IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	Jeroen Poeze et al.	
U.S. Patent No.:	10,588,554	Attorney Docket No.: 50095-00013IP2
Issue Date:	March 17, 2020	
Appl. Serial No.:	16,544,713	
Filing Date:	August 19, 2019	
Title:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

DECLARATION OF DR. THOMAS W. KENNY

Declaration

I declare that all statements made herein on 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 under Section 1001 of Title 18 of the United States Code.

By: ______________________________

Thomas W. Kenny, Ph.D.

Contents

I. QUALIFICATIONS AND BACKGROUND INFORMATION

1. My education and experience are described more fully in the attached curriculum vitae (Exhibit 1004). For ease of reference, I have highlighted certain information below.

2. My academic and professional background is in Physics, Mechanical Engineering, Sensing, and Robotics, with a research specialization focused on microfabricated physical sensors, and I have been working in those fields since the completion of my Ph.D. more than 30 years ago. The details of my background and education and a listing of all publications I have authored in the past 35 years are provided in my curriculum vitae, Exhibit 1004. Below I provide a short summary of my education and experience which I believe to be most pertinent to the opinions that I express here.

3. I received a B.S. in Physics from University of Minnesota, Minneapolis in 1983, and a Ph.D. in Physics from University of California at Berkeley in 1989. I was educated as a Physicist specializing in sensors and measurement. My Physics Ph.D. thesis involved measurements of the heat capacity of monolayers of atoms on surfaces, and relied on precision measurements of temperature and power using time-varying electrical signals, and also on the design and construction of miniature sensor components and associated electrical circuits for conditioning and conversion to digital format.

4. