記受光手段に受光される外部光を検出して、前記外部光の受光量に応じた外部受光信号を出力する外部光検出手段と、
前記外部受光信号と、前記発光手段が光を照射した時の前記受光信号とに基づいて、前記生体の脈波を検出する脈波検出手段と、
を備えることを特徴とする脈波検出装置。
【請求項15】
前記脈波検出手段は、前記受光信号から前記外部受光信号を差分した差分信号に基づいて前記脈波を検出する、
ことを特徴とする請求項１３または請求項１４に記載の脈波検出装置。
【請求項16】
前記外部光検出手段は、前記発光手段が発光を停止している時に前記外部光を検出することを特徴とする請求項１３～請求項１５何れかに記載の脈波検出装置。
【請求項17】
前記発光手段は間欠的に発光し、
前記外部光検出手段は、前記発光手段が発光を停止する毎に、前記外部光を検出する、
ことを特徴とする請求項１６に記載の脈波検出装置。
【発明の詳細な説明】
【技術分野】
【0001】
本発明は、発光素子と受光素子を用いて生体の脈波を検出する脈波検出装置に関する。
【背景技術】
【0002】
近年、生活習慣病などの予防を目的として、歩数計や消費カロリー計など定期的な運動を支援する携帯型の装置が利用されている。この運動量をより正確に判断するには脈拍数を計測することが有効であり、このために、血液成分による吸光特性を利用した光学式脈波センサが利用されることが多い。この光学式脈波センサは、発光素子と受光素子を備え、発光素子から人体に向けて光を照射し、反射してきた光を受光素子で受光するように構成されており、この受光量の変化により脈波を検出する。そして、この光学式脈波センサとしては、例えば、発光素子と受光素子とから構成された脈波センサが、センサ固定用バンドによって人間の人差し指の根元から第２指関節までの間に固定されるものが知られている（例えば、特許文献１参照。）。
【特許文献1】再表９７／０３７５８８号公報
【発明の開示】
【発明が解決しようとする課題】
【0003】
しかし、光学式脈波センサを屋外で利用する場合には、太陽光ノイズが大きな問題となる。つまり、屋外では太陽光が脈波センサに入射することで、本来検出すべき脈波成分が太陽光ノイズに埋もれてしまい脈波を精度良く検出できなくなるという問題があった。
【0004】

本発明は、こうした問題に鑑みなされたものであり、太陽光の影響を除去して精度良く脈波を検出する脈波検出装置を提供することを目的とする。

【課題を解決するための手段】

【0005】

係る目的を達成するためになされた請求項１に記載の脈波検出装置は、生体の皮膚に接触させて固定されており、発光手段は生体に対して光を照射するとともに、受光手段は、発光手段から照射された光の反射光を、透光板を介して受光することにより生体の脈波を検出する。そして、当該脈波検出装置は、透光板の端面を覆い光を遮光する遮光板を備えており、この遮光板は、当該脈波検出装置の外部から照射された光が生体の皮膚を介して受光手段に受光されるのを阻止する。

【0006】

このため、外部から照射された光の影響を除去して精度良く脈波を検出することができる。

ところで、当該脈波検出装置の外部から照射された光（以降、外部光とも称す）が生体の皮膚を介して受光手段に受光される経路としては、図６（ａ）に示すように、皮膚表面と皮膚内部の伝播が挙げられる。このうち、皮膚表面の伝播は、遮光板と生体の皮膚との間に形成された隙間から外部光が入射し、遮光板と生体の皮膚との間で反射を繰り返しながら受光手段に到達するものである。

【0007】

この皮膚表面の伝播を抑制するためには、請求項１に記載の脈波検出装置において、請求項２～請求項５何れかに記載のようにするとよい。

即ち、請求項１に記載の脈波検出装置において、請求項２に記載のように、前記遮光板の材質は、光を吸収する特性を有するようにするとよい。

【0008】

このように構成された脈波検出装置によれば、遮光板と生体の皮膚との間に形成された隙間から入射した外部光が遮光板に当たると、外部光は遮光板に吸収されるため、外部光が受光手段に受光されることを抑制できる。

【0009】

また、請求項１または請求項２に記載の脈波検出装置において、請求項３に記載のように、前記遮光板の前記外側表面は光を吸収する色で塗装されているようにするとよい。

このように構成された脈波検出装置によれば、遮光板と生体の皮膚との間に形成された隙間から入射した外部光が遮光板に当たると、外部光は塗装された部分に吸収されるため、外部光が受光手段に受光されることを抑制できる。

【0010】

また、請求項１～請求項３何れかに記載の脈波検出装置において、請求項４に記載のように、前記遮光板の材質は、当該脈波検出装置を前記生体の皮膚に固定した際に、前記遮光板の前記外側表面が前記生体の皮膚と隙間なく接触する程度に柔軟な特性を有するようにするとよい。

【0011】

このように構成された脈波検出装置によれば、外部光が入射する原因となる隙間が形成されないため、外部光が受光手段に受光されることを抑制できる。

また、請求項１～請求項４何れかに記載の脈波検出装置において、請求項５に記載のように、前記遮光板の前記外側表面上には、該外側表面が鏡面でないと見做すことができる程度の凹凸が形成されているようにするとよい。

【0012】

このように構成された脈波検出装置によれば、遮光板と生体の皮膚との間に形成された隙間から入射した外部光が遮光板に当たると、外部光は四方に散乱するために、外部光が受光手段に受光されることを抑制できる。

【0013】

一方、皮膚内部の伝播は、図６（ａ）に示すように、外部光が皮膚の内部を通過して受

光手段に到達するものである。

この皮膚内部の伝播を抑制するためには、請求項１～請求項５何れかに記載の脈波検出装置において、請求項６に記載のように、当該脈波検出装置を前記生体の皮膚に固定した際に該皮膚に窪みを生じさせる遮光凸部を前記遮光板の前記外側表面上に備えるようにするとよい。

【0014】

このように構成された脈波検出装置によれば、皮膚に窪みを生じさせる程度に遮光凸部が皮膚を押圧することにより、皮膚内部を伝播する外部光の経路上に遮光凸部が立ちはだかるために、遮光凸部に当たった外部光は四方に散乱し、外部光が受光手段に受光されることを抑制できる。

【0015】

また、請求項６に記載の脈波検出装置において、更に、請求項７に記載のように、前記遮光凸部の材質は、当該脈波検出装置を前記生体の皮膚に固定した際に、前記遮光凸部が前記生体の皮膚と隙間なく接触する程度に柔軟な特性を有するようにするとよい。

【0016】

このように構成された脈波検出装置によれば、遮光凸部と生体の皮膚との間に、外部光が入射する原因となる隙間が形成されないため、外部光が受光手段に受光されることを更に抑制できる。

【0017】

また、請求項６または請求項７に記載の脈波検出装置において、更に、請求項８に記載のように、前記遮光凸部は、前記透光板を取り巻くように配置されるようにするとよい。

このように構成された脈波検出装置によれば、皮膚内部を伝播する外部光が受光手段に到達するまでの経路上に確実に遮光凸部が配置されるので、外部光が受光手段に受光されることを更に抑制できる。

【0018】

また、請求項８に記載の脈波検出装置において、更に、請求項９に記載のように、前記遮光凸部が複数配置されているようにするとよい。

このように構成された脈波検出装置によれば、皮膚内部を伝播する外部光が受光手段に到達するまでの経路上に多くの遮光凸部が配置されることになり、外部光が受光手段に受光されることを更に抑制できる。

【0019】

ところで、遮光凸部間の配置間隔が、外部光の周波数の整数倍に一致している場合には、その外部光の経路上に遮光凸部が配置されていても、皮膚内部を伝播する外部光が遮光凸部に当たることなく通過することがある。

【0020】

このため、請求項９に記載の脈波検出装置において、更に、請求項１０に記載のように、前記複数の遮光凸部は、互いの配置間隔がランダムになるように配置されているようにするとよい。

【0021】

このように構成された脈波検出装置によれば、皮膚内部を伝播する外部光の経路上に、配置間隔が外部光の周波数の整数倍に一致していない遮光凸部が、確実に配置されるので、外部光が受光手段に受光されることを抑制できる。

【0022】

また、請求項８～請求項１０何れかに記載の脈波検出装置において、更に、請求項１１に記載のように、前記遮光凸部は、始端部と終端部とを有する突条で構成されるようにするとよい。

【0023】

このように構成された脈波検出装置によれば、突条の端部間に形成される空隙を介して、脈波検出装置と生体の皮膚との間の隙間にある空気と、脈波検出装置の外部の空気とが、突条の端部間に形成される空隙を介して循環することができる。

【0024】
つまり、当該脈波検出装置と皮膚とが密着している部分で起こりやすくなる蒸れを抑制できる。
また、請求項１１に記載の脈波検出装置において、更に、請求項１２に記載のように、前記複数の遮光凸部の内で前記透光板から最も離れた位置に配置された遮光凸部を構成する突条の端部間に形成された空隙と、前記透光板とを結ぶ直線上に、少なくとも１つの遮光凸部が配置されているようにするとよい。
【0025】
このように構成された脈波検出装置によれば、透光板から最も離れた位置に配置された遮光凸部を構成する突条において、その端部間に形成された空隙から入射した外部光の経路上に遮光凸部が配置されるので、外部光が受光手段に受光されることを抑制できる。
【0026】
ところで、請求項１～請求項１２に記載の脈波検出装置は、外部光が受光手段に受光されることを抑制することによって、精度良く脈波を検出するものであるが、請求項１４に記載のように、当該脈波検出装置の外部から照射されて前記受光手段に受光される外部光を検出して、前記外部光の受光量に応じた外部受光信号を出力する外部光検出手段と、前記外部受光信号と、前記発光手段が光を照射した時の前記受光信号とに基づいて、前記生体の脈波を検出する脈波検出手段とを備えるようにしてもよい。
【0027】
このように構成された脈波検出装置によれば、外部光検出手段は、受光手段に受光される外部光を検出して外部光の受光量に応じた外部受光信号を出力し、脈波検出手段は、外部受光信号と、発光手段が光を照射した時の受光信号とに基づいて、生体の脈波を検出する。
【0028】
即ち、発光手段が光を照射した時の受光信号の内で、外部光に起因する部分を考慮して生体の脈波を検出できるため、外部から照射された光の影響を除去して、精度良く脈波を検出することができる。
【0029】
尚、請求項１３に記載のように、請求項１４に記載の外部光検出手段及び脈波検出手段は、請求項１～請求項１２に記載の脈波検出装置が備えるようにしてもよい。
また、請求項１３または請求項１４に記載の脈波検出装置において、請求項１５に記載のように、前記脈波検出手段は、前記受光信号から前記外部受光信号を差分した差分信号に基づいて前記脈波を検出するようにしてもよい。
【0030】
このように構成された脈波検出装置によれば、受光信号から外部受光信号を差分するという簡便な演算により、外部光の影響が除去された信号を得ることができる。
また、請求項１３～請求項１５何れかに記載の脈波検出装置において、発光手段が光を照射していない時に受光手段が受光する光は、通常、外部光であるので、請求項１５に記載のように、前記外部光検出手段は、前記発光手段が発光を停止している時に前記外部光を検出するようにするとよい。
【0031】
このように構成された脈波検出装置によれば、発光手段から照射される光の影響を受けることなく外部光を検出することができる。
また、請求項１６に記載の脈波検出装置において、請求項１７に記載のように、前記発光手段は間欠的に発光し、前記外部光検出手段は、前記発光手段が発光を停止する毎に、前記外部光を検出するようにするとよい。
【0032】
このように構成された脈波検出装置によれば、発光手段が前回発光してから今回発光するまでに、受光手段に入射した外部光を検出するので、発光手段が今回発光した時に受光手段に入射した外部光の影響を精度良く除去することができる。

【発明を実施するための最良の形態】
【0033】
以下に本発明の実施形態について図面をもとに説明する。
まず、本発明の脈波検出装置を適用した脈波検出装置１を、図１に基づいて説明する。
本実施形態の脈波検出装置１は、人体の脈拍数を検出する装置であり、図１に示すように、発光素子として赤外ＬＥＤ２１と緑色ＬＥＤ２３を備えるとともに、受光素子としてフォトダイオード（ＰＤ）２５を備えた脈波センサ３と、赤外ＬＥＤ２１と緑色ＬＥＤ２３とに対して、それぞれ異なるタイミングで光を照射させるための駆動信号を出力することにより脈波センサ３を駆動する駆動回路５と、脈波センサ３からの信号を処理するとともに駆動回路５を制御するデータ処理装置７とから構成されている。尚、駆動回路５とデータ処理装置７とは、脈波検出装置本体９の筐体内に収容されている。
【0034】
まず、脈波センサ３の構成を図２に基づいて説明する。図２（ａ）は脈波センサ３の構成を示す断面図、図２（ｂ）は脈波センサ３の皮膚と接触する側から見た平面図である。尚、図２（ａ）は図２（ｂ）のＡ－Ａ断面部を示している。
【0035】
脈波センサ３は、人体の腕等に固定して利用するものであり、図２（ａ）に示すように、約９４０ｎｍの波長の赤外光を照射する赤外ＬＥＤ２１と、約５２０ｎｍの緑色光を照射する緑色ＬＥＤ２３と、光を受光して受光量に応じた信号（受光信号）を出力するＰＤ２５とを備える光学式反射型センサである。
【0036】
この赤外ＬＥＤ２１，緑色ＬＥＤ２３，ＰＤ２５は、それぞれ脈波センサ３の筐体２０の底部２７に、ＰＤ２５を挟んで左右に赤外ＬＥＤ２１と緑色ＬＥＤ２３とが位置するように並列して配置され、透明な透光板２９を介して、赤外光又は緑色光を人体に対して照射できるようにされている。さらに、光を遮光する遮光板３１が透光板２９の端面を覆うように配置されている。尚、遮光板３１は、脈波センサ３を人体の腕等に固定した際に、遮光板３１が皮膚と隙間なく接触する程度に柔軟な特性を有する材質のものが用いられ、例えばシリコン材が好適である。また、遮光板３１の皮膚と接触する側の表面は光を吸収する色（例えば黒色）で塗装されている。なお、図では遮光板３１と筐体２０が別体のものを示すが、筐体２０を加工することで遮光板３１と同じ機能を有する構成としてもよい。
【0037】
また、遮光板３１上には、凸部３３が透光板２９を３重に取り巻くように配置されている。ここでは３重としたが、１重，２重または４重以上でもよい。また、凸部３３の高さは、脈波センサ３を人体の腕等に固定した際に、皮膚に窪みを生じさせる程度の高さであればよく、例えば０．３ｍｍ程度にするとよい。この凸部３３は、後に詳述するように、外部からの光がＰＤ２５に受光されるのを阻止するためのものである。さらに、凸部３３は始端部と終端部を有する複数の突条で構成されており、突条の端部間には、蒸れ防止のための空隙３５が形成されている。また、３重に配置された凸部３３の互いの配置間隔（例えば、図２（ｂ）の間隔Ｓ１，Ｓ２参照）は、均等ではなくランダムになっている。尚、凸部３３は、脈波センサ３を人体の腕等に固定した際に、凸部３３が皮膚と隙間なく接触する程度に柔軟な特性を有する材質のものが用いられ、例えばシリコン材が好適である。なお、図では凸部３３および遮光板３１と筐体２０が別体のものを示すが、筐体２０を加工することで凸部３３および遮光板３１と同じ機能を有する構成としてもよい。
【0038】
さらに、透光板２９から最も離れた位置に配置された凸部３３において形成された空隙（例えば空隙３５ａ）と、透光板２９とを結ぶ線分（例えば線分Ｂ－Ｂ）上に、少なくとも１つの凸部３３が配置されるように構成されている。
【0039】
このように構成された脈波センサ３において、まず、図１に示すように、透光板２９と

遮光板３１を例えば人体の腕の皮膚上に接触させて脈波センサ３を固定する。その後、赤外ＬＥＤ２１および緑色ＬＥＤ２３が、それぞれ赤外光および緑色光を人体に向かって交互に照射し、この光の反射光をＰＤ２５が受光する。そして、ＰＤ２５は、その受光量の変化を受光信号（例えば電圧信号）としてデータ処理装置７に出力する。

【0040】

尚、赤外ＬＥＤ２１および緑色ＬＥＤ２３から人体に照射された光は、その一部が人体の内部を通る小・細動脈（毛細動脈）にあたって、毛細動脈を流れる血液中のヘモグロビンに吸収され、残りの光が毛細動脈で反射して散乱する。この時、血液の脈動により毛細動脈にあるヘモグロビンの量が波動的に変化するので、ヘモグロビンに吸収される光も波動的に変化する。即ち、血液の脈動に応じて、毛細動脈で反射してＰＤ２５で検出される受光量が変化する。

【0041】

従って、ＰＤ２５が出力した（赤外ＬＥＤ２１又は緑色ＬＥＤ２３から照射された光の反射光に対応した）受光信号から、脈波に関する情報が得られる。

以下に、脈波を検出するために赤外ＬＥＤ２１と緑色ＬＥＤ２３を用いる理由について説明する。

【0042】

図５に示すように、ＰＤ２５が出力した受光信号には、毛細動脈に当たって反射した脈波を示す信号（脈波成分）と、皮膚表面又は毛細動脈以外で反射した反射波の成分（反射波成分）との両成分が含まれている。この受光信号を周波数解析すると、主に、心拍に同期する脈拍成分と、体動に同期する体動成分と、（体動成分を除いた反射波成分である）概ね直流成分とに分離される。

【0043】

このうち、直流成分は、血管の拡張収縮による血流変化のともなう光量変化（以下、ノイズＡと称す）、脈波センサ３のずれに伴う皮膚表面散乱光量変化（以下、ノイズＢと称す）、脈波センサ３の外部から入射する光（太陽光など）の光量変化などに起因するものであり、検出回路１１において後述する方法によってカットされる。

【0044】

そして、脈拍成分と体動成分については、赤外光と緑色光とで吸光特性が異なっており、緑色ＬＥＤ２３を発光させた時にＰＤ２５が出力する受光信号では、脈拍成分と体動成分とがいずれも抽出可能な信号レベルで得られるのに対して、赤外ＬＥＤ２１を発光させた時にＰＤ２５が出力する受光信号では、体動成分と比較して脈拍成分が非常に小さく、体動成分のみが抽出可能な信号レベルで得られる。

【0045】

つまり、緑色ＬＥＤ２３を発光させた時にＰＤ２５が出力する受光信号（脈拍成分と体動成分を含む）と、赤外ＬＥＤ２１を発光させた時にＰＤ２５が出力する受光信号（体動成分のみを含む）とを比較することにより、脈拍成分のみを抽出できるようにされている。

【0046】

ところで、太陽光などの脈波センサ３の外部からの光（以下、外部光とも称す）は、皮膚表面や皮膚内部を伝播してＰＤ２５に入射する。

このうち、皮膚表面を伝播する外部光は、光を吸収する色で塗装された遮光板３１の表面にて、図６（ｂ）に示すように、その一部が吸収される。

【0047】

また、遮光板３１は（皮膚に密着して）、外部光入射の原因となる隙間が形成されることを防止する。

さらに、皮膚内部を伝播する外部光については、遮光板３１の表面上に形成された凸部３３が皮膚を押圧することにより、図６（ｃ）に示すように、皮膚内部を伝播する外部光の経路上に凸部３３が立ちはだかるために、凸部３３に当たった外部光は散乱する。

【0048】

これらにより、外部光がＰＤ２５に到達することを抑制する。

次に、データ処理装置７は、脈波センサ３から得られた受光信号を増幅する検出回路１１と、検出回路１１からの信号を処理して脈波の検出等の各種の演算処理を行うマイクロコンピュータ（以下、マイコンと称す）１３とを備えている。

【0049】

そして、検出回路１１は、図３に示すように、脈波センサ３から得られた受光信号を増幅する増幅部４１と、上記直流成分に相当する直流成分信号を増幅部４１に出力する補正部４３とから構成されている。

【0050】

このうち、増幅部４１は、オペアンプＯＰ１を中心に構成されている。オペアンプＯＰ１の非反転入力端子（＋）は、抵抗Ｒ２を介して脈波センサ３からの受光信号が入力されるとともに、抵抗Ｒ１を介して接地されている。また、オペアンプＯＰ１の反転入力端子（－）は、抵抗Ｒ４を介して補正部４３からの直流成分信号が入力されるとともに、抵抗Ｒ３を介してオペアンプＯＰ１の出力端子に接続されている。また、オペアンプＯＰ１の出力端子は、後述する１０ビットＡ／Ｄ変換器１３ｄのＡ／ＤポートＰＡＤ１に接続されている。さらに、脈波センサ３からの受光信号は、後述するＡ／Ｄ変換器１３ｄのＡ／ＤポートＰＡＤ２にも入力される。尚、抵抗Ｒ１の抵抗値は抵抗Ｒ３と等しく、抵抗Ｒ２の抵抗値は抵抗Ｒ４と等しくなるように設定されている。また、オペアンプＯＰ１の増幅度が、例えば｛（Ｒ１の抵抗値）／（Ｒ２の抵抗値）｝＝１０００となるように抵抗Ｒ１～Ｒ４の抵抗値が設定されている。

【0051】

このように構成された増幅部４１では、受光信号の電圧値から直流成分信号の電圧値分をカットした信号を増幅して出力する。

即ち、赤外ＬＥＤ２１及び緑色ＬＥＤ２３から照射された光の内、ヘモグロビンに吸収される光は僅かであり、これにより受光信号に現れる脈拍成分の変化を、マイコン１３が備えるＡ／Ｄ変換器１３ｄにおいて検出可能とするために増幅が必要となる。本実施形態では１０００倍程度の増幅が必要である。

【0052】

また、直流成分の変化は、脈拍成分の変化よりも数倍から数百倍大きいため、受光信号から直流成分を差分することなしに増幅すると、増幅した信号はＡ／Ｄ変換器１３ｄの入力可能電圧の上限を超えてしまう。このため、受光信号から直流成分を差分した後に増幅を行っている。

【0053】

次に、補正部４３はオペアンプＯＰ２と分圧抵抗Ｒ９，Ｒ１０とを中心に構成されている。後述する１０ビットＤ／Ａ変換器１３ｅのＤ／ＡポートＰＤＡ２は、分圧抵抗Ｒ９，Ｒ１０を介して接地されている。また、オペアンプＯＰ２の非反転入力端子（＋）は、抵抗Ｒ６を介して、後述するＤ／Ａ変換器１３ｅのＤ／ＡポートＰＤＡ１からの信号が入力されるとともに、抵抗Ｒ５を介して接地されている。また、オペアンプＯＰ２の反転入力端子（－）は、抵抗Ｒ８を介して、分圧抵抗Ｒ９とＲ１０との接続点に接続されるとともに、抵抗Ｒ７を介してオペアンプＯＰ２の出力端子に接続されている。尚、抵抗Ｒ５の抵抗値は抵抗Ｒ７と等しく、抵抗Ｒ６の抵抗値は抵抗Ｒ８と等しくなるように設定されている。また、オペアンプＯＰ２の増幅度が、例えば｛（Ｒ５の抵抗値）／（Ｒ６の抵抗値）｝＝１となるように抵抗Ｒ５～Ｒ８の抵抗値が設定されている。さらに、分圧抵抗Ｒ９，Ｒ１０の抵抗値は、例えば、「（抵抗Ｒ９の抵抗値）／（抵抗Ｒ１０の抵抗値）＝１０２４」となるように設定されている。

【0054】

このように構成された補正部４３では、Ｄ／ＡポートＰＤＡ２から出力されたアナログ信号の電圧値（Ｖ２）を（１／１０２４）倍した信号がオペアンプＯＰ２の反転入力端子（－）に入力されるとともに、Ｄ／ＡポートＰＤＡ１から出力されたアナログ信号に等しい電圧値（Ｖ１）をもつ信号がオペアンプＯＰ２の非反転入力端子（＋）に入力されるこ

とにより、オペアンプＯＰ２の出力端子から（Ｖ１－Ｖ２／１０２４）の電圧値をもつアナログ信号が出力される。

【0055】

即ち、オペアンプＯＰ２の出力端子から出力されるアナログ信号の電圧値の分解能は、Ｄ／ＡポートＰＤＡ２から出力されるアナログ信号の電圧値の分解能の１０２４倍となる。

【0056】

つまり、１０ビットのＤ／Ａポートを２つ使用することにより、２０ビット分の分解能をもつアナログ信号を出力させている。そして、上記の（Ｖ１－Ｖ２／１０２４）の値が、上記直流成分信号の電圧値に一致するように、Ｄ／ＡポートＰＤＡ１から電圧値Ｖ１のアナログ信号、Ｄ／ＡポートＰＤＡ２から電圧値Ｖ２のアナログ信号が出力される。

【0057】

このため、Ｄ／ＡポートＰＤＡ２において、出力するアナログ信号の電圧値を最小分解能の１ビット分変化させた場合に、Ａ／ＤポートＰＡＤ１の入力電圧幅を超える信号がＡ／ＤポートＰＡＤ１に入力されるということを防ぐことができる。即ち、例えば、１０ビットのＡ／ＤポートＰＡＤ１の入力電圧幅が３Ｖ、１０ビットのＤ／ＡポートＰＤＡ１の出力電圧幅が３Ｖで、Ｄ／ＡポートＰＤＡ１のみを用いて、上記直流成分信号に対応するアナログ信号を出力する場合を想定すると、Ｄ／ＡポートＰＤＡ１から出力されるアナログ信号の最小電圧変化は３ｍＶであり、オペアンプＯＰ１の増幅率が上記と同様に１０００倍とすると、直流成分信号の３ｍＶの電圧変化によるオペアンプＯＰ１の出力変化は３Ｖとなる。つまり、Ｄ／ＡポートＰＤＡ１から出力される直流成分信号の数ビット分の電圧変化によって、オペアンプＯＰ１の出力電圧がＡ／ＤポートＰＡＤ１の入力電圧幅を超えることになる。

【0058】

これに対して、本実施形態においては、２０ビット分の分解能をもつアナログ信号を直流成分信号として出力させているので、出力電圧幅が３Ｖとすると最小電圧変化は約３μＶであり、最小電圧変化によるオペアンプＯＰ１の出力変化は約３ｍＶとなる。つまり、Ｄ／ＡポートＰＤＡ１，ＰＤＡ２から出力される直流成分信号の数ビット分の電圧変化では、オペアンプＯＰ１の出力電圧がＡ／ＤポートＰＡＤ１の入力電圧幅を超えることはない。

【0059】

このように構成された検出回路１１では、Ｄ／Ａ変換器１３ｅからのアナログ信号に応じて、直流成分信号の電圧値を調整しながら、直流成分信号の電圧値をオフセットとした受光信号を増幅して、Ａ／Ｄ変換器１３ｄへ出力する。

【0060】

次に、マイコン１３は、図１に示すように、所定の処理プログラムに基づいて処理を実行するＣＰＵ１３ａと、種々の制御プログラムが格納されたＲＯＭ１３ｂと、種々のデータを格納する各種メモリが設けられたＲＡＭ１３ｃと、アナログ信号の電圧値を１０ビットのデジタル値に変換するＡ／Ｄ変換器１３ｄと、ＣＰＵ１３ａが生成した１０ビットのデジタルデータを、アナログ信号に変換するＤ／Ａ変換器１３ｅと、各種デジタル信号が入力される複数の入力ポートと、各種デジタル信号が出力される複数の出力ポートとを有する入出力ポート１３ｆとを備えている。

【0061】

尚、図１に示すように、Ａ／Ｄ変換器１３ｄは、アナログ信号が入力されるＡ／ＤポートＰＡＤ１，ＰＡＤ２を備え、Ｄ／Ａ変換器１３ｅは、アナログ信号を出力するＤ／ＡポートＰＤＡ１，ＰＤＡ２を備えている。また、入出力ポート１３ｆは、図１に示すように、出力ポートＰＯ１を備えており、出力ポートＰＯ１には駆動回路７が接続されている。

【0062】

このように構成されたマイコン１３において、ＣＰＵ１３ａは、上記直流成分信号の内、上記ノイズＡ及び上記ノイズＢに対応する成分の信号を出力する処理と、外部光に対応

する成分の信号を出力する処理とを、それぞれ個別に行う。

【0063】

まず、上記ノイズＡ及び上記ノイズＢに対応する成分の信号を出力する処理を説明する。

上記ノイズＡ及び上記ノイズＢに起因する受光信号の電圧変動の周波数は脈拍成分に比べて十分低く、これらのノイズに起因する電圧変動は短時間では小さい。このため、ＣＰＵ１３ａは、所定時間範囲（例えば１０秒間）毎に、その所定時間内における受光信号の電圧変動を解析することにより、上記ノイズＡ及び上記ノイズＢに起因する電圧変動分を、現時点のＤ／ＡポートＰＤＡ１，ＰＤＡ２の出力値に対して調整する。これにより、上記ノイズＡ及び上記ノイズＢに対応した分の直流成分信号が、補正部４３から出力される。つまり、上記所定時間ごとに直流成分信号の電圧値を調整する。

【0064】

次に、外部光に対応する成分の信号（以下、外部受光信号と称す）を出力するための外部光調整処理を図４に基づいて説明する。図４は、外部光調整処理を表すフローチャートである。この外部光調整処理は、ＣＰＵ１３ａが起動（電源ＯＮ）している間に、例えば赤外ＬＥＤ２１及び緑色ＬＥＤ２３が照射する毎に繰り返し実行される処理である。

【0065】

この外部光調整処理においては、ＣＰＵ１３ａは、まずＳ１０にて、Ａ／ＤポートＰＡＤ２に入力した信号の電圧値のデータを取得する。その後、Ｓ２０にて、Ｓ１０で取得した電圧値データが、前回にＡ／ＤポートＰＡＤ２から取得した電圧値データと同じ値であるか否かを判断する。ここで、同じ値であると判断すると（Ｓ２０：ＹＥＳ）、Ｓ５０に移行する。一方、同じ値でないと判断すると（Ｓ２０：ＮＯ）、Ｓ３０に移行する。

【0066】

そして、Ｓ３０に移行すると、Ｓ１０で取得した電圧値データと前回に取得した電圧値との差分の電圧値に基づいて、Ｄ／ＡポートＰＤＡ１，ＰＤＡ２から出力する電圧の変動分を計算する。さらに、Ｓ４０にて、Ｓ３０で計算された電圧変動分を、現時点のＤ／ＡポートＰＤＡ１，ＰＤＡ２の出力値に対して調整する。その後、Ｓ５０に移行する。

【0067】

そして、Ｓ５０に移行すると、緑色ＬＥＤ２３を発光させるとともにＡ／ＤポートＰＡＤ１に入力した信号の電圧値のデータを取得する。

さらに、Ｓ６０にて、赤外ＬＥＤ２１を発光させるとともにＡ／ＤポートＰＡＤ１に入力した信号の電圧値のデータを取得し、当該外部光調整処理を終了する。

【0068】

即ち、外部光調整処理では、赤外ＬＥＤ２１及び緑色ＬＥＤ２３が発光していない時のＰＤ２５からの受光信号を外部受光信号と見做し、この受光信号の電圧値に応じてＤ／ＡポートＰＤＡ１，ＰＤＡ２から出力するアナログ信号の電圧値を調整する。

【0069】

このように構成された本実施形態の脈波検出装置１では、緑色ＬＥＤ２３が発光する直前に、ＰＤ２５が受光した光を外部受光信号として検出し（Ｓ１０）、外部受光信号を出力する（Ｓ２０～Ｓ４０）。その後、緑色ＬＥＤ２３→赤外ＬＥＤ２１の順に発光させ、緑色ＬＥＤ２３または赤外ＬＥＤ２１が発光した時にＰＤ２５が出力する受光信号と、外部受光信号とを増幅部４１において差分し、この差分した信号を取得する（Ｓ５０～Ｓ６０）ことにより脈波を検出する。

【0070】

このため、赤外ＬＥＤ２１または緑色ＬＥＤ２３が光を照射した時の受光信号の内で外部光に起因する部分を考慮して人体の脈波を検出できるため、外部光の影響を除去して精度良く脈波を検出することができる。

【0071】

また、受光信号から外部受光信号を差分するという簡便な演算により、外部光の影響が除去された信号を得ることができる。

また、赤外ＬＥＤ２１及び緑色ＬＥＤ２３が発光を停止している時に外部受光信号を検出するので、赤外ＬＥＤ２１または緑色ＬＥＤ２３から照射される光の影響を受けることなく外部光を検出することができる。

【0072】

また、緑色ＬＥＤ２３が発光する直前に外部受光信号を検出するので、赤外ＬＥＤ２１及び緑色ＬＥＤ２３が発光した時にＰＤ２５に入射した外部光の影響を精度良く除去することができる。このとき、緑色ＬＥＤ２３と赤外ＬＥＤ２１の発光順序はどちらからでもよい。

【0073】

また、本実施形態の脈波検出装置１は、脈波センサ３を人体の皮膚に固定された状態で使用され、遮光板３１の皮膚と接触する側の表面は光を吸収する色で塗装されているために、遮光板３１と皮膚との間に形成された隙間から入射した外部光が遮光板に当たると、外部光は遮光板３１に吸収され、外部光がＰＤ２５に受光されることを抑制できる。

【0074】

また、遮光板３１の、皮膚と接触する側の表面上には、複数の凸部３３が透光板２９を取り巻くように配置されているため、皮膚内部を伝播する外部光の経路上に凸部３３が立ちはだかり、凸部３３に当たった外部光は四方に散乱し、外部光がＰＤ２５に受光されることを抑制できる。尚、凸部３３の数が多いほど、皮膚内部を伝播する外部光がＰＤ２５に到達するまでの経路上に多くの凸部３３が配置されることになり、外部光がＰＤ２５に受光されることを抑制できる。

【0075】

また、複数の凸部３３は、互いの配置間隔がランダムになるように配置されているために、皮膚内部を伝播する外部光の経路上に、外部光の周波数の整数倍に一致していない配置間隔をもつ凸部３３が確実に配置されるので、外部光がＰＤ２５に受光されることを抑制できる。

【0076】

また、凸部３３は、始端部と終端部とを有する突条で構成されているので、突条の端部間に形成される空隙３５を介して、脈波センサ３と皮膚との間の隙間にある空気と、脈波センサ３の外部の空気とが循環することができる。つまり、脈波センサ３と皮膚とが密着している部分で起こりやすくなる蒸れを抑制できる。

【0077】

また、透光板２９から最も離れた位置に配置された凸部３３において、その端部間で形成された空隙３５ａと、透光板２９とを結ぶ線分（線分Ｂ－Ｂ）上に、少なくとも１つの凸部３３が配置されるように構成されているため、外部光が空隙３５ａから入射した場合でも、この外部光がＰＤ２５に受光されることを抑制できる。

【0078】

また、遮光板３１と凸部３３の材質には、脈波センサ３を人体の皮膚に固定した際に、遮光板３１及び凸部３３が皮膚と隙間なく接触する程度に柔軟な特性を有するシリコン材が用いられている。このため、外部光が入射する原因となる隙間が形成されず、外部光がＰＤ２５に受光されることを抑制できる。

【0079】

以上説明した実施形態において、赤外ＬＥＤ２１，緑色ＬＥＤ２３は本発明における発光手段、ＰＤ２５は本発明における受光手段、凸部３３は本発明における遮光凸部、図４におけるＳ１０～Ｓ４０の処理と補正部４３は本発明における外部光検出手段、図４におけるＳ５０～Ｓ６０の処理と増幅部４１は本発明における脈波検出手段である。

【0080】

以上、本発明の一実施例について説明したが、本発明は上記実施例に限定されるものではなく、種々の態様を採ることができる。

例えば、上記実施形態においては、遮光板３１の皮膚と接触する側の表面が、光を吸収する色で塗装されているものを示した。しかし、遮光板３１の材質を、光を吸収する特性

を有するもの（例えば、樹脂やゴム）にしてもよい。このようにすれば、遮光板３１と皮膚との間に形成された隙間から入射した外部光が遮光板に当たると、外部光は遮光板３１に吸収されるため、外部光がＰＤ２５に受光されることを抑制できる。

【0081】

また、遮光板３１の皮膚と接触する側の表面上に、この表面が鏡面でないと見做すことができる程度に粗い凹凸を形成するようにしてもよい。このようにすれば、遮光板３１と皮膚との間に形成された隙間から入射した外部光が遮光板３１に当たると、外部光は四方に散乱するために、外部光がＰＤ２５に受光されることを抑制できる。

【0082】

また、上記実施形態においては、外部光として太陽光が入射した場合について示したが、脈波センサ３の外部から入射する光であれば、太陽光以外であっても適用可能である。例えば、蛍光灯から照射された光であってもよい。

【0083】

また、上記実施形態においては、遮光板３１及び凸部３３の材質として、シリコン材を用いた。しかし、脈波センサ３を人体の腕等に固定した際に、皮膚と隙間なく接触する程度に柔軟な特性を有していれば、シリコン材以外の材料でもよい。例えば、ゴム，布，ゲル状の固形物を用いてもよい。

【0084】

また、上記実施形態においては、遮光板３１及び凸部３３とを筐体２０と別体の構成として示したが、同様の効果をもたらすように同一部材で一体形成してもよい。

また、上記実施形態においては、凸部３３に空隙３５が形成されているものを示した。しかし、凸部３３は、環状、つまり空隙３５がない形状をしていてもよい。

【図面の簡単な説明】

【0085】

【図1】脈波検出装置１の主要な構成を示す説明図。

【図2】脈波センサ３の構成を示す説明図。

【図3】検出回路１１の構成を示す回路図。

【図4】外部光調整処理の手順を示すフローチャート。

【図5】脈波センサ３により得られる受光信号を示す説明図。

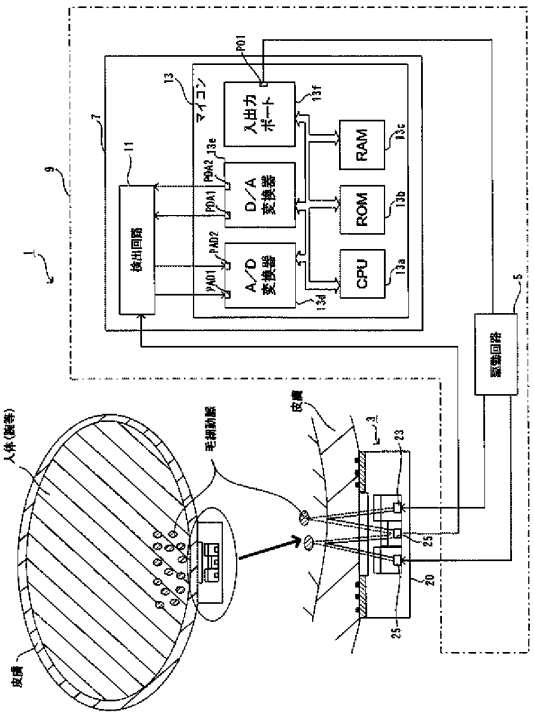
【図6】外部光の皮膚表面伝播と皮膚内部伝播を示す説明図。

【符号の説明】

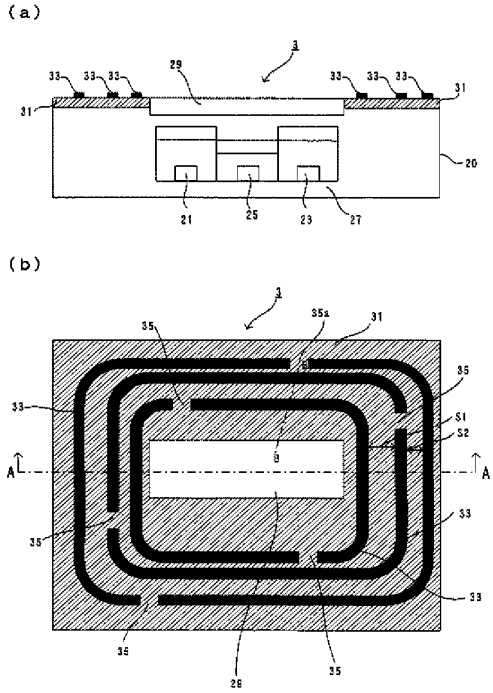
【0086】

１…脈波検出装置、３…脈波センサ、５…駆動回路、７…データ処理装置、９…脈波検出装置本体、１１…検出回路、１３…マイコン、１３ａ…ＣＰＵ、１３ｂ…ＲＯＭ、１３ｃ…ＲＡＭ、１３ｄ…Ａ／Ｄ変換器、１３ｅ…Ｄ／Ａ変換器、１３ｆ…入出力ポート、２０…筐体、２１…赤外ＬＥＤ、２３…緑色ＬＥＤ、２５…ＰＤ、２７…底部、２９…透光板、３１…遮光板、３３…凸部、３５…空隙、４１…増幅部、４３…補正部、ＯＰ１，ＯＰ２…オペアンプ、ＰＡＤ１，ＰＡＤ２…Ａ／Ｄポート、ＰＤＡ１，ＰＤＡ２…Ｄ／Ａポート、ＰＯ１…出力ポート、Ｒ１～Ｒ１０…抵抗。

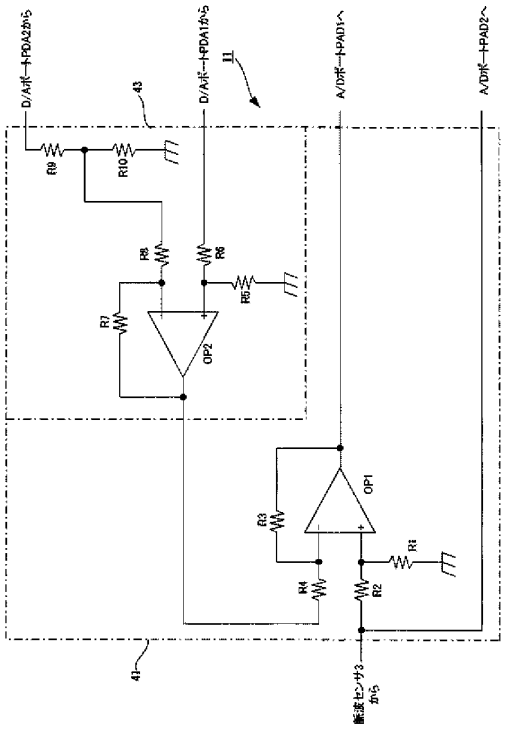
【図1】


マイコン
入出力ポート
D/A変換器
A/D変換器
RAM
ROM
CPU
検出回路
駆動回路
人体(腕等)
毛細動脈
皮膚
皮膚

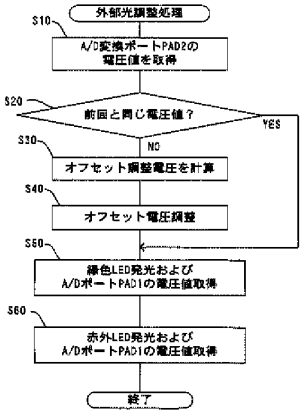
【図2】


(a)
(b)

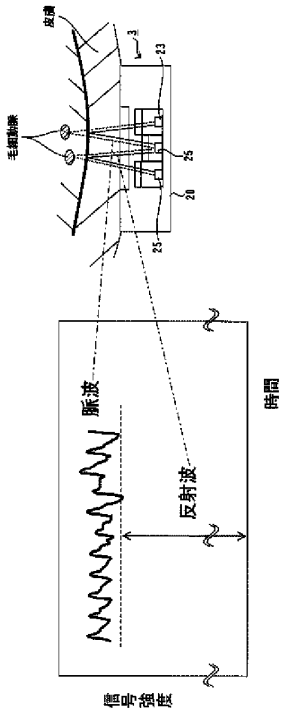
【図3】


D/AポートPDA2から
D/AポートPDA1から
A/DポートPAD1へ
A/DポートPAD2へ
OP1
OP2
脈波センサ3

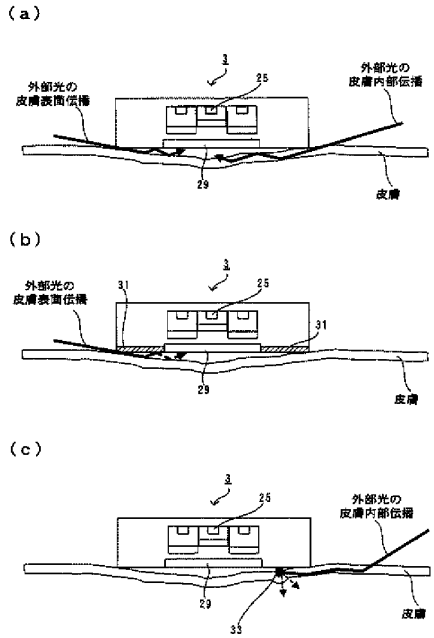
【図4】


外部光調整処理
A/D変換ポートPAD2の電圧値を取得
前回と同じ電圧値？
YES
NO
オフセット調整電圧を計算
オフセット電圧調整
緑色LED発光およびA/DポートPAD1の電圧値取得
赤外LED発光およびA/DポートPAD1の電圧値取得
終了

【図5】


皮膚
3
23
25
20
25
毛細血管
入射波
反射波
時間
血管断面

【図6】


(a)
3
25
外部光の
皮膚表面伝播
外部光の
皮膚内部伝播
29
皮膚
(b)
3
31
25
外部光の
皮膚表面伝播
31
29
皮膚
(c)
3
25
外部光の
皮膚内部伝播
29
33
皮膚

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Ｆターム(参考) 4C017 AA09　AA10　AB01　AB02　AC28　BC16　FF05

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(Machine translated text)

Title: Pulse Wave Sensor

Abstract: PROBLEM TO BE SOLVED: To provide a pulse wave sensor 1 which can detect a pulse wave stably with a high probability of detection. ;SOLUTION: The pulse wave sensor 1 includes a detection section 2 and a main body 3 of the sensor which are respectively fixed to the back side of a wrist by exclusive belts 10 and 14. Thereby, a shift of the position of the detection section can be made small and an influence of a body movement can be made small so that an excellent S/N ratio can be secured. Also, a surface side to touch the skin of a human body of a translucent plate 8 of the detection section 2 is comprised of a convex surface. Thereby, a degree of adhesion of the translucent plate 8 to the skin surface is improved and reflected light from the skin surface or noise light such as disturbance light or the like can be prevented from intruding so that the pulse wave sensor with high probability of detection can be realized. Moreover, a cushioning material 15 of a sponge or a gel type is inserted between the main body 3 of the sensor which is superposed on the top of the detection section 2 and the detection section 2. Thereby, the force applied to the main body 3 of the sensor or the movement of the main body 3 of the sensor is not easily transmitted to the detection section 2

Description:

PROBLEM TO BE SOLVED: To provide a pulse wave sensor 1 capable of detecting a stable pulse wave and having a high detection probability. A pulse wave sensor (1) has a detector (2) and a sensor body (3), both of which are fixed to the back of the wrist by dedicated belts (10, 14). Thereby, since the position shift of a detection part can be made small and the influence of a body movement can also be made small, a favorable S / N ratio is securable. Moreover, as for the translucent board 8 of the detection part 2, the surface side which contacts the skin of a human body is comprised by the convex curve. As a result, the degree of adhesion of the translucent plate 8 to the skin surface is improved, and noise light such as the amount of light reflected from the skin surface and disturbance light can be prevented from entering, so that a pulse wave sensor with a high detection probability can be realized. Further, a sponge or gel-type cushioning material 15 is inserted between the sensor main body 3 and the detection unit 2 that are arranged on top of the detection unit 2. This makes it difficult for the force applied to the sensor body 3 and the movement of the sensor body 3 to be transmitted to the detection unit 2. BACKGROUND OF THE INVENTION 1.

Field of the

Invention The present invention relates to a pulse wave sensor that detects a pulse wave of a human body.

As a prior art, there is a wristwatch type pulse wave detection device disclosed in, for example, Japanese Patent Application Laid-Open No. 11-70087. This pulse wave detection device is used by being worn on the wrist of a human body, and has a detection unit for detecting a pulse wave and a sensor main body having a display unit, and a detection unit via a band attached to the sensor main body. Can be fixed to the ventral side (back side) of the wrist, and the pulse wave information detected by the detection unit can be displayed on the display unit of the sensor body provided on the back side of the wrist.

[0003] However, since two bones (radius and ulna) pass through the ventral side of the wrist, when the wrist is moved, the movement of the skin surface is large, and the detection unit moves away from the wrist detection site. There is a problem that it is easy to shift. In addition, when the detection unit is fixed to the ventral side of the wrist, the ribs and the ulna are pressed, so that the wearing feeling is deteriorated. As a result, the wrist is often moved unconsciously, and it becomes difficult to detect the pulse wave in a stable state. The present invention has been made based on the above circumstances, and an object of the present invention is to provide a pulse wave sensor capable of detecting a stable pulse wave and having a high detection probability.

[0004] A detection unit including a light emitting element and a light receiving element, and a sensor main body including a circuit unit connected to the detection unit via a signal line, the detection unit being attached to a wrist or a forearm of a human body A pulse wave sensor for detecting a pulse wave of a human body, wherein the detection unit is fixed to a wrist or a forearm portion by a first belt, and the sensor main body is disposed so as to overlap with the upper part of the detection unit. It is fixed to a wrist or a forearm part by the 2nd belt wound around.

[0005] According to this configuration, since the dedicated belt (first belt) for fixing the detection unit is provided separately from the sensor main body, the movement of the sensor main body is not easily transmitted to the detection unit, and the detection unit is stable. Pulse wave detection.

[0006] The first belt may be made of a stretchable material.

[0007] Further, the pressure applied to the wrist by the first belt may be limited to 5 to 15 mmHg.

Next, an embodiment of the pulse wave sensor of the present invention will be described with reference to the drawings. FIG. 1 is a cross-sectional view showing an attached state of the pulse wave sensor. The pulse wave sensor 1 of the present embodiment is used for medical diagnosis, health checkup, etc. by measuring the pulse wave of the human body, and has a detection unit 2 and a sensor main body

3, and as shown in FIG. Used by attaching to the back side (back side) of the wrist 4.

As shown in FIG. 2, the detection unit 2 includes a package 5 having an opening, a light emitting element 6 and a light receiving element 7 accommodated in the package 5, and a translucent plate attached to the opening of the package 5. 8 etc. A circuit board 9 is provided inside the package 5, and a light emitting element 6 (for example, LED) and a light receiving element 7 (for example, PD) are assembled side by side on the circuit board 9. The translucent plate 8 is, for example, a glass plate that can transmit light, and the surface side that contacts the skin of the human body is formed by a convex curved surface (see FIG. 2).

This detection unit 2 is fixed to the wrist 4 by a dedicated belt 10 attached to the detection unit 2 separately from the sensor body 3 (see FIG. 1). The belt 10 may use a material having elasticity, for example, so that a certain pressure is applied to the wrist 4. Thereby, since the surface of the translucent board 8 can be closely_contact | adhered to the skin surface, invasion of the reflected light from the skin surface, disturbance light, etc. can be prevented. However, if the pressure applied to the wrist 4 is large, the feeling of pressure increases and the wearing feeling deteriorates, so it is desirable to limit the pressure to a level that does not deteriorate the wearing feeling, for example, 5-15 mmHg.

As shown in FIG. 2, in the detection unit 2, the light emitting element 6 and the light receiving element 7 are arranged side by side, and therefore the direction in which the light emitting element 6 and the light receiving element 7 are arranged (left and right in FIG. 2). Direction). In this case, if the longitudinal direction of the detection unit 2 (the direction in which the light emitting element 6 and the light receiving element 7 are arranged) is aligned with the circumferential direction of the wrist 4, the displacement of the detection unit 2 becomes large and the wearing feeling may be deteriorated. Therefore, it is better to arrange the detection unit 2 so that the longitudinal direction thereof matches the longitudinal direction of the arm. Therefore, when the belt 10 is wound around the wrist 4, the belt 10 is attached to the detection unit 2 so that the longitudinal direction of the detection unit 2 matches the longitudinal direction of the arm.

As shown in FIG. 2, the sensor body 3 includes a drive circuit 11 that drives the light emitting element 6 and a microcomputer 12 that calculates a pulse rate from pulse wave information detected by the detection unit 2. It has a monitor display unit (not shown) that displays the measured pulse rate and the like, and is connected to the detection unit 2 by a signal line 13. The sensor body 3 is attached to the wrist 4 in the same manner as a wristwatch. As shown in FIG. 1, the sensor body 3 is placed on top of the detection unit 2 and is attached to the wrist 4 by a dedicated belt 14 attached to the sensor body 3. Fixed to. However, for example, a sponge or a gel-type cushioning material 15 is inserted between the detection unit 2 and the sensor main body 3 so that the detection unit 2 and the sensor main body 3 are not

in direct contact with each other.

[0013] Here, a mechanism for detecting a pulse wave by the pulse wave sensor 1 will be described. As shown in FIG. 2, when light is emitted from the light emitting element 6 toward the wrist 4, a part of the light hits the capillary artery 16 passing through the wrist 4 and is absorbed by hemoglobin in the blood flowing through the capillary artery 16. Then, the remaining light is reflected and scattered by the capillary artery 16, and a part of the light enters the light receiving element 7. At this time, since the amount of hemoglobin in the blood flowing through the capillary artery 16 changes in a wave manner due to the pulsation of the blood, the light absorbed in the hemoglobin also changes in the wave manner. As a result, the amount of received light that is reflected by the capillary artery 16 and incident on the light receiving element 7 changes, so that this change in the amount of received light can be detected as pulse wave information.

(Operation and Effect of the Present Embodiment) The pulse wave sensor 1 of the present embodiment is used by arranging the detection unit 2 on the back side (back side) of the wrist 4 as shown in FIG. Compared with the case where the detection unit 2 is fixed to the ventral side of the wrist 4, the positional deviation of the detection unit 2 can be reduced when the wrist 4 is moved. Further, if the detection unit 2 is fixed to the back side of the wrist 4, the ribs and ulna are not strongly compressed, and therefore the wrist 4 is not moved unconsciously due to the feeling of pressure, and the detection unit 2 is stably detected with respect to the detection site. Can be fixed. Further, when the pulse wave is measured on the back side of the wrist 4, the amount of received light (that is, the signal intensity) incident on the light receiving element 7 is smaller than that on the abdominal side through which the radial artery or the ulnar artery passes. It can be said that the influence of body movement is small as compared with the case where measurement is performed on the ventral side because the change in the signal intensity due to the positional deviation of the part 2 is small.

[0015] Here, it was examined how the influence of body motion appears when the pulse wave is measured on the back side of the wrist 4 and when the pulse wave is measured on the ventral side of the wrist 4. As a result, as shown in FIG. 3, it is possible to measure pulse waves on both the instep side and the ventral side in a completely stationary state. It can be seen that b) is greatly influenced by body movement. In this case, the pulse wave cannot be measured. On the other hand, when measured on the back side (a), the influence of body movement is small compared to the abdominal side, and the pulse wave can be measured.

The detection unit 2 of the pulse wave sensor 1 uses the surface of the translucent plate 8 having a convex curved surface, and the convex curved surface is used in close contact with the skin surface, so that the degree of adhesion of the translucent plate 8 to the skin surface is used. Will improve. Thereby, the

fluctuation | variation of the reflected light amount (refer FIG. 2) which the light irradiated from the light emitting element 6 reflects on the skin surface, and injects into the light receiving element 7 can be suppressed, and mixing of noises, such as disturbance light, can also be prevented. Moreover, since the translucent plate 8 bites into the skin surface, it is possible to obtain the effect of preventing the positional deviation of the detection unit 2.

Here, FIG. 4 shows the result of measuring the pulse wave using the translucent plate 8 having a convex curved surface and the flat translucent plate 8. In this case, when the pulse wave is measured in a state where there is a body motion, when the surface is measured using the light-transmitting plate 8 having a flat surface (b), the surface is convexly curved although it is greatly affected by the body motion. In the case (a) of measurement using the translucent plate 8, it is understood that the influence of body movement is small and the pulse wave can be measured.

In addition, since the pulse wave sensor 1 of the present embodiment fixes the detection unit 2 and the sensor main body 3 to the wrist 4 with dedicated belts 10 and 14, respectively, the movement of the sensor main body 3 is transmitted to the detection unit 2. It is difficult to fix the detection unit 2 stably. Further, since the cushioning material 15 is inserted between the detection unit 2 and the sensor main body 3, it is difficult for the force applied to the sensor main body 3 and the movement of the sensor main body 3 to be transmitted to the detection unit 2. As a result, the detection unit 2 can be stably fixed to the wrist 4 and the amount of noise incident on the light receiving element 7 can be suppressed, so that the S / N is good not only at rest but also in daily life and light exercise. The pulse wave sensor 1 having a high detection probability can be provided.

(Modification) In the present embodiment, the sensor main body 3 includes the microcomputer 12 and the pulse wave number can be calculated. However, the detection result of the detection unit 2 is transmitted to an external receiver. It is also possible to have only the transmission function to perform. In this case, since the sensor body 3 can be reduced in size and the weight of the sensor body 3 can be reduced, it is possible to make it difficult to transmit the force applied to the sensor body 3 and the movement of the sensor body 3 to the detection unit 2. In this embodiment, the example in which the detection unit 2 and the sensor main body 3 are mounted on the wrist 4 has been described. However, the detection unit 2 and the sensor body 3 are not limited to the wrist 4 and may be attached to the back side of the forearm.

[0020] FIG. 5 is a cross-sectional view showing a state of attachment of a pulse wave sensor. It is explanatory drawing of the mechanism which detects a pulse wave. It is the pulse wave graph which measured the influence of body movement by the back side and the ventral side of a wrist. It is the pulse wave graph which measured the relationship between the surface shape of a light transmission board,

and the influence of a body motion.

DESCRIPTION

OF SYMBOLS 1 Pulse wave sensor
2 Detector
3 Sensor body
4 Wrist
6 Light emitting element
7 Light receiving element
8 Light transmissive plate (light transmissive member)
10 Belt (first belt)
12 Microcomputer (circuit portion)
13 Signal line
14 Belt (second belt)
15 Buffer material

Claim(s):

1. A detection unit including a light emitting element and a light receiving element, and a sensor body including a circuit unit connected to the detection unit via a signal line, and the detection unit is attached to a wrist or a forearm portion of a human body. A pulse wave sensor for detecting a pulse wave of a human body, wherein the detection unit is fixed to a wrist or a forearm portion by a first belt, and the
sensor main body is disposed to overlap the detection unit. A pulse wave sensor, wherein the pulse wave sensor is fixed to a wrist or a forearm portion by a second belt wound around the outside of the belt.

2. The pulse wave sensor according to claim 1, wherein a material having elasticity is used for the first belt.

3. The pulse wave sensor according to claim 2, wherein the pressure applied to the wrist by the first belt is limited to 5 to 15 mmHg.

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(54)【発明の名称】脈波センサ

(57)【特許請求の範囲】
【請求項1】
発光素子と受光素子を具備する検出部と、この検出部と信号線を介して接続された回路部を内蔵するセンサ本体とを備え、前記検出部を人体の手首または前腕部に取り付けて人体の脈波を検出する脈波センサであって、
前記検出部は第１のベルトによって手首または前腕部に固定され、
前記センサ本体は、前記検出部の上部に重ねて配置され、前記第１のベルトの外側に巻き付けられる第２のベルトによって手首または前腕部に固定されることを特徴とする脈波センサ。
【請求項2】
前記第１のベルトは伸縮性を有する素材を使用したことを特徴とする請求項１記載の脈波センサ。
【請求項3】
前記第１のベルトによる手首に加える圧力は、５～１５mmHgに制限したことを特徴とする請求項２記載の脈波センサ。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、人体の脈波を検出する脈波センサに関する。

【背景技術】
【0002】
従来技術として、例えば特開平１１－７００８７号公報に開示された腕時計型脈波検出装置がある。この脈波検出装置は、人体の手首に装着して使用するもので、脈波を検出する検出部と表示部を有するセンサ本体とを有し、センサ本体に取り付けられたバンドを介して検出部を手首の腹側（裏側）に固定し、その検出部で検出された脈波情報を手首の甲側に設けたセンサ本体の表示部に表示することができる。
【発明の開示】
【発明が解決しようとする課題】
【0003】
ところが、手首の腹側には、２本の骨（橈骨と尺骨）が通っているため、手首を動かした時等に、皮膚表面の動きが大きく、検出部が手首の検出部位からずれ易いという問題がある。また、検出部を手首の腹側に固定すると、橈骨や尺骨を圧迫するため、装着感が悪くなる。その結果、無意識に手首を動かすことが多くなり、安定した状態で脈波を検出することが困難となる。本発明は、上記事情に基づいて成されたもので、その目的は、安定した脈波検出ができ、検出確率の高い脈波センサを提供することにある。
【課題を解決するための手段】
【0004】
発光素子と受光素子を具備する検出部と、この検出部と信号線を介して接続された回路部を内蔵するセンサ本体とを備え、検出部を人体の手首または前腕部に取り付けて人体の脈波を検出する脈波センサであって、検出部は第１のベルトによって手首または前腕部に固定され、センサ本体は、検出部の上部に重ねて配置され、第１のベルトの外側に巻き付けられる第２のベルトによって手首または前腕部に固定されることを特徴とする。
【0005】
この構成によれば、センサ本体とは別に検出部を固定する専用のベルト（第１のベルト）を具備しているので、センサ本体の動きが検出部に伝わり難く、検出部で安定した脈波検出ができる。
【0006】
また、第１のベルトは伸縮性を有する素材を使用してもよい。
【0007】
さらに、第１のベルトによる手首に加える圧力は、５～１５ｍｍＨｇに制限するようにしてもよい。
【発明を実施するための最良の形態】
【0008】
次に、本発明の脈波センサの実施例を図面に基づいて説明する。図１は脈波センサの取付け状態を示す断面図である。本実施例の脈波センサ１は、人体の脈波を計測して医療診断や健康診断等に用いるもので、検出部２とセンサ本体３とを有し、図１に示すように、人体の手首４の甲側（背側）に取り付けて使用される。
【0009】
検出部２は、図２に示すように、開口部を有するパッケージ５と、このパッケージ５に収容される発光素子６と受光素子７、及びパッケージ５の開口部に取り付けられる透光板８等より構成される。パッケージ５の内部には、回路基板９が具備され、この回路基板９上に発光素子６（例えばＬＥＤ）と受光素子７（例えばＰＤ）とが並んで組み付けられている。透光板８は、光を透過できる例えばガラス板であり、人体の皮膚に接触する表面側が凸曲面で構成されている（図２参照）。
【0010】
この検出部２は、センサ本体３とは別に、検出部２に取り付けられた専用のベルト１０によって手首４に固定される（図１参照）。ベルト１０は、例えば伸縮性を有する素材を使用して、手首４に一定の圧力が加わるようにしても良い。これにより、透光板８の表面を皮膚表面に密着できるため、皮膚表面からの反射光や外乱光等の侵入を防止できる。但

し、手首４に加える圧力が大きいと、圧迫感が増大して装着感が悪化するため、装着感が悪化しない程度の圧力、例えば５～１５ｍｍＨｇの圧力に制限することが望ましい。

【0011】

なお、検出部２は、図２に示すように、発光素子６と受光素子７とが並んで配置されているため、発光素子６と受光素子７とが並ぶ方向（図２の左右方向）に長く設けられている。この場合、検出部２の長手方向（発光素子６と受光素子７とが並ぶ方向）を手首４の周方向に合わせて配置すると、検出部２のずれが大きくなり、且つ装着感も悪化する可能性があるため、検出部２の長手方向を腕の長手方向に合わせて配置した方が良い。従って、ベルト１０を手首４に巻き付けた時に、検出部２の長手方向が腕の長手方向に合うように、検出部２にベルト１０が取り付けられている。

【0012】

センサ本体３は、図２に示すように、発光素子６を駆動する駆動回路１１および検出部２で検出された脈波情報から脈拍数を算出するマイクロコンピュータ１２等を内蔵するとともに、計測された脈拍数等を表示するモニタ表示部（図示しない）を有し、検出部２とは信号線１３によって接続されている。このセンサ本体３は、腕時計と同様に手首４に装着するもので、図１に示すように、検出部２の上部に重ねて配置し、センサ本体３に取り付けられた専用のベルト１４によって手首４に固定される。但し、検出部２とセンサ本体３との間には、検出部２とセンサ本体３とが直接接触しない様に、例えばスポンジやゲル状タイプの緩衝材１５が挿入されている。

【0013】

ここで、脈波センサ１により脈波を検出するメカニズムについて説明する。図２に示すように、発光素子６から手首４に向かって光が照射されると、光の一部が手首４の内部を通る毛細動脈１６に当たって、毛細動脈１６を流れる血液中のヘモグロビンに吸収され、残りの光が毛細動脈１６で反射して散乱し、その一部が受光素子７に入射する。この時、血液の脈動により毛細動脈１６を流れる血液中のヘモグロビンの量が波動的に変化するので、ヘモグロビンに吸収される光も波動的に変化する。その結果、毛細動脈１６で反射して受光素子７に入射する受光量が変化するため、この受光量の変化を脈波情報として検出することができる。

【0014】

（本実施例の作用及び効果）本実施例の脈波センサ１は、図１に示したように、検出部２を手首４の甲側（背側）に配置して使用するため、手首４の腹側に検出部２を固定した場合と比較して、手首４が動いた時等に検出部２の位置ずれを小さくできる。また、手首４の甲側に検出部２を固定すれば橈骨や尺骨を強く圧迫することがないので、圧迫感により無意識に手首４を動かすことも少なく、検出部位に対し安定して検出部２を固定することができる。更に、手首４の甲側で脈波を測定する場合は、橈骨動脈や尺骨動脈が通っている腹側と比較して受光素子７に入射する受光量（つまり信号強度）は少なくなるが、検出部２の位置ずれに伴う信号強度の変化が小さいため、腹側で測定する場合に比べて体動の影響も小さいと言える。

【0015】

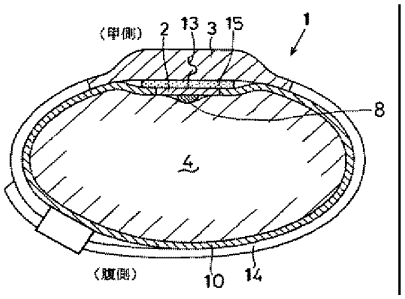
ここで、手首４の甲側で脈波を測定した場合と、手首４の腹側で脈波を測定した場合とで、体動の影響がどの様に現れるかを調べた。その結果、図３に示すように、完全静止している状態では、甲側でも腹側でも脈波を測定することが可能であるが、体動がある状態では、腹側で測定した場合（ｂ）に体動の影響を大きく受けていることが分かる。この場合、脈波の測定は不可能である。これに対し、甲側で測定した場合（ａ）は、腹側と比較して体動の影響が小さく、脈波の測定が可能である。

【0016】

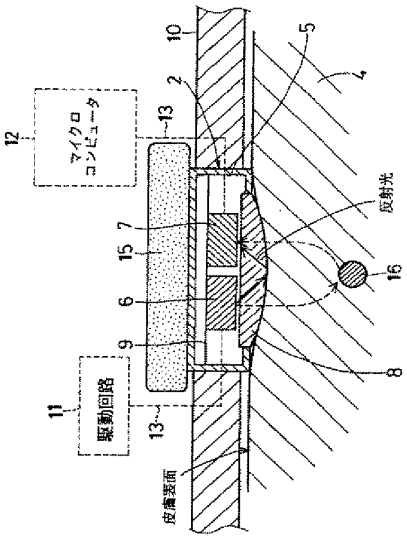
脈波センサ１の検出部２は、透光板８の表面が凸曲面で構成され、その凸曲面を皮膚表面に密着させて使用するため、皮膚表面に対する透光板８の密着度が向上する。これにより、発光素子６から照射された光が皮膚表面で反射して受光素子７に入射する反射光量（図２参照）の変動を抑制でき、且つ外乱光等のノイズの混入も防止できる。また、透光板

８が皮膚表面に食い込むため、検出部２の位置ずれ防止効果を得ることもできる。
【0017】
ここで、表面が凸曲面の透光板８と、平面の透光板８とを用いてそれぞれ脈波を測定した結果を図４に示す。この場合、体動がある状態で脈波を測定した時に、表面が平面の透光板８を用いて測定した場合（ｂ）は、体動の影響を大きく受けているが、表面が凸曲面の透光板８を用いて測定した場合（ａ）は、体動の影響が小さく、脈波の測定が可能であることが分かる。
【0018】
また、本実施例の脈波センサ１は、検出部２とセンサ本体３とをそれぞれ専用のベルト１０、１４で手首４に固定するため、センサ本体３の動きが検出部２に伝わり難く、検出部２を安定的に固定することができる。また、検出部２とセンサ本体３との間に緩衝材１５が挿入されているので、センサ本体３に加わる力やセンサ本体３の動きが検出部２に伝わり難くなる。以上の結果、検出部２を安定して手首４に固定でき、且つ受光素子７に入射するノイズ光量を抑制できることから、安静時のみならず、日常生活や軽い運動時等でも良好なＳ／Ｎ比を得ることができ、検出確率の高い脈波センサ１を提供できる。
【0019】
（変形例）本実施例では、センサ本体３にマイクロコンピュータ１２を内蔵して、脈波数を算出できる構成として説明しているが、検出部２の検出結果を外部の受信機に送信する送信機能だけを持たせても良い。この場合、センサ本体３を小型化でき、センサ本体３の重さを小さくできるので、センサ本体３に加わる力やセンサ本体３の動きを検出部２に伝え難くできる効果がある。本実施例では、検出部２及びセンサ本体３を手首４に装着する例を説明したが、手首４に限定する必要はなく、前腕部の甲側に取り付けても良い。
【図面の簡単な説明】
【0020】
【図1】脈波センサの取付け状態を示す断面図である。
【図2】脈波を検出するメカニズムの説明図である。
【図3】手首の甲側と腹側とで体動の影響を測定した脈波グラフである。
【図4】透光板の表面形状と体動の影響との関係を測定した脈波グラフである。
【符号の説明】
【0021】
１　脈波センサ
２　検出部
３　センサ本体
４　手首
６　発光素子
７　受光素子
８　透光板（透光部材）
１０　ベルト（第１のベルト）
１２　マイクロコンピュータ（回路部）
１３　信号線
１４　ベルト（第２のベルト）
１５　緩衝材

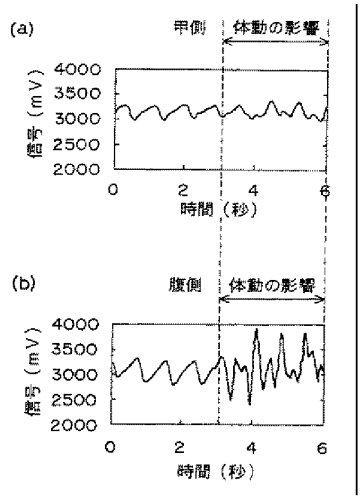
【図1】


（甲側）
2
13
3
15
1
8
4
（腹側）
10
14

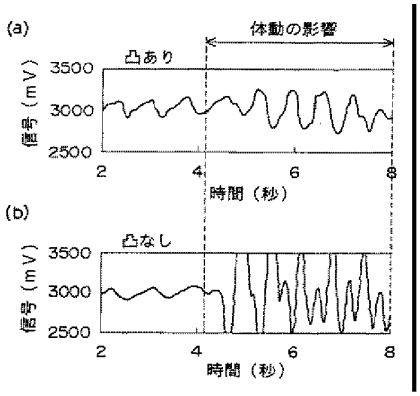
【図2】


10
5
2
4
12
マイクロコンピュータ
13
反射光
7
15
16
6
9
8
11
駆動回路
13
皮膚表面

【図3】


(a)
甲側
体動の影響
信号（mV）
4000
3500
3000
2500
2000
0
2
4
6
時間（秒）
(b)
腹側
体動の影響
信号（mV）
4000
3500
3000
2500
2000
0
2
4
6
時間（秒）

【図4】


(a)
体動の影響
凸あり
信号（mV）
3500
3000
2500
2
4
6
8
時間（秒）
(b)
凸なし
信号（mV）
3500
3000
2500
2
4
6
8
時間（秒）

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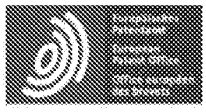
(56)参考文献　特開平１１－２３５３２０（ＪＰ，Ａ）
特開平１１－１１３８６２（ＪＰ，Ａ）
特開平８－２１５１６３（ＪＰ，Ａ）

(58)調査した分野(Int.Cl.，ＤＢ名)
Ａ６１Ｂ　５／０２４５



Espacenet

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PULSE WAVE INFORMATION MEASURING DEVICE

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Abstract of JP2004188224 (A)

PROBLEM TO BE SOLVED: To provide a pulse wave information measuring device of high detection sensitivity and data reliability by improving adhesion performance between a living body surface and a transparent plate. ;SOLUTION: In this pulse wave measuring device of an arm-installed type, the transparent plate 34 is disposed on the surface of an LED 31 and a photo-transistor 32 in a sensor unit 30. An outside surface 341 of the transparent plate 34 to which a finger is pressed is at a position protruded from a reference surface when an outside surface 361 of a sensor frame 36 surrounding the transparent plate 34 is set as the reference surface. Around the transparent plate 34, two human body grounding terminals 38 are disposed to get in contact with the surface of the finger when the finger is tightly applied to the transparent plate 34. The human body grounding terminal 38 is protruded from the reference surface. An outside surface 381 of the human body grounding terminal 38 is at a lower position than the outside surface 341 of the transparent plate 34. ;COPYRIGHT: (C)2004,JPO&NCIPI

Notice

CLAIMS JP2004188224

1.
A light emitting element that emits light toward the surface of the living body, a light receiving element that can receive light reflected from the living body side among the light emitted from the light emitting element, and the light receiving element and the light emitting element disposed on the surface side of the light emitting element A pulse wave signal detection unit including a translucent plate in which the living body surface is in close contact with the outer surface, a data processing unit for obtaining pulse wave information based on a light reception result of the light receiving element, and the data processing unit In the pulse wave information measuring device having a device main body provided with a display unit for displaying the pulse wave information, when the outer surface around the translucent plate in the pulse wave signal detection unit is a reference plane, The pulse wave information measuring apparatus according to claim 1, wherein an outer surface of the translucent plate is located at a position protruding from the reference plane in order to push away stagnant blood.

2.
A light emitting element that emits light toward the surface of the living body, a light receiving element that can receive light reflected from the living body side among the light emitted from the light emitting element, and the light receiving element and the light emitting element disposed on the surface side of the light emitting element A pulse wave signal detection unit including a translucent plate in which the living body surface is in close contact with the outer surface, a data processing unit for obtaining pulse wave information based on a light reception result of the light receiving element, and the data processing unit In the pulse wave information measuring device having a device main body provided with a display unit for displaying the pulse wave information, when the outer surface around the translucent plate in the pulse wave signal

detection unit is a reference plane, The pulse wave information measuring apparatus according to claim 1, wherein the outer surface of the translucent plate is a position protruding from the reference surface of the liquid to push away stagnant blood and a convex face for pushing away stagnant blood.

3.

3. The pulse wave information measuring device according to claim 1, wherein an outer surface of the light transmitting plate is a flat surface.

4.

4. The method according to claim 1, further comprising the step of contacting the living body surface when the light transmitting plate is brought into close contact with the living body surface on the outer surface around the translucent board in the pulse wave signal detection unit. A pulse wave information measuring device comprising: a human body grounding terminal, wherein the outer surface of the human body grounding terminal is located at a position protruding from the reference plane to a position lower than the outer surface of the translucent plate.

5.

The wristband for attaching the apparatus main body to an arm according to any one of claims 1 to 3, and a cable extending from the apparatus main body, wherein the pulse wave signal detection unit is configured as a sensor unit at a distal end portion. And a pulse wave information measuring device having unit fixing means for attaching the sensor unit to the living body so that the outer surface of the translucent plate and the living body surface are in close contact with each other.

Notice

DESCRIPTION JP2004188224

[Objective] To provide a pulse wave information measuring device having high detection sensitivity and high data reliability by enhancing the adhesion between a living body surface and a translucent plate. [Structure] In an arm-mounted pulse wave measuring device, a light transmitting plate 34 is disposed on the surface of an LED 31 and a phototransistor 32 in a sensor unit 30 used therein. The outer surface 341 of the translucent plate 34 against which the finger is pressed is located at a position protruding from the reference surface when the outer surface 361 of the sensor frame 36 surrounding the translucent plate 34 is taken as a reference plane. Around the translucent plate 34 are arranged two human ground terminals 38 that come into contact with the finger surface when the translucent plate 34 and the finger are brought into close contact with each other. The human ground terminals 38 also protrude from the reference plane. ing. However, the outer surface 381 of the human body grounding terminal 38 is at a position lower than the outer surface 341 of the translucent plate 34. [Selection] Figure 6

Pulse wave information measuring device

[0001]
The present invention relates to a pulse wave information measuring device for measuring and displaying pulse wave information such as a pulse rate, and more particularly to a structure technique of the pulse wave signal detection unit.

[0002]

Among the pulse wave information measuring devices that can measure and display pulse wave

information such as the pulse rate, the optical type irradiates light from the LED toward the finger surface, while reflecting light reflected from the finger (blood vessel). By receiving light with a phototransistor, a change in blood volume is detected as a change in the amount of received light, and the pulse rate and the like are measured based on the detection result.

In such a pulse wave information measuring device, as shown in FIGS. 29 (a) and (b), translucent plates 34C and 34D are arranged on the surface side of the LEDs 31C and 31D and the phototransistors 32C and 32D. A pulse wave signal is detected by pressing a finger against the outer surfaces 341C and 341D of the optical plates 34C and 34D. Here, when the peripheries of the translucent plates 34C and 34D are the reference surfaces 361C and 361D, the outer surfaces 341C and 341D of the translucent plates 34C and 34D are on the same plane as the reference surfaces 361C and 361D. Alternatively, it is in a position retracted from the reference surfaces 361C and 361D.

[0003]

However, conventional pulse wave information measurement measures have low detection sensitivity of pulse wave signals, and in particular, there is a problem that sensitivity and data reliability when used while carrying such as monitoring of the pulse rate during running are low. is there. The inventor of the present application examined the reason for this problem, and reached a conclusion that the adhesion between the outer surfaces 341C and 341D of the translucent plates 34C and 34D and the finger was not sufficient.

[0004]

Here, the subject of this invention is providing the pulse wave information measuring device with high detection sensitivity and high reliability of data by improving the adhesiveness of the biological body surface and a translucent board.

[0005]

In order to solve the above problems, the present invention provides a light-emitting element that emits light toward the surface of a living body, a light-receiving element that can receive light reflected from the living body side among light emitted from the light-emitting element, and A pulse wave signal detector disposed on the surface side of the light receiving element and the light emitting element and provided with a translucent plate in which a living body surface is in close contact with an outer surface; and pulse wave information based on a light reception result of the light receiving element In the pulse wave information measuring device, comprising: a data

processing unit for obtaining the pulse wave information; and a device main body including a display unit for displaying the pulse wave information obtained by the data processing unit, the light transmitting plate in the pulse wave signal detecting unit The outer surface of the light-transmitting plate is located at a position protruding from the reference surface in order to push away stagnant blood.

[0006]
Further, in the present invention, a light emitting element that emits light toward the surface of a living body, a light receiving element that can receive light reflected from the living body side among light emitted from the light emitting element, and the light receiving element and the light emitting element A pulse wave signal detector provided with a translucent plate that is disposed on the surface side of the living body and is in close contact with the outer surface, and a data processor that obtains pulse wave information based on the light reception result of the light receiving element, A pulse wave information measuring device having a device main body provided with a display unit for displaying the pulse wave information obtained by the data processing unit, wherein the pulse wave signal detection unit has an outer surface around the translucent plate as a reference The outer surface of the translucent plate is a position protruding from the liquid reference surface to push away stagnant blood and a convex surface for pushing away stagnant blood.

[0007]
In the present invention, the outer surface of the translucent plate can be configured as a flat surface.

[0008]
In the present invention, there is a case where a terminal for grounding a human body is provided on the outer surface of the periphery of the light transmitting plate in the pulse wave signal detecting unit, which contacts the living body surface when the light transmitting plate is brought into close contact with the living body surface. In this case, it is preferable that the outer surface of the human body grounding terminal is in a position protruding from the reference plane to a position lower than the outer surface of the light transmitting plate.

[0009]
In the present invention, a wristband for attaching the apparatus main body to the arm, a cable extending from the apparatus main body and having a pulse wave signal detection unit as a sensor unit at the tip, an outer surface of the translucent plate, and a biological surface If it is provided with a unit fixing means for attaching the sensor unit to the living body so as to be in

close contact with each other, it can be configured as an arm-mounted type pulse wave information measuring device capable of detecting the pulse rate during running.

[0010]

In the pulse wave information measuring device according to the present invention, the outer surface of the light transmissive plate covering the light emitting element and the light receiving element has a structure that protrudes from the surrounding portion of the light transmissive plate in order to push away stagnant blood. The living body surface is in close contact with the entire outer surface of the translucent plate.

In addition, the contact state remains stable even when the force with which the living body pushes the light-transmitting plate changes, such as when used when being carried.

In addition, when the living body is pressed by the amount by which the outer surface of the translucent plate protrudes, the blood staying in the blood vessel is pushed away from this portion. There is little influence.

Therefore, the detection sensitivity of the light receiving element with respect to the pulse wave signal is high, and the reliability of the obtained data is high.

[0011]

When the outer surface of the translucent plate is configured as a flat surface, the living body can be brought into close contact with the entire outer surface of the translucent plate.

On the other hand, when the outer surface of the translucent plate is configured as a convex surface, the living body surface and the outer surface of the translucent plate can be obtained by applying a pressing force to the translucent plate simply by lightly touching the outer surface of the translucent plate. Adhesion can be improved.

[0012]

In the sensor unit, when the outer surface of the human body grounding terminal also protrudes from the surrounding portion, when the living body is pressed against the light transmitting plate, the living body reliably contacts the human body grounding terminal.

Even in this case, since the outer surface of the human body grounding terminal is located at a position lower than the outer surface of the translucent plate, it does not prevent the living body and the outer surface of the translucent plate from coming into close contact with each other.

[0013]

As described above, in the pulse wave information measurement device according to the present invention, the outer surface of the light transmissive plate covering the light emitting element and the light receiving element protrudes from the peripheral portion of the light transmissive plate to push away stagnant blood. It has a configuration.

Therefore, according to this invention, the biological body surface will be in the state closely_contact | adhered to the whole outer surface of a translucent board. In addition, the contact state remains stable even when the force with which the living body pushes the light-transmitting plate changes, such as when used when being carried. In addition, when the living body is pressed by the amount by which the outer surface of the translucent plate protrudes, the staying blood in the blood vessel is pushed away from this portion, so that the signal detected by the light receiving element is less affected by the staying blood. Therefore, the detection sensitivity of the light receiving element with respect to the pulse wave signal is high, and the reliability of the obtained data is high. Furthermore, in order to obtain a stable high sensitivity, the force for pressing the translucent plate against the living body is small, and there is no sense of incongruity when it is worn.

[0014]
When the outer surface of the translucent plate is configured as a flat surface, the living body can be brought into close contact with the entire outer surface of the translucent plate.

[0015]
When the outer surface of the translucent plate is configured as a convex surface, a light

pressure is applied to the translucent plate simply by lightly touching the outer surface of the translucent plate. Adhesion can be increased.

[0016]

In the sensor unit, when the outer surface of the human body grounding terminal also protrudes from the surrounding portion, when the living body is pressed against the light transmitting plate, the living body reliably contacts the human body grounding terminal.

Even in this case, since the outer surface of the human body grounding terminal is located at a position lower than the outer surface of the translucent plate, it does not prevent the living body and the outer surface of the translucent plate from coming into close contact with each other.

[0017]

An embodiment of the present invention will be described with reference to the drawings.

(Whole structure) FIG. 1: is explanatory drawing which shows the use condition of the arm mounting ¦ wearing type pulse wave information measuring device of this example.

[0018]

In FIG. 1, an arm-mounted pulse wave information measuring device 1 (pulse wave information measuring device) of this example includes a device body 10 having a wristwatch structure, a cable 20 connected to the device body 10, and It is mainly composed of a sensor unit 30 (pulse wave signal detection unit) provided on the distal end side. The apparatus main body 10 is provided with a wrist band 12 that is wound around the arm from the twelve o'clock direction of the wristwatch and fixed in the six o'clock direction. With the wrist band 12, the apparatus main body 10 is detachable from the arm. The sensor unit 30 is mounted between the base of the index finger (living body) and the finger joint by a sensor fixing band 40 (unit fixing means). (Configuration of Device Main Body) FIG. 2 is a plan view showing the device main body of the arm-worn pulse wave information measuring device of this example with the wristband, cable, etc. removed, and FIG. 3 is the arm-worn pulse wave information. It is the side view which looked

at the measuring device from the 3 o'clock direction.

[0019]

In FIG. 2, the apparatus main body 10 includes a resin watch case 11 (main body case). On the surface side of the watch case 11, in addition to the current time and date, pulse wave information such as the pulse rate, etc. A liquid crystal display device 13 (display unit) for digitally displaying is displayed. Inside the watch case 11, there is a data processing circuit 50 for performing signal processing on the detection signal in order to display a change in pulse rate on the liquid crystal display device 13 based on the detection result (pulse wave signal) by the sensor unit 30. It is configured. Since the data processing circuit 50 is also configured with a timer circuit, normal time, lap time, split time, and the like can be displayed on the liquid crystal display device 13.

[0020]

On the outer periphery of the watch case 11, button switches 111 to 115 for adjusting the time and switching the display mode are configured. On the surface of the watch case 11, button switches 116 and 117 are configured. The power source of the wrist-worn pulse wave information measuring device 1 is a button-type battery 59 built in the watch case 11, and the cable 20 supplies power from the battery 59 to the sensor unit 30, and The detection result is input to the data processing circuit 50 in the watch case 11.

[0021]

In the arm-mounted type pulse wave information measuring apparatus 1, it is necessary to increase the size of the apparatus main body 10 as the functions thereof are increased. However, since the apparatus main body 10 has a restriction of being attached to the arm, the apparatus main body is limited. 10 cannot be expanded in the direction of 6 o'clock and 12 o'clock on a wristwatch. Therefore, in this example, the device body 10 uses a horizontally-long watch case 11 whose length in the 3 o'clock and 9 o'clock directions is longer than the length in the 6 o'clock and 12 o'clock directions. However, since the wristband 12 is connected at a position biased toward the 3 o'clock direction, when viewed from the wristband 12, the wristband 12 has a large overhanging portion 101 in the 9 o'clock direction. The part is not in the 3 o'clock direction. Therefore, instead of using the horizontally long watch case 11, the wrist can be bent

freely, and the back of the hand does not hit the watch case 11 even if it falls.

[0022]

Inside the watch case 11, a buzzer flat piezoelectric element 58 is arranged at 9 o'clock with respect to the battery 59. Since the battery 59 is heavier than the piezoelectric element 58, the position of the center of gravity of the apparatus main body 10 is offset in the 3 o'clock direction. Since the wristband 12 is connected to the side where the center of gravity is biased, the apparatus main body 10 can be attached to the arm in a stable state. Further, since the battery 59 and the piezoelectric element 58 are arranged in the plane direction, the apparatus main body 10 can be thinned, and by providing a battery lid 118 on the back surface 119 as shown in FIG. The battery 59 can be easily replaced. (Anti-rotation prevention structure of the apparatus main body) In FIG. 3, the connection part 105 for hold | maintaining the stop axis | shaft 121 attached to the edge part of the wristband 12 is formed in the 12 o'clock direction of the timepiece case 11. . In the 6 o'clock direction of the watch case 11, the wristband 12 wound around the arm is folded back at an intermediate position in the length direction, and a receiving portion 106 to which a fastener 122 for holding the intermediate position is attached is formed. Has been.

[0023]

In the 6 o'clock direction of the apparatus main body 10, a portion from the back surface portion 119 to the receiving portion 106 is formed integrally with the watch case 11 and becomes a rotation stop portion 108 that forms an angle of about 115 ° with respect to the back surface portion 119. ing. That is, when the apparatus main body 10 is attached to the upper surface portion L1 (back side of the hand) of the right wrist L (arm) by the wristband 12, the back surface portion 119 of the watch case 11 is attached to the upper surface portion L1 of the wrist L. On the other hand, the rotation stopper 108 abuts against the side face L2 with the rib R. In this state, the back surface portion 119 of the apparatus main body 10 feels to straddle the radius R and the ulna U, while the bent portion 109 between the rotation stop portion 108 and the back surface portion 119 and the rotation stop portion 108 contact the rib R. I feel touched. In this way, the rotation stop portion 108 and the back surface portion 119 form an anatomically ideal angle of about 115 ° , so that the apparatus main body 10 is directed in the direction of arrow A and the apparatus main body 10 is directed to the arrow. Even if it tries to turn in the direction of B, the apparatus main body 10 does not shift further unnecessarily. Further, the rotation of the apparatus main body 10 is only restricted at two positions on one side around the arm by the back surface portion 119 and the rotation stopper portion 108. For this reason, even if the arm is thin, the back surface portion 119 and the rotation stop portion 108 are in contact

with the arm reliably, so that the rotation stop effect can be reliably obtained, but there is no tight feeling even if the arm is thick. (Configuration of Sensor Unit) FIG. 4 is a plan view of the sensor unit used in the arm-mounted type pulse wave information measuring apparatus of this example, FIG. 5 is a cross-sectional view taken along the line II ′ of FIG. 4, and FIG. 4 is a cross-sectional view taken along the line II-II ′ of FIG. 4, and FIG. 7 is a cross-sectional view taken along the line III-III ′ of FIG.

[0024]

In FIG. 4, the sensor unit 30 includes a component storage space 300 inside a sensor frame 36 as a case body, and a circuit board 35 is disposed inside the component storage space 300. Electronic components such as an LED 31, a phototransistor 32, a diode 391, and a transistor 392 are mounted on the circuit board 35. Further, the end of the cable 20 is fixed to the sensor unit 30 by a bush 393, and each wiring of the cable 20 is soldered onto the pattern of the circuit board 35. Here, the sensor unit 30 is attached to the finger so that the cable 20 is pulled out from the base side of the finger to the apparatus main body 10 side. Therefore, the LED 31 and the phototransistor 32 are arranged along the length direction of the finger. Among them, the LED 31 is located on the tip side of the finger, and the phototransistor 32 is located on the base of the finger.

[0025]

As can be seen from FIG. 5, the component storage space 300 is configured by covering the back side of the sensor frame 36 with a back cover 302. A light transmission window is formed by a light transmission plate 34 made of a glass plate on the upper surface portion (substantially pulse wave signal detection unit) of the sensor frame 36, and the circuit board 35 is a component facing the light transmission plate 34. It is fixed in the storage space 300. Therefore, the LED 31 and the phototransistor 32 have the light emitting surface and the light receiving surface directed toward the light transmitting plate 34, respectively. For this reason, when the finger surface is brought into close contact with the outer surface 341 (contact surface / sensor surface with the finger surface) of the translucent plate 34, the LED 31 emits light toward the finger surface, and the phototransistor 32 The light reflected from the finger side among the light emitted from the LED 31 can be received.

[0026]

As shown in FIGS. 5, 6, and 7, when the outer surface 361 of the sensor frame 36 surrounding

the translucent plate 34 is a reference plane, the outer surface 341 of the translucent plate 34 is a reference plane (the sensor frame 36). Of the outer surface 361).

[0027]

Further, as shown in FIG. 6, around the translucent plate 34, two human body grounding terminals 38 that come into contact with the finger surface when the translucent plate 34 and the finger are brought into close contact with each other are attached to the sensor frame by screws 306. It is fixed to 301.

Here, the two human body grounding terminals 38 are arranged on both sides of the light transmitting plate 34 so as to sandwich the light transmitting plate 34. A packing 394 is fitted around the human body grounding terminal 38.

[0028]

Here, the human body grounding terminal 38 also protrudes from the reference plane (the outer surface 361 of the sensor frame 36), as can be seen from FIG. However, the outer surface 381 (contact surface with the finger surface) of the human body grounding terminal 38 is positioned lower than the outer surface 341 of the light transmitting plate 34 when viewed from the reference surface (the outer surface 361 of the sensor frame 36). .

[0029]

In this example, an InGaN-based (indium-gallium-nitrogen-based) blue LED is used as the LED 31, and its emission spectrum has an emission peak at 450 nm as shown in FIG. , In the range from 350 nm to 600 nm. In this example, a GaAsP-based (gallium-arsenic-phosphorous) phototransistor is used as the phototransistor 32 in correspondence with the LED 31 having such light emission characteristics, and the light receiving wavelength region of the element itself is shown in FIG. As shown, the main sensitivity region is in the range from 300 nm to 600 nm, and there is a sensitivity region at 300 nm or less. Here, a sensor unit in which a filter is added to the element may be used as the phototransistor 32. An example of the light receiving wavelength region of such a sensor unit is as shown in FIG. 10, in which the main sensitivity region is from 400 nm to 550 nm. It is in the range.

[0030]

In the sensor unit 30 configured in this manner, as shown in FIG. 11, when the sensor fixing band 40 is attached to the base of the finger, the LED 31 and the phototransistor 32 face the light emitting surface and the light receiving surface toward the finger surface. It becomes a state. In this state, when the LED 31 emits light toward the finger, the phototransistor 32 receives the light reflected from the living body (blood vessel), and the light reception result (pulse wave signal) is transmitted via the cable 20 to the apparatus main body 10. In the apparatus main body 10, the pulse rate is obtained from the pulse wave signal. (Configuration of Data Processing Circuit) That is, in FIG. 12, the pulse wave signal conversion unit 51 in the data processing circuit 50 includes a part of functions of the data processing circuit configured inside the watch case in a block diagram. The signal input from the sensor unit 30 via the cable 20 is converted into a digital signal and output to the pulse wave signal storage unit 52. The pulse wave signal storage unit 52 is a RAM that stores pulse wave data converted into a digital signal. The pulse wave signal calculation unit 53 reads a signal stored in the pulse wave signal storage unit 52, performs frequency analysis on the signal, and inputs the result to the pulse wave component extraction unit 54. The pulse wave component extraction unit 54 extracts a pulse wave component from the input signal from the pulse wave signal calculation unit 53 and outputs the pulse wave component to the pulse rate calculation unit 55. The pulse rate calculation unit 55 receives the frequency of the input pulse wave. The pulse rate is calculated based on the components, and the result is output to the liquid crystal display device 13. (Connection structure between cable and apparatus main body) In the arm-mounted pulse wave information measuring apparatus 1 of this example, as shown in FIG. It can be attached and detached on the surface side of the end located in the hour direction. That is, as shown in FIG. 3, a connector portion 70 is formed on the surface side of the portion extending as the rotation stopper portion 108 in the 6 o'clock direction of the apparatus main body 10, and there is a cable 20. A connector piece 80 configured at the end of the connector can be mounted. Therefore, the connector part 70 is on the near side when viewed from the user and is easy to operate. Further, since the connector part 70 does not protrude from the apparatus main body 10 in the direction of 3 o'clock, the user can freely move the wrist during running and the back of the hand hits the connector part 70 even if it falls during running. Absent.

[0031]

The electrical connection performed in the connector part 70 and the connector piece 80 (connector means) is as shown in FIG.

[0032]

In FIG. 13, terminals 751 to 756 (first terminal group) are configured in the connector portion 70 configured on the apparatus main body 10 side, and connector pieces corresponding to these terminals 751 to 756 are formed. 80 includes electrode portions 831 to 836 (second terminal group).

Among them, the terminal 752 is a positive terminal for supplying the second drive voltage VDD to the LED 31 via the electrode portion 832, the terminal 753 is a terminal that is the negative potential of the LED 31 via the electrode portion 833, and the terminal 754 is The terminal 751 is a terminal for supplying a constant voltage VREG for driving to the collector terminal of the phototransistor 32 via the electrode portion 834. A signal from the emitter terminal of the phototransistor 32 is input to the terminal 751 via the electrode portion 831. The terminal, terminal 755 is a terminal to which a signal for detecting whether or not the connector piece 80 is attached to the connector part 70 via the electrode part 835 is input.

[0033]

The electrode portion 836 is grounded to the human body in the sensor unit 30 via the human body grounding terminal 38 shown in FIGS. 4 and 6, and when the terminal 756 and the electrode portion 836 are electrically connected, VDD Is used as a ground line to shield the electrode portions 831 to 836.

[0034]

In the connector piece 80, the first capacitor C1 and the first switch SW1 are inserted between the terminals of the LED 31 (between the electrode portions 832 and 833).

The switch SW1 is closed when the connector piece 80 is removed from the connector portion 70, and is connected when the first capacitor C1 is connected in parallel to the LED 31 and the connector piece 80 is attached to the connector portion 70. It becomes a state. Similarly, a second capacitor C2 and a second switch SW2 are interposed between the terminals of the phototransistor 32 (electrode portions 831 and 834). This switch SW2 is closed when the connector piece 80 is removed from the connector part 70, and when the second capacitor C2 is connected in parallel to the phototransistor 32 and the connector piece 80 is attached to the connector part 70. Will be open.

[0035]
The structure of the connector part 70 and the connector piece 80 will be described in detail with reference to FIGS.

[0036]
FIG. 14 is an enlarged view showing the configuration of the connector piece formed at the end of the cable, FIG. 15 is an enlarged view of the connector part on the apparatus main body side, and FIG. 16 is a diagram showing the connector piece coupled to the connector part. It is a longitudinal cross-sectional view which shows a state.

[0037]

In FIG. 14, the lower surface portion 801 of the connector piece 80 is formed with a pair of projecting portions 81 and 82 projecting downward on both sides thereof.

At the lower ends of these protrusions 81 and 82, four engagement pieces 811, 812, 821 and 822 (second engagement protrusion group) protrude toward the inside thereof.

[0038]

Six electrode portions 831, 832, 833, 834, 835, and 836 (second terminal group) are formed on the lower surface portion 801 of the connector piece 80, and annular ridge portions 841 and 842 are formed around the electrodes. , 843, 844, 845, 846 are formed.

Here, when the connector piece 80 is attached to the connector portion 70, as described later, after the connector piece 80 is put on the connector portion 70, the connector piece 80 is slid in the direction of the arrow Q. Along the direction of arrow Q), the electrode portions 831 to 836 are formed in two rows of electrode portions 831, 832, and 833 and electrode portions 834, 835, and 836. Moreover, in any row, each electrode part 831-836 is diagonally arrange | positioned so that it may slip | deviate to the direction orthogonal to the sliding direction (direction of arrow Q) of the connector piece 80. FIG.

[0039]

Further, two operation pins 837 and 838 for switching a circuit for preventing the influence of static electricity when the cable 20 is connected to the apparatus main body 10 are formed on the bottom surface of the connector piece 80. These operating pins 837, 838 are in a state where their tips protrude from the lower surface 801 of the connector piece 80 when the connector piece 80 is removed from the connector part 70.

[0040]

On the other hand, as shown in FIG. 15, the connector portion 70 is formed with engaging portions 71, 72, 73, and 74 (first engaging protrusion group) protruding outward. Accordingly, the protrusions 81 and 82 of the connector piece 80 are positioned on the outer sides of the engaging portions 71, 72, 73 and 74 of the connector portion 70, and between the engaging portion 71 and the engaging portion 72. After the connector piece 80 is put on the connector part 70 so that the engaging pieces 811 and 821 of the connector piece 80 are positioned between the joining part 73 and the engaging part 74, the engaging pieces 811 and 821 are engaged. The connector piece 80 is pressed toward the connector part 70 so as to pass between the part 71 and the engaging part 72 and between the engaging part 73 and the engaging part 74, and then in the direction of the arrow Q. When the connector piece 80 is slid, the engaging pieces 811 and 821 are under the engaging portions 71 and 73. Further, the engagement pieces 812 and 822 sink under the engagement portions 72 and 74. As a result, the engagement pieces 811, 821, 812, and 822 hold the engagement portions 71, 72, 73, and 74 between the lower surface portion 801 of the connector piece 80. It is easily and securely attached to the portion 70.

[0041]

In this way, when the connector piece 80 is slid in the direction of the arrow Q on the connector portion 70, the connector piece 80 is slid in the opposite direction (the direction of the arrow R) from this state. The engagement mechanism 700 is configured to release the engagement state. The engagement mechanism having such a configuration is surely engaged although it is a small number of parts. Further, when the connector piece 80 is slid on the connector part 70 from the 6 o'clock direction to the 12 o'clock direction, the force applied to the apparatus main body 10 is such that the apparatus main body 10 is more difficult to rotate by the rotation stopper 108. It is.

Therefore, when the connector piece 80 is mounted, the apparatus main body 10 does not rotate around the wrist, so that the mounting is easy.

[0042]

Here, each of the terminals 751 to 756 has two terminals 751, 752, and 753, and terminals 754, 755, and 756 along the sliding direction of the connector piece 80 (the direction of the arrow Q), similarly to the electrode portions 831 to 836. Formed in rows. In any row, the terminals 751 to 756 are arranged obliquely so as to be shifted in a direction perpendicular to the sliding direction of the connector piece 80 (direction of the arrow Q), like the electrode portions 831 to 836. Therefore, when the connector piece 80 is attached to the connector portion 70, the six terminals 751 to 756 of the connector portion 70 are electrically connected to the six electrode portions 831 to 836 of the connector piece 80, respectively. This measurement result can be input to the apparatus main body 10 via the cable 20.

[0043]

The terminals 751 to 756 and the electrode portions 831 to 836 are arranged in two rows along the sliding direction of the connector piece 80, and are positioned between the terminals and between the electrodes in a direction perpendicular to the sliding direction. Therefore, even if the connector piece 80 is slid on the connector part 70, the non-corresponding terminals 751 to 756 and the electrode parts 831 to 836 do not come into contact with each other. Moreover, even if the formation area of the connector part 70 is narrowed, the terminals and the electrode parts can be arranged at positions away from each other, so even when water enters between the connector piece 80 and the connector part 70, Difficult to short between electrodes. In addition, since the terminals 752, 754, and 756 and the electrode portions 832, 834, and 836 to which the driving voltage is applied are arranged so as to be separated from each other, tracking is performed between terminals of different potentials and between the electrode portions. Does not occur. (Configuration of Stopper Mechanism) As can be seen from FIG. 15, the engaging portions 71 to 74 are formed with vertical walls 711, 721, 731, and 741 on the side in the direction of the arrow Q. Accordingly, when the connector piece 80 is attached to the connector portion 70 and the connector piece 80 is slid in the direction of the arrow R (second operation), the engagement pieces 811, 812, 821, 822 become the vertical walls 711, 721, 731 and 741, respectively, and the connector piece 80 is stopped at the mounting position of the connector portion 70. That is, the vertical walls 711, 721, 731, and 741 function as a first stopper for the connector piece 80. Conversely, when the connector piece 80 is slid in the direction of the arrow R in order to remove it from the connector portion 70, the engagement pieces 811 and 821 abut

against the back sides of the vertical walls 721 and 741 of the engagement portions 72 and 74, respectively. The connector piece 80 stops the connector part 70 at the original position. That is, the back sides of the vertical walls 721 and 741 function as a second stopper for the connector piece 80. (Structure of Terminal and Electrode Portion) In the connector portion 70, all of the terminals 751 to 756 are disposed in holes 761, 762, 763, 764, 765, and 766 formed in the connector portion 70, of which FIG. 16 shows a cross section of the terminal 753, 756, the operating pin 838, and the electrode portions 833, 836 cut at positions passing through the formation positions.

[0044]

In FIG. 16, the connector piece 80 has a structure in which a cover member 806 is covered on an exterior case 805 that can accommodate a circuit board 85 therein. Holes 863 and 866 are formed in the lid member 806, and annular ridges 843 and 846 are formed along the opening edge on the lower side. Electrode portions 833 and 836 are arranged inside the holes 863 and 866, respectively. The electrode portion 833 is fixed by a screw 881, and the electrode portion 836 is fixed by being sandwiched between the circuit board 85 and the lid member 806. Waterproof packings 873 and 876 are attached to the electrode portions 833 and 836. The electrode portions 833 and 836 are electrically connected on the circuit pattern of the circuit board 85 disposed inside the connector piece 80. This electrode structure is the same for the electrode portions 831, 832, 834, and 835 other than the electrode portions 833 and 836. Note that the core wire of the cable 20 is also electrically connected to the circuit pattern of the circuit board 85 by soldering. (Configuration of Click Mechanism) The connector portion 70 has a structure in which a lid member 706 is covered in the concave portion. Holes 763 and 766 are formed in the lid member 706. Inside these holes 763, 766, the terminals 753, 756 are arranged as advancement / retraction pins that can be advanced / retracted so that their tips protrude from the holes 763, 766. Coil springs 773 and 776 are disposed on the flange portions 783 and 786 formed on the base side of the terminals 753 and 756, and the terminals 753 and 756 have holes 763 by the coil springs 773 and 776. , 766 is biased toward the direction protruding from 766. However, since the outer diameters of the flanges 783 and 786 are larger than the inner diameters of the holes 763 and 766, the terminals 753 and 756 do not come out of the holes 763 and 766. This terminal structure is the same for the terminals 751, 752, 754, and 755 other than the terminals 753 and 756.

[0045]

When the connector piece 80 is mounted on the connector portion 70, the terminals 753 and

756 are connected to the annular protrusions 843 and 846 of the connector piece 80 by coil springs 773 and 776 in order to slide the connector piece 80 on the connector portion 70. It overcomes while being urged by and is securely connected to the electrode portions 833 and 836. In addition, since the click mechanism is configured by using the protrusions 843 and 846, the terminals 753 and 756, and the coil springs 773 and 776 as they are, the connector piece 80 can be reliably attached to the connector part 70. In order to configure such a click mechanism, conversely to this example, a terminal using an advancing / retreating pin may be provided on the connector piece 80 side, and a protrusion may be provided on the connector part 70 side. (Configuration of Switch Mechanism) A hole 868 is formed in the cover member 806 of the connector piece 80, and an operation pin 838 is disposed in the hole 838. The operating pin 838 is in a state where it can advance and retreat inside the hole 868 so that its tip protrudes from the hole 868. A leaf spring-like switch spring 88 is disposed on the flange 898 formed at the base of the operating pin 838. The switch spring 88 urges the operating pin 838 toward the direction protruding from the hole 868 by the tip end portion 885 thereof. However, since the outer diameter of the flange 898 is larger than the inner diameter of the hole 868, the operating pin 838 does not come out of the hole 868. The base of the switch spring 88 is fixed to the upper end surface of the electrode portion 833 with a screw 881 and is electrically connected to the electrode portion 833. Here, although not shown in the drawing, the tip end portion 885 of the switch spring 88 is formed with a contact portion that comes into contact with the base portion of the operating pin 838 and a contact point that is formed on a portion protruding laterally therefrom. Yes. This contact is electrically connected to the circuit pattern of the circuit board 85, and the circuit pattern is interposed between the first capacitor C1 and the electrode portion 833.

[0046]

Therefore, in a state where the connector piece 80 is not attached to the connector part 70, as shown by a solid line in FIG. 16, the operating pin 838 is pushed by the switch spring 88 and the tip protrudes from the hole 868. In FIG. The switch SW1 is closed and the first capacitor C1 is in electrical connection with the LED 31 in parallel. Therefore, even if a high potential due to static electricity touches the electrode portions 832 and 833, the charge is accumulated in the first capacitor C1, so that the LED 31 is not damaged. On the other hand, when the connector piece 80 is attached to the connector portion 70, the operating pin 838 moves in the direction of retracting into the hole 868 as shown by a two-dot chain line in FIG. Deform as shown in. As a result, in FIG. 13, since the first switch SW1 is in an open state, a circuit configuration capable of measuring a pulse wave is obtained. At this time, even if charges are accumulated in the first capacitor C1, each charge built in the connector unit 70 and the apparatus main body 10 via the electrode units 832 and 833 and the terminals 752 and 753 is stored in this circuit. Does not discharge.

[0047]

Although the switch mechanism is also configured in the phototransistor 32, the configuration is the same as the switch mechanism for the LED 31, and thus the description thereof is omitted. (Operation) The operation of the arm-mounted pulse wave information measuring apparatus 1 configured as described above will be briefly described with reference to FIGS.

[0048]

First, in FIG. 1, when the arm-mounted pulse wave information measuring device 1 is used as a normal wristwatch, the cable 20 and the sensor unit 30 are disconnected at the connector portion 70 of the device main body 10, Install the connector cover. As this connector cover, one having the same configuration as the connector piece 80 can be used. However, the electrode cover or the like is not necessary for the connector cover. When measuring the pulse rate during running using the arm-mounted pulse wave information measuring device 1, the connector piece 80 is attached to the connector portion 70, the cable 20 is connected to the device main body 10, and then the device main body 10. Is worn on the wrist with the wristband 12. Further, running is performed in a state where the sensor unit 30 is in close contact with the base of the finger by the sensor fixing band 40. As described above, when the sensor unit 30 is attached to the base of the finger, the cable 20 can be shortened, so the cable 20 does not get in the way during running. Further, when the distribution of the body temperature from the palm to the fingertip is measured, the temperature of the fingertip is remarkably lowered when it is cold, but the temperature at the base of the finger is not relatively lowered. Therefore, if the sensor unit 30 is attached to the base of the finger, the pulse rate and the like can be accurately measured even when running outdoors on a cold day.

[0049]

In this state, as shown in FIG. 11, when light is emitted from the LED 31 toward the finger, the light reaches the blood vessel, and a part of the light is absorbed by hemoglobin in the blood, and a part of the light is reflected. The light reflected from the finger (blood vessel) is received by the phototransistor 32, and the change in the amount of received light corresponds to the change in blood volume (blood pulse wave). That is, when the blood volume is large, the reflected light becomes weak, while when the blood volume decreases, the reflected light becomes strong.

Therefore, if a change in the reflected light intensity is detected, the pulse rate and the like can be measured. In order to perform such measurement, the data processing circuit 50 shown in FIG. 12 converts the signal input from the phototransistor 32 (sensor unit 30) into a digital signal, performs frequency analysis on the digital signal, and the pulse rate. Is calculated. Then, the pulse rate obtained by the calculation is displayed on the liquid crystal display device 13.

[0050]

In FIG. 11, a part of the light emitted from the LED 31 reaches the blood vessel through a finger as indicated by an arrow C, and a phototransistor 32 such that reflected light from hemoglobin in the blood is indicated by an arrow D. To reach. Note that a part of the light emitted from the LED 31 is reflected by the finger surface as indicated by an arrow E and reaches the phototransistor 32. Further, as shown by arrows F and G, part of the light emitted from the LED 31 and the light reflected from the blood vessel is absorbed or dispersed in the finger and does not reach the phototransistor 32.

[0051]

In this example, an LED 31 having an emission wavelength region in the range from 350 nm to 600 nm and a phototransistor 32 having a light reception wavelength region in the range from 300 nm to 600 nm are used, and the overlapping region is from about 300 nm to about 600 nm. The biological information is displayed based on the detection result in the wavelength region. Using such a sensor unit 30, even when external light is exposed to the finger, light having a wavelength region of 700 nm or less out of the light included in the external light is transmitted to the phototransistor 32 (light receiving unit) using the finger as a light guide. Not reach.

[0052]

The reason will be described with reference to FIG. FIG. 17A is a graph showing the relationship between the wavelength of light and the light transmittance of the skin. A broken line a is a transmission characteristic in light having a wavelength of 200 nm, and a broken line b is transmitted in light having a wavelength of 300 nm. Characteristics, a broken line c indicates transmission characteristics for light having a wavelength of 500 nm, a broken line d indicates transmission characteristics for light having a wavelength of 700 nm, and a broken line e indicates transmission characteristics for light having a wavelength of 1 μ m. As is apparent from

this figure, among the light included in the external light, the light having a wavelength region of 700 nm or less tends to hardly pass through the finger, and thus the external light is not covered with the sensor fixing band 40. Even if the portion is irradiated, as shown by the dotted line X in FIG. 11, it does not reach the phototransistor 32 through the finger. On the other hand, when an LED having an emission peak near 880 nm and a silicon phototransistor are used, the light receiving wavelength range extends from 350 nm to 1200 nm. That is, as indicated by an arrow Y in FIG. 11, a detection result by light having a wavelength of 1 μm (light indicated by a broken line e in FIG. 17A) that can easily reach the light receiving unit using a finger as a light guide. If a pulse wave is detected based on the above, false detection due to fluctuations in external light is likely to occur.

[0053]
From the viewpoint of obtaining pulse wave information without being affected by external light, for example, as shown in FIG. 18, a GaP-based LED having a main light emitting region in the range from 540 nm to 570 nm, and light receiving As shown in FIG. 19 for the sensitivity characteristics, a GaP phototransistor having a sensitivity region in a range from 200 nm to nearly 700 nm may be used.

[0054]

Furthermore, since the pulse wave information is obtained using light in the wavelength region from about 300 nm to about 700 nm, the S / N ratio of the pulse wave signal based on the blood volume change is high.

That is, in FIG. 17 (b), the hemoglobin in blood is represented by the curve Hb, and the hemoglobin in the blood is represented by the curve HbO2. The absorption coefficient for light having a wavelength of 300 nm to 700 nm is large, and is several times to about 100 times or more larger than the absorption coefficient for light having a wavelength of 880 nm as conventional detection light. Therefore, as shown in this example, when light in a wavelength region (300 nm to 700 nm) having a large extinction coefficient is used as detection light in accordance with the light absorption characteristics of hemoglobin, the detection value changes with high sensitivity to changes in blood volume. The pulse wave detection rate (S / N ratio) based on blood volume change is high. (Main effects of the embodiment) In this way, the arm-mounted pulse wave information measuring apparatus 1 of this example is convenient to carry, such as being able to measure the pulse rate during running, as well as sensitivity and measurement results. High reliability. That is, as shown in FIG. 20A, in the sensor unit 30 of the present example, the outer surface 341 of the translucent plate 34 is at a position protruding

from the reference plane (the outer surface 361 of the sensor frame 36). The finger surface is in close contact with the entire outer surface 341 of the translucent plate 34. Further, in this state, even if the position of the finger is slightly shifted, the state remains in close contact with the entire outer surface 341 of the translucent plate 34. On the other hand, as shown in FIG. 20B, in the conventional structure, the outer surface 31D of the translucent plate 34D is retracted, so that even if the finger is put on the translucent plate 34D, the translucent plate 34D The corner cannot be covered. As described above, the pulse wave signal cannot be detected in the corner portion that is not covered with the finger because the air layer is interposed. Further, in the conventional structure, even if the finger position is slightly shifted, an air layer is interposed over a wide range between the translucent plate 34D and the finger, so when the finger moves while carrying, Sensitivity is significantly reduced.

[0055]

Furthermore, in the sensor unit 30 of the present example, as shown in FIG. 21, the blood staying in the blood vessel (indicated by white circles in FIG. 21), as the outer surface 341 of the translucent plate 34 protrudes.) To the side, it can be said that the influence of the staying blood is small. That is, the signal detected by the phototransistor 32 includes a signal component due to staying blood and a signal component due to flowing blood, and the pulse rate is obtained from the signal component due to flowing blood. On the other hand, since the signal component due to the staying blood is the background (noise) of the detected signal, it is more sensitive to measure in the state where the staying blood is pushed away as in this example. I can say that.

[0056]
Such an effect can be confirmed from the examination results shown in FIGS.

[0057]

First, in FIG. 22 and FIG. 23, as shown in FIG. 20B, in the sensor unit (conventional example) in which the outer surface 341D of the translucent plate 34D is retracted 0.2 mm from the reference surface, The result of evaluating the relationship between the weight (pressing force) on the AC and the levels of the AC components (solid lines P1, P3) and DC components (solid lines P2, P4) included in the detected signal is shown.

Here, FIG. 22 and FIG. 23 show the results of two experiments among the repeated experiments.

[0058]

In this evaluation, the alternating current component (AC) is a signal based on the blood flow in the blood vessel, and corresponds to a pulse wave signal. On the other hand, the direct current component (DC) is a signal based on disturbance or other causes. Therefore, it can be said that the sensitivity is higher as the ratio of the AC component in the detected signal is larger.

[0059]

Therefore, the ratio of the AC component to the DC component is obtained based on the result shown in FIG. 22, and the relationship between this ratio and the weight on the finger surface of the sensor unit is shown in FIG.

[0060]

As a result, in the sensor unit according to the comparative example, as shown in FIGS. 22 and 23, the AC component level is as low as around 6 mV even when a large weight is applied.

As shown in FIG. 24, the ratio of the AC component to the DC component does not increase unless a weight of about 110 gf or more is applied.

[0061]

On the other hand, in FIG. 25 and FIG. 26, as shown in FIG. 20A, in the sensor unit 30 (example) having a structure in which the outer surface 341 of the light transmitting plate 34 is projected by 0.25 mm from the reference plane, The relationship between the weight (pressing force) on the finger surface and the AC components (solid lines P5 and P7) and DC components (solid lines P6 and P8) included in the detected signal is shown. 25 and 26 show the results of two experiments among the repeated experiments. Further, the ratio of the AC component to the DC component is obtained based on the result shown in FIG. 25, and the relationship between this ratio and the weight on the finger surface of the sensor unit 30 is shown in FIG.

[0062]

As a result, in the sensor unit 30 of this example, as shown in FIGS. 25 and 26, the level of the AC component reaches 7 mV or more only by applying a relatively small weight, and the level is stable. . Moreover, as shown in FIG.25 and FIG.27, if the weight of 30gf-230gf was applied, it has also confirmed that the ratio of the alternating current component with respect to a direct current component was large and stable, ie, the sensitivity was high.

[0063]

Therefore, unlike the conventional sensor unit, the sensor unit 30 of this example requires a small force to press the sensor unit 30 against the finger in order to obtain a stable and high sensitivity. There is no.

[0064]

Furthermore, in the sensor unit 30 of the present example, as shown in FIG. 20A, the outer surface 381 of the human body grounding terminal 38 protrudes from the reference surface (the outer surface 361 of the sensor frame 36). Reliably contacts the human body grounding terminal 38.

Even in this case, the outer surface 381 of the human body grounding terminal 38 is located at a position lower than the outer surface 341 of the translucent plate 34, so that the finger surface is prevented from coming into close contact with the outer surface 341 of the translucent plate 34. Absent.

[0065]

In addition, since the human body grounding terminals 38 are disposed on both sides of the translucent plate 34 so as to sandwich the translucent plate 34, even if the finger is slightly displaced from the translucent plate 34, the finger and the human body grounding terminal 38 are reliably in contact with each other. It remains. Other Embodiments In this example, the outer surface 341 of the translucent plate 34 is a flat surface. Instead, as shown in FIG. 28, an outer surface 341A of the translucent plate 34A is used. You may comprise on a convex surface. In this case, since the pressing force is applied to the light transmitting plate 34A only by lightly

touching the outer surface 341A of the light transmitting plate 34A, the adhesion between the finger surface and the outer surface 341A of the light transmitting plate 34A is improved. Can be increased.

[0066]
In this example, since it is an arm-mounted type, the sensor unit 30 (pulse wave signal detection unit) is provided at the tip of the cable 20, but the pulse wave signal detection unit is integrated with the surface portion of the apparatus body 10 itself. You may comprise.

[0067]
Further, in this example, the pulse wave is measured on the finger surface. However, even if the pulse wave is measured on other surface parts of the living body, for example, the skin surface such as the wrist and the earlobe, the same effect as in this example is obtained.

[0068]

BRIEF DESCRIPTION OF THE DRAWINGS Explanatory drawing which shows the whole structure of the arm mounting | wearing type pulse wave information measuring device which concerns on one Example of this invention, and a use condition.

The top view of the apparatus main body of an arm wearing type pulse wave information measuring device.

Explanatory drawing when the apparatus main body of an arm wearing type pulse wave information measuring device is seen from the direction of time. The top view of the sensor unit used for the arm wearing type pulse wave information measuring device. Sectional drawing in the II 'line of FIG. Sectional drawing in the II-II 'line | wire of FIG. Sectional drawing in the III-III 'line of FIG. Explanatory drawing which shows the emission spectrum of InGaN-type blue LED used for the arm mounting | wearing type pulse wave information measuring device. Explanatory drawing which shows the light reception characteristic of the InGaP type phototransistor used for the arm mounting | wearing type pulse wave information measuring device. Explanatory drawing which shows the light reception characteristic of the phototransistor unit with a filter used for the arm mounting | wearing type pulse wave information measuring device. Explanatory drawing which shows the state which mounted | wore the finger | toe with the sensor unit used for the arm mounting | wearing type pulse wave information measuring device. The block

diagram which shows the function of the data processing circuit of an arm mounting | wearing type pulse wave information measuring device. Explanatory drawing which shows the electrical connection relationship in the connector part of an arm mounting | wearing type pulse wave information measuring device. Explanatory drawing which shows the structure of the connector piece used for the connector part of an arm mounting | wearing type pulse wave information measuring device. Explanatory drawing which shows the structure of the connector part used for the connector part of an arm mounting | wearing type pulse wave information measuring device. Sectional drawing which shows the state which mounted | wore the connector part shown in FIG. 15 with the connector piece shown in FIG. (A) is a graph which shows the relationship between the wavelength of light and the light transmittance of skin, (b) is explanatory drawing which shows the relationship between the wavelength of light and the light absorption characteristic of various hemoglobin. It is explanatory drawing which shows the emission spectrum of GaP type LED which can be used for an arm mounting | wearing type pulse wave information measuring device. It is explanatory drawing which shows the light reception characteristic of the GaAsP type phototransistor which can be used for an arm mounting | wearing type pulse wave information measuring device. It is explanatory drawing for demonstrating the effect which improves the adhesiveness of a finger and a translucent board in the sensor unit of an arm mounting | wearing type pulse wave information measuring device. It is explanatory drawing for demonstrating the effect which makes the influence of a staying blood small from the signal which a phototransistor detects in the sensor unit of an arm mounting | wearing type pulse wave information measuring device. As a comparative example of the wrist-worn pulse wave information measuring device, in a sensor unit having a structure in which a translucent plate is retracted 0.2 mm from the reference surface, the pressing force of the sensor unit on the finger and the alternating current detected by the phototransistor It is a graph which shows the result of having evaluated the relationship with the magnitude | size of a signal and a DC signal. Among the arm-mounted pulse wave information measuring devices, as a comparative example, in a sensor unit having a structure in which a translucent plate is retracted 0.2 mm from the reference surface, it is obtained from another experiment performed with the same contents as the evaluation shown in FIG. 4 is a graph showing the results (relationship between the pressing force of the sensor unit on the finger and the magnitudes of the AC signal and the DC signal detected by the phototransistor).

It is a graph which shows the result of having calculated | required the relationship between the pressing force of the sensor unit to a finger | toe, and the ratio with respect to the direct current signal of the alternating current signal which the phototransistor detected from the result shown in FIG. As an example of the wrist-worn pulse wave information measuring device, in the sensor unit having a structure in which the translucent plate protrudes from the reference plane by 0.25 mm, the pressing force of the sensor unit on the finger and the alternating current detected by the phototransistor It is a graph which shows the relationship between the magnitude | size of a signal and a DC signal. As an example of the arm-mounted type pulse wave information

measuring device, the sensor unit having a structure in which the light transmitting plate protrudes from the reference plane by 0.25 mm is obtained from another experiment performed with the same content as the evaluation shown in FIG. 4 is a graph showing the results (relationship between the pressing force of the sensor unit on the finger and the magnitudes of the AC signal and the DC signal detected by the phototransistor). It is a graph which shows the result of having calculated ¦ required the relationship between the pressing force of the sensor unit to a finger ¦ toe, and the ratio with respect to the direct current signal of the alternating current signal which the phototransistor detected from the result shown in FIG. It is sectional drawing of another sensor unit used for the arm mounting ¦ wearing type pulse wave information measuring device. (A) is sectional drawing of the sensor unit used for the conventional pulse-wave information measuring apparatus, (b) is sectional drawing of another sensor unit.

Explanation of symbols

[0069]

1. Pulse wave information measuring device, 10. Device body, 12. Wristband, 13. Liquid crystal display device (display unit), 20. Cable, 30. Sensor unit (pulse wave signal detection unit), 31. LED, 32. Phototransistor, 34 / translucent plate, 36 / sensor frame, 38 / terminal for grounding human body, 40 / band for sensor fixing (unit fixing means), 50 / data processing circuit, 70 / connector part, 80 / connector piece, 300 -Parts storage space, 341-Outer surface of translucent plate (contact surface with finger surface), 361-Outer surface of sensor frame (reference surface), 381-Outer surface of human body grounding terminal (contact surface with finger surface))

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(54)【発明の名称】脈波情報計測装置

(57)【特許請求の範囲】
【請求項1】
生体表面に向けて光を発する発光素子、前記発光素子が発した光のうち生体の側から反射してくる光を受光可能な受光素子、及び前記受光素子及び前記発光素子の表面側に配置され、外側表面に生体表面が密着した状態とされる透光板を備える脈波信号検出部と、前記受光素子の受光結果に基づいて脈波情報を求めるデータ処理部と、前記データ処理部が求めた前記脈波情報を表示するための表示部を備える装置本体とを有する脈波情報計測装置において、
前記脈波信号検出部における前記透光板の周囲の外側表面を基準面としたときに、前記透光板の外側表面は、滞留血を押し退けるために前記基準面から突出した位置にあり、
さらに、前記脈波信号検出部における前記透光板の周囲の外側表面には、前記透光板を生体表面に密着させたときに生体表面に接触する人体アース用端子を有し、前記人体アース用端子の外側表面は、前記透光板の外側表面より低い位置まで前記基準面から突出した位置にあることを特徴とする脈波情報計測装置。
【請求項2】
請求項１において、前記透光板の外側表面は、平坦面であることを特徴とする脈波情報計測装置。
【請求項3】
請求項１または２のいずれかの項において、さらに、前記装置本体を腕に取り付けるためのリストバンドと、前記装置本体から延び、先端部に前記脈波信号検出部がセンサユニッ

トとして構成されたケーブルと、前記透光板の外側表面と生体表面とが密着した状態となるように前記センサユニットを生体に取り付けるためのユニット固定手段と有することを特徴とする脈波情報計測装置。

【発明の詳細な説明】

【技術分野】

【0001】

本発明は、脈拍数などの脈波情報を計測、表示するための脈波情報計測装置に関するものであり、更に詳しくは、その脈波信号検出部の構造技術に関するものである。

【背景技術】

【0002】

脈拍数などの脈波情報を計測、表示可能な脈波情報計測装置のうち、光学式のものでは、ＬＥＤから指表面に向けて光を照射する一方、指（血管）から反射してきた光をフォトトランジスタで受光することにより、血量変化を受光量の変化として検出し、その検出結果に基づいて脈拍数などを計測するようになっている。このような脈波情報計測装置では、図２９（ａ）、（ｂ）に示すように、ＬＥＤ３１Ｃ、３１Ｄ、及びフォトトランジスタ３２Ｃ、３２Ｄの表面側に透光板３４Ｃ、３４Ｄが配置され、この透光板３４Ｃ、３４Ｄの外側表面３４１Ｃ、３４１Ｄに指を押し当てて脈波信号を検出する。ここで、透光板３４Ｃ、３４Ｄの周囲を基準面３６１Ｃ、３６１Ｄとしたときに、透光板３４Ｃ、３４Ｄの外側表面３４１Ｃ、３４１Ｄは、この基準面３６１Ｃ、３６１Ｄと同一面上にあるか、あるいは、基準面３６１Ｃ、３６１Ｄよりも引っ込んだ位置にある。

【発明の開示】

【発明が解決しようとする課題】

【0003】

しかしながら、従来の脈波情報計測措置では、脈波信号の検出感度が低く、特に、ランニング中の脈拍数の監視など、携帯しながら用いたときの感度やデータの信頼性が低いという問題点がある。かかる問題点について、本願発明者は、その理由を検討したところ、透光板３４Ｃ、３４Ｄの外側表面３４１Ｃ、３４１Ｄと指との密着性が十分でないという結論に到達した。

【0004】

ここに、本発明の課題は、生体表面と透光板との密着性を高めることによって、検出感度やデータの信頼性が高い脈波情報計測装置を提供することにある。

【課題を解決するための手段】

【0005】

上記の課題を解決するために、本発明では、生体表面に向けて光を発する発光素子、該発光素子が発した光のうち生体の側から反射してくる光を受光可能な受光素子、及び該受光素子及び前記発光素子の表面側に配置され、外側表面に生体表面が密着した状態とされる透光板を備える脈波信号検出部と、前記受光素子の受光結果に基づいて脈波情報を求めるデータ処理部と、該データ処理部が求めた前記脈波情報を表示するための表示部を備える装置本体とを有する脈波情報計測装置において、

前記脈波信号検出部における前記透光板の周囲の外側表面を基準面としたときに、前記透光板の外側表面は、滞留血を押し退けるために前記基準面から突出した位置にあり、

さらに、前記脈波信号検出部における前記透光板の周囲の外側表面には、該透光板を生体表面に密着させたときに生体表面に接触する人体アース用端子を有し、該人体アース用端子の外側表面は、前記透光板の外側表面より低い位置まで前記基準面から突出した位置にあることを特徴とする。

【0007】

本発明において、透光板の外側表面は、平坦面で構成することができる。

【0009】

本発明において、さらに、装置本体を腕に取り付けるためのリストバンドと、装置本体から延び、先端部に脈波信号検出部がセンサユニットとして構成されたケーブルと、透光

板の外側表面と生体表面とが密着した状態となるようにセンサユニットを生体に取り付けるためのユニット固定手段と設ければ、ランニング中の脈拍数などを検出できる腕装着型脈波情報計測装置として構成できる。

【0010】

本発明に係る脈波情報計測装置において、発光素子及び受光素子を覆う透光板の外側表面は、滞流血を押し退けるために透光板の周囲の部分よりも突出した構造になっているため、生体表面は、透光板の外側表面の全体に密着した状態となる。また、携帯時に用いたときなど、生体が透光板を押す力が変化しても、密着状態は安定したままである。しかも、透光板の外側表面が突出している分だけ、生体を押し当てたとき、血管中で滞留している血をこの部分から押し退けるため、受光素子で検出した信号には、滞留する血の影響が少ない。それ故、受光素子の脈波信号に対する検出感度が高いとともに、得られたデータの信頼性が高い。

【0011】

透光板の外側表面を平坦面で構成した場合には、生体を透光板の外側表面全体に均等に密着させることができる。一方、透光板の外側表面を凸面に構成した場合には、透光板の外側表面に軽く生体を当てるだけで、透光板に押圧力がかかるので、生体表面と透光板の外側表面との密着性を高めることができる。

【0012】

センサユニットにおいて、人体アース用端子の外側表面もその周囲の部分から突出している場合には、生体を透光板に押し当てたとき、生体は人体アース用端子に確実に接触する。この場合でも、人体アース用端子の外側表面は、透光板の外側表面よりも低い位置にあるので、生体と透光板の外側表面とが密着するのを妨げない。

【発明の効果】

【0013】

以上説明したように、本発明に係る脈波情報計測装置において、発光素子及び受光素子を覆う透光板の外側表面は、滞流血を押し退けるために透光板の周囲の部分よりも突出している構成を有する。従って、本発明によれば、生体表面は、透光板の外側表面の全体に密着した状態となる。また、携帯時に用いたときなど、生体が透光板を押す力が変化しても、密着状態は安定したままである。しかも、透光板の外側表面が突出している分だけ、生体を押し当てたとき、血管中の滞留血をこの部分から押し退けるため、受光素子で検出した信号には、滞留血の影響が少ない。それ故、受光素子の脈波信号に対する検出感度が高いとともに、得られたデータの信頼性が高い。さらに、安定した高い感度を得るにも、生体に対して透光板を押し当てる力が小さくて済み、装着したときの違和感がない。

【0014】

透光板の外側表面を平坦面で構成した場合には、生体を透光板の外側表面全体に均等に密着させることができる。

【0015】

透光板の外側表面を凸面に構成した場合には、透光板の外側表面に軽く生体を当てるだけで、透光板に押圧力がかかるので、生体表面と透光板の外側表面との密着性を高めることができる。

【0016】

センサユニットにおいて、人体アース用端子の外側表面もその周囲の部分から突出している場合には、生体を透光板に押し当てたとき、生体は人体アース用端子に確実に接触する。この場合でも、人体アース用端子の外側表面は、透光板の外側表面よりも低い位置にあるので、生体と透光板の外側表面とが密着するのを妨げない。

【発明を実施するための最良の形態】

【0017】

図面に基づいて、本発明の一実施例を説明する。

（全体構成）

図１は、本例の腕装着型脈波情報計測装置の使用状態を示す説明図である。

【0018】
図１において、本例の腕装着型脈波情報計測装置１（脈波情報計測装置）は、腕時計構造を有する装置本体１０と、この装置本体１０に接続されるケーブル２０と、このケーブル２０の先端側に設けられたセンサユニット３０（脈波信号検出部）とから大略構成されている。装置本体１０には、腕時計における１２時方向から腕に巻きついてその６時方向で固定されるリストバンド１２が設けられ、このリストバンド１２によって、装置本体１０は、腕に着脱自在である。センサユニット３０は、センサ固定用バンド４０（ユニット固定手段）によって人差し指（生体）の根元から指関節までの間に装着されている。
（装置本体の構成）
図２は、本例の腕装着型脈波情報計測装置の装置本体を、リストバンドやケーブルなどを外した状態で示す平面図、図３は、腕装着型脈波情報計測装置を３時の方向からみた側面図である。
【0019】
図２において、装置本体１０は、樹脂製の時計ケース１１（本体ケース）を備えており、この時計ケース１１の表面側には、現在時刻や日付に加えて、脈拍数などの脈波情報などをデジタル表示する液晶表示装置１３（表示部）が構成されている。時計ケース１１の内部には、センサユニット３０による検出結果（脈波信号）に基づいて脈拍数の変化などを液晶表示装置１３で表示するために、検出信号に対する信号処理を行なうデータ処理回路５０が構成されている。データ処理回路５０には、計時回路も構成されているため、通常時刻、ラップタイム、スプリットタイムなども液晶表示装置１３に表示可能である。
【0020】
時計ケース１１の外周部には、時刻合わせや表示モードの切り換えなどを行なうためのボタンスイッチ１１１～１１５が構成され、時計ケース１１の表面には、ボタンスイッチ１１６、１１７が構成されている。腕装着型脈波情報計測装置１の電源は、時計ケース１１に内蔵されているボタン形の電池５９であり、ケーブル２０は、電池５９からセンサユニット３０に電力を供給するとともに、センサユニット３０の検出結果を時計ケース１１内のデータ処理回路５０に入力している。
【0021】
腕装着型脈波情報計測装置１では、その機能を増やすにともなって、装置本体１０を大型化する必要があるが、装置本体１０には、腕に装着されるという制約があるため、装置本体１０を腕時計における６時及び１２時の方向に向けては拡大できない。そこで、本例では、装置本体１０には、３時及び９時の方向における長さ寸法が６時及び１２時の方向における長さ寸法よりも長い横長の時計ケース１１を用いてある。但し、リストバンド１２は、３時の方向側に偏った位置で接続しているため、リストバンド１２からみると、腕時計における９時の方向に大きな張出部分１０１を有するが、かかる大きな張出部分は、３時の方向にはない。従って、横長の時計ケース１１を用いたわりには、手首を自由に曲げることができ、かつ、転んでも手の甲を時計ケース１１にぶつけることがない。
【0022】
時計ケース１１の内部において、電池５９に対して９時の方向には、ブザー用の偏平な圧電素子５８が配置されている。電池５９は、圧電素子５８に比較して重いため、装置本体１０の重心位置は、３時の方向に偏った位置にある。この重心が偏っている側にリストバンド１２が接続しているので、装置本体１０を腕に安定した状態で装着できる。また、電池５９と圧電素子５８とを面方向に配置してあるため、装置本体１０を薄型化できるとともに、図３に示すように、裏面部１１９に電池蓋１１８を設けることによって、ユーザーは、電池５９を簡単に交換できる。
（装置本体の回り止め防止構造）
図３において、時計ケース１１の１２時の方向には、リストバンド１２の端部に取り付けられた止め軸１２１を保持するための連結部１０５が形成されている。時計ケース１１の６時の方向には、腕に巻かれたリストバンド１２が長さ方向の途中位置で折り返されるとともに、この途中位置を保持するための留め具１２２が取り付けられる受け部１０６が

形成されている。

【0023】

装置本体１０の６時の方向において、裏面部１１９から受け部１０６に至る部分は、時計ケース１１と一体に成形されて裏面部１１９に対して約１１５°の角度をなす回転止め部１０８になっている。すなわち、リストバンド１２によって装置本体１０を右の手首Ｌ（腕）の上面部Ｌ１（手の甲の側）に位置するように装着したとき、時計ケース１１の裏面部１１９は、手首Ｌの上面部Ｌ１に密着する一方、回転止め部１０８は、橈骨Ｒのある側面部Ｌ２に当接する。この状態で、装置本体１０の裏面部１１９は、橈骨Ｒと尺骨Ｕを跨ぐ感じにある一方、回転止め部１０８と裏面部１１９との屈曲部分１０９から回転止め部１０８にかけては、橈骨Ｒに当接する感じになる。このように、回転止め部１０８と裏面部１１９とは、約１１５°という解剖学的に理想的な角度をなしているため、装置本体１０を矢印Ａの方向に、また、装置本体１０を矢印Ｂの方向に回そうとしても、装置本体１０は、それ以上不必要にずれない。また、裏面部１１９及び回転止め部１０８によって腕の回りの片側２ヵ所で装置本体１０の回転を規制するだけである。このため、腕が細くても、裏面部１１９及び回転止め部１０８は確実に腕に接するので、回転止め効果が確実に得られる一方、腕が太くても窮屈な感じがない。

（センサユニットの構成）

図４は、本例の腕装着型脈波情報計測装置に用いたセンサユニットの平面図、図５は、図４のＩ－Ｉ´線における断面図、図６は、図４のII－II´線における断面図、図７は、図４のIII－III´線における断面図である。

【0024】

図４において、センサユニット３０は、そのケース体としてのセンサ枠３６の内側に部品収納空間３００が構成され、この部品収納空間３００の内部には、回路基板３５が配置されている。回路基板３５には、ＬＥＤ３１、フォトトランジスタ３２、ダイオード３９１、及びトランジスタ３９２などの電子部品が実装されている。また、センサユニット３０には、ブッシュ３９３によってケーブル２０の端部が固定され、ケーブル２０の各配線は、回路基板３５のパターン上にはんだ付けされている。ここで、センサユニット３０は、ケーブル２０が指の根元側から装置本体１０の側に引き出されるようにして指に取り付けられる。従って、ＬＥＤ３１及びフォトトランジスタ３２は、指の長さ方向に沿って配列されることになり、そのうち、ＬＥＤ３１は指の先端側に位置し、フォトトランジスタ３２は指の根元の方に位置する。

【0025】

図５からわかるように、部品収納空間３００は、センサ枠３６の裏側に裏蓋３０２が被されることによって構成されている。センサ枠３６の上面部分（実質的な脈波信号検出部）には、ガラス板からなる透光板３４によって光透過窓が形成され、この透光板３４に対向するように回路基板３５が部品収納空間３００内で固定されている。従って、ＬＥＤ３１及びフォトトランジスタ３２は、それぞれ発光面及び受光面を透光板３４の方に向けている。このため、透光板３４の外側表面３４１（指表面との接触面／センサ面）に指表面を密着させると、ＬＥＤ３１は、指表面の側に向けて光を発するとともに、フォトトラジスタ３２は、ＬＥＤ３１が発した光のうち指の側から反射してくる光を受光可能である。

【0026】

図５、図６及び図７に示すように、透光板３４の周囲を取り巻くセンサ枠３６の外側表面３６１を基準面とすると、透光板３４の外側表面３４１は、基準面（センサ枠３６の外側表面３６１）よりも突出した位置にある。

【0027】

また、図６に示すように、透光板３４の周囲には、透光板３４と指とを密着させたときに指表面に接触する２本の人体アース用端子３８がねじ３０６によってセンサ枠３０１に固定されている。ここで、２本の人体アース用端子３８は、透光板３４を挟むようにその両側に配置されている。なお、人体アース用端子３８の周りには、パッキン３９４が嵌められている。

【0028】
ここで、人体アース用端子３８も、図６からわかるように、基準面（センサ枠３６の外側表面３６１）から突出している。但し、人体アース用端子３８の外側表面３８１（指表面との接触面）は、基準面（センサ枠３６の外側表面３６１）からみれば、透光板３４の外側表面３４１よりも低い位置にある。
【0029】
本例では、ＬＥＤ３１として、ＩｎＧａＮ系（インジウムーガリウムー窒素系）の青色ＬＥＤを用いてあり、その発光スペクトルは、図８に示すように、４５０ｎｍに発光ピークを有し、その発光波長領域は、３５０ｎｍから６００ｎｍまでの範囲にある。かかる発光特性を有するＬＥＤ３１に対応させて、本例では、フォトトランジスタ３２として、ＧａＡｓＰ系（ガリウムー砒素ーリン系）のフォトトランジスタを用いてあり、その素子自身の受光波長領域は、図９に示すように、主要感度領域が３００ｎｍから６００ｎｍまでの範囲にあって、３００ｎｍ以下にも感度領域がある。ここで、フォトトランジスタ３２として、素子にフィルタを付加したセンサユニットを用いることもあり、このようなセンサユニットの受光波長領域の一例は、図１０に示すように、主要感度領域が４００ｎｍから５５０ｎｍまでの範囲にある。
【0030】
このように構成したセンサユニット３０において、図１１に示すように、センサ固定用バンド４０を指の根元に装着すると、ＬＥＤ３１及びフォトトランジスタ３２は、それぞれの発光面及び受光面を指表面に向いた状態になる。この状態で、ＬＥＤ３１が指に向けて光を照射すると、生体（血管）から反射してきた光をフォトトランジスタ３２が受光し、その受光結果（脈波信号）を、ケーブル２０を介して装置本体１０に入力すると、装置本体１０では、脈波信号から脈拍数が求められる。
（データ処理回路の構成）
すなわち、図１２に、時計ケースの内部に構成されたデータ処理回路の機能の一部をブロック図で示すように、データ処理回路５０において、脈波信号変換部５１は、センサユニット３０からケーブル２０を介して入力された信号をデジタル信号に変換して脈波信号記憶部５２に出力するようになっている。脈波信号記憶部５２は、デジタル信号に変換された脈波データを記憶しておくＲＡＭである。脈波信号演算部５３は、脈波信号記憶部５２に記憶されている信号を読み出してそれに周波数分析を行ない、その結果を脈波成分抽出部５４に入力するようになっている。脈波成分抽出部５４は、脈波信号演算部５３からの入力信号から脈波成分を抽出して脈拍数演算部５５に出力し、この脈拍数演算部５５は、入力された脈波の周波数成分により脈拍数を演算し、その結果を液晶表示装置１３に出力するようになっている。
（ケーブルと装置本体との接続構造）
本例の腕装着型脈波情報計測装置１では、通常の腕時計と同様に扱えるように、図１に示すように、ケーブル２０は、装置本体１０の６時の方向に位置する端部の表面側で着脱できるようになっている。すなわち、図３に示したように、装置本体１０の６時の方向において、回転止め部１０８として延設されている部分の表面側には、コネクタ部７０が構成され、そこには、ケーブル２０の端部に構成されたコネクタピース８０を装着できるようになっている。従って、コネクタ部７０は、利用者からみると手前側にあり、操作が簡単である。また、コネクタ部７０は、装置本体１０から３時の方向に張り出さないので、利用者は、ランニング中に手首を自由に動かすことができるとともに、ランニング中に転んでも手の甲がコネクタ部７０にぶつからない。
【0031】
コククタ部７０及びコネクタピース８０（コネクタ手段）において行なわれる電気的な接続は、図１３に示すとおりである。
【0032】
図１３において、装置本体１０の側に構成されているコネクタ部７０には、端子７５１～７５６（第１の端子群）が構成されており、これらの端子７５１～７５６に対応して、

コネクタピース８０には、電極部８３１～８３６（第２の端子群）が構成されている。そのうち、端子７５２は、電極部８３２を介してＬＥＤ３１に第２の駆動電圧ＶＤＤの供給するためのプラス端子、端子７５３は、電極部８３３を介してＬＥＤ３１のマイナス電位とされる端子、端子７５４は、電極部８３４を介してフォトトランジスタ３２のコレクタ端子に駆動用の定電圧ＶＲＥＧを供給するための端子、端子７５１は、電極部８３１を介してフォトトランジスタ３２のエミッタ端子からの信号が入力される端子、端子７５５は、電極部８３５を介してコネクタピース８０をコネクタ部７０に装着したか否かを検出するための信号が入力される端子である。

【0033】

電極部８３６は、図４及び図６に示した人体アース用端子３８を介して、センサユニット３０において人体にアースを落としており、端子７５６と電極部８３６とが電気的に接続したとき、ＶＤＤをグランド線とすることによって、電極部８３１～８３６をシールドするようになっている。

【0034】

コネクタピース８０では、ＬＥＤ３１の端子間（電極部８３２、８３３の間）に対して、第１のキャパシタＣ１、及び第１のスイッチＳＷ１が介挿されている。このスイッチＳＷ１は、コネクタピース８０をコネクタ部７０から外したときに閉状態になって、ＬＥＤ３１に対して第１のキャパシタＣ１を並列接続させ、コネクタピース８０をコネクタ部７０に装着したときに開状態になる。同様に、フォトトランジスタ３２の端子間（電極部８３１、８３４）に対しては、第２のキャパシタＣ２、及び第２のスイッチＳＷ２が介挿されている。このスイッチＳＷ２は、コネクタピース８０をコネクタ部７０から外したときに閉状態になって、フォトトランジスタ３２に対して第２のキャパシタＣ２を並列接続させ、コネクタピース８０をコネクタ部７０に装着したときに開状態になる。

【0035】

コネクタ部７０及びコネクタピース８０の構造を、図１４～図１７を参照して詳述する。

【0036】

図１４は、ケーブルの端部に構成されたコネクタピースの構成を示す拡大図、図１５は、装置本体側のコククタ部の拡大図、図１６は、コネクタ部に対してコネクタピースを結合させた状態を示す縦断面図である。

【0037】

図１４において、コネクタピース８０の下面部８０１には、その両側で下方に向けて張り出す一対の突出部８１、８２が形成されている。これらの突出部８１、８２の下端部では、その内側に向かって４個の係合片８１１、８１２、８２１、８２２（第２の係合用突起群）が突き出ている。

【0038】

コネクタピース８０の下面部８０１には、６つの電極部８３１、８３２、８３３、８３４、８３５、８３６（第２の端子群）が形成されており、その周囲には環状の凸条部８４１、８４２、８４３、８４４、８４５、８４６が形成されている。ここで、コネクタピース８０をコネクタ部７０に装着する際には、後述するとおり、コネクタピース８０をコネクタ部７０に被せた後、矢印Ｑの方向にコネクタピース８０をスライドさせるが、かかるスライド方向（矢印Ｑの方向）に沿って、電極部８３１～８３６は、電極部８３１、８３２、８３３と、電極部８３４、８３５、８３６との２列に形成されている。また、いずれの列でも、各電極部８３１～８３６は、コネクタピース８０のスライド方向（矢印Ｑの方向）に対して直交する方向にずれるように斜めに配置されている。

【0039】

さらに、コネクタピース８０の底面部には、装置本体１０にケーブル２０を接続したときの静電気の影響を防止するための回路をスイッチングする２本の作動ピン８３７、８３８が形成されている。これらの作動ピン８３７、８３８は、コネクタピース８０をコネクタ部７０から外した状態では、先端がコネクタピース８０の下面部８０１から突出した状

態にある。

【0040】

一方、図１５に示すように、コネクタ部７０には、外側に張り出す係合部７１、７２、７３、７４（第１の係合用突起群）が形成されている。従って、コクネタピース８０の突出部８１、８２がコネクタ部７０の係合部７１、７２、７３、７４が外側に位置し、かつ、係合部７１と係合部７２との間、及び係合部７３と係合部７４との間に、コネクタピース８０の係合片８１１、８２１が位置するように、コネクタピース８０をコネクタ部７０に被せた後、係合片８１１、８２１が係合部７１と係合部７２との間、及び係合部７３と係合部７４との間をそれぞれ通り抜けるように、コネクタピース８０をコネクタ部７０に向けて押し付け、しかる後に、矢印Ｑの方向にコネクタピース８０をスライドさせると、係合部７１、７３の下に係合片８１１、８２１が潜り込む。また、係合部７２、７４の下に係合片８１２、８２２が潜り込む。その結果、係合片８１１、８２１、８１２、８２２は、コネクタピース８０の下面部８０１との間に係合部７１、７２、７３、７４をそれぞれ保持する状態になり、コネクタピース８０は、コネクタ部７０に簡単に、かつ、確実に装着される。

【0041】

このようにして、コネクタピース８０をコネクタ部７０上で矢印Ｑの方向にスライドさせたときに係合するとともに、この状態からコネクタピース８０を逆の方向（矢印Ｒの方向）にスライドさせたときに係合状態が解除される係合機構７００が構成されている。かかる構成の係合機構は、少ない部品でありながら、係合が確実である。また、コネクタピース８０をコネクタ部７０上で６時の方向から１２時の方向に向けてスライドさせたとき、装置本体１０に加わる力は、回転止め部１０８によって、装置本体１０がより回転しにくい向きである。従って、コネクタピース８０を装着するときも、装置本体１０は、手首の周りを回転しないので、装着が簡単である。

【0042】

ここで、各端子７５１～７５６は、電極部８３１～８３６と同様、コネクタピース８０のスライド方向（矢印Ｑの方向）に沿って、端子７５１、７５２、７５３と、端子７５４、７５５、７５６の２列に形成されている。また、いずれの列でも、各端子７５１～７５６は、電極部８３１～８３６と同様、コネクタピース８０のスライド方向（矢印Ｑの方向）に対して直交する方向にずれるように斜め配置されている。従って、コネクタピース８０をコネクタ部７０に装着すると、コネクタピース８０の６つの電極部８３１～８３６に対して、コネクタ部７０の６つの端子７５１～７５６がそれぞれ電気的に接続し、センサユニット３０での計測結果をケーブル２０を介して装置本体１０に入力することが可能となる。

【0043】

なお、端子７５１～７５６、及び電極部８３１～８３６は、コネクタピース８０のスライド方向に沿って２列に配置され、かつ、このスライド方向に直交する方向に、各端子間及び各電極間の位置が斜めにずれているので、コネクタピース８０をコネクタ部７０の上でスライドさせても、対応しない端子７５１～７５６と電極部８３１～８３６とが接触するということがない。また、コネクタ部７０の形成面積を狭くしても、端子同士及び電極部同士を離れた位置に配置できるので、コネクタピース８０とコネクタ部７０との間に水が侵入した場合でも、端子間及び電極間がショートしにくい。また、駆動電圧がかかる端子７５２、７５４、７５６、及び電極部８３２、８３４、８３６については、特に、離れるように配置してあるため、異なる電位の端子同士及び電極部同士の間では、トラッキングが発生しない。

（ストッパー機構の構成）

図１５からわかるように、係合部７１～７４には、矢印Ｑの方向の側に垂直壁７１１、７２１、７３１、７４１が形成されている。従って、コネクタピース８０をコネクタ部７０に装着するときに、コネクタピース８０を矢印Ｒの方向にスライドさせると（第２の動作）、係合片８１１、８１２、８２１、８２２は、垂直壁７１１、７２１、７３１、７４

１にそれぞれ当接し、コネクタピース８０をコネクタ部７０の装着位置で停止させる。すなわち、垂直壁７１１、７２１、７３１、７４１は、コネクタピース８０に対する第１のストッパーとして機能する。逆に、コネクタピース８０をコネクタ部７０から外すために矢印Ｒの方向にスライドさせると、係合片８１１、８２１は、それぞれ係合部７２、７４の垂直壁７２１、７４１の裏側に当接し、コネクタピース８０をコネクタ部７０を元の位置で停止させる。すなわち、垂直壁７２１、７４１の裏側は、コネクタピース８０に対する第２のストッパーとして機能する。

（端子及び電極部の構造）

コネクタ部７０において、端子７５１～７５６は、いずれも、コネクタ部７０に形成された孔７６１、７６２、７６３、７６４、７６５、７６６の内部に配置されており、そのうちの端子７５３、７５６、作動ピン８３８、及び電極部８３３、８３６の形成位置を通る位置で切断したときの断面が、図１６に表れている。

【0044】

図１６において、コネクタピース８０は、内部に回路基板８５を収容可能な外装ケース８０５に蓋材８０６を被せた構造になっている。蓋材８０６には、孔８６３、８６６が形成され、その下方側の開口縁に沿って環状の凸条部８４３、８４６が形成されている。孔８６３、８６６の内部には、電極部８３３、８３６が配置されている。電極部８３３は、ねじ８８１によって固定され、電極部８３６は、回路基板８５と蓋材８０６とに挟まれて固定されている。電極部８３３、８３６に対しては、防水パッキン８７３、８７６が装着されている。電極部８３３、８３６は、コネクタピース８０の内部に配置された回路基板８５の回路パターン上に電気的接続されている。かかる電極構造は、電極部８３３、８３６以外の電極部８３１、８３２、８３４、８３５も同様である。なお、回路基板８５の回路パターン上には、ケーブル２０の芯線もハンダ付けにより電気的接続されている。

（クリック機構の構成）

コネクタ部７０では、その凹部に蓋材７０６を被せた構造になっている。蓋材７０６には孔７６３、７６６が形成されている。これらの孔７６３、７６６の内部において、端子７５３、７５６は、先端を孔７６３、７６６から突出させた状態となるように進退可能な進退ピンとして配置されている。各端子７５３、７５６の基部側に形成された鍔部７８３、７８６に対しては、コイルばね７７３、７７６が配置されており、これらのコイルばね７７３、７７６によって、端子７５３、７５６は、孔７６３、７６６から突出する方向に向けて付勢されている。但し、鍔７８３、７８６の外径は、孔７６３、７６６の内径よりも大きいので、端子７５３、７５６が孔７６３、７６６から抜け出てしまうことはない。かかる端子構造は、端子７５３、７５６以外の端子７５１、７５２、７５４、７５５も同様である。

【0045】

コネクタピース８０をコネクタ部７０上に装着するときには、コネクタピース８０をコネクタ部７０上でスライドさせるため、端子７５３、７５６は、コネクタピース８０の環状の凸条部８４３、８４６をコイルばね７７３、７７６に付勢されながら乗り越えて、電極部８３３、８３６に対して確実に接続する。また、かかる凸条部８４３、８４６、端子７５３、７５６、及びコイルばね７７３、７７６をそのまま利用してクリック機構が構成されているので、コネクタピース８０をコネクタ部７０に確実に装着できる。なお、かかるクリック機構を構成するには、本例とは逆に、コネクタピース８０の側に進退ピンを利用した端子を設け、コネクタ部７０の側に凸条部を設けてもよい。

（スイッチ機構の構成）

コネクタピース８０の蓋材８０６には、孔８６８が形成されており、この孔８３８には、作動ピン８３８が配置されている。この作動ピン８３８は、先端を孔８６８から突出させた状態となるように孔８６８の内部で進退可能な状態にある。作動ピン８３８の基部に形成された鍔部８９８に対しては、板ばね状のスイッチばね８８が配置されている。スイッチばね８８は、その先端部８８５によって作動ピン８３８を孔８６８から突出する方向に向けて付勢している。但し、鍔８９８の外径は、孔８６８の内径よりも大きいので、作

動ピン８３８は、孔８６８から抜け出ることがない。スイッチばね８８は、その基部が電極部８３３の上端面にねじ８８１によって止められ、電極部８３３に電気的接続している。ここで、スイッチばね８８の先端部８８５には、その図示を省略するが、作動ピン８３８の基部に接する当接部と、そこから側方に張り出した部分に形成された接点とが形成されている。この接点は、回路基板８５の回路パターンに電気的に接続し、回路パターンは、第１のキャパシタＣ１と電極部８３３との間に介挿されている。

【0046】

従って、コネクタピース８０をコネクタ部７０に装着しない状態では、図１６に実線で示すように、作動ピン８３８は、スイッチばね８８に押されて先端が孔８６８から突出し、図１３において、第１のスイッチＳＷ１が閉じて、第１のコンデンサＣ１は、ＬＥＤ３１に並列に電気的接続している状態にある。従って、静電気によって高い電位にあるものが電極部８３２、８３３に触れても、その電荷は、第１のコンデンサＣ１に蓄積されるので、ＬＥＤ３１は、破損しない。これに対して、コネクタピース８０をコネクタ部７０に装着すると、作動ピン８３８は、図１６に二点鎖線で示すように、孔８６８の内部に引っ込む方向に移動してスイッチばね８８を二点鎖線で示すように変形させる。その結果、図１３において、第１のスイッチＳＷ１は、開いた状態になるので、脈波を計測可能な回路構成になる。このとき、第１のコンデンサＣ１に電荷が蓄積されていても、この電荷は、電極部８３２、８３３、及び端子７５２、７５３を介して、コネクタ部７０及び装置本体１０に内蔵されている各回路には放電しない。

【0047】

スイッチ機構は、フォトトランジスタ３２にも構成されているが、その構成は、ＬＥＤ３１に対するスイッチ機構と同様であるため、その説明を省略する。

（動作）

このように構成した腕装着型脈波情報計測装置１の動作を、図１及び図１１を参照して簡単に説明する。

【0048】

まず、図１において、腕装着型脈波情報計測装置１を通常の腕時計として用いる場合には、ケーブル２０及びセンサユニット３０を装置本体１０のコネクタ部７０で外し、コネクタ部７０には、所定のコネクタカバーを装着する。このコネクタカバーとしては、コネクタピース８０と同じ構成のものを用いることができる。但し、コネクタカバーには、電極部などが不要である。

腕装着型脈波情報計測装置１を用いてランニング中の脈拍数を計測する場合には、コネクタピース８０をコネクタ部７０に装着して、ケーブル２０を装置本体１０に接続した後、装置本体１０をリストバンド１２で腕に装着する。また、センサユニット３０をセンサ固定用バンド４０によって指の根元に密着させた状態でランニングを行なう。このように、センサユニット３０を指の根元に装着すると、ケーブル２０が短くて済むので、ケーブル２０は、ランニング中に邪魔にならない。また、掌から指先までの体温の分布を計測すると、寒いときには、指先の温度が著しく低下するのに対し、指の根元の温度は比較的低下しない。従って、指の根元にセンサユニット３０を装着すれば、寒い日に屋外でランニングしたときでも、脈拍数などを正確に計測できる。

【0049】

この状態で、図１１に示すように、ＬＥＤ３１から指に向けて光を照射すると、この光が血管に届いて血液中のヘモグロビンによって一部が吸収され、一部が反射する。指（血管）から反射してきた光は、フォトトランジスタ３２によって受光され、その受光量変化が血量変化（血液の脈波）に対応する。すなわち、血量が多いときには、反射光が弱くなる一方、血量が少なくなると、反射光が強くなるので、反射光強度の変化を検出すれば、脈拍数などを計測できる。かかる計測を行なうために、図１２に示したデータ処理回路５０は、フォトトランジスタ３２（センサユニット３０）から入力された信号をデジタル信号に変換し、このデジタル信号に周波数分析などを行なって脈拍数を演算する。そして、演算により求めた脈拍数を液晶表示装置１３に表示させる。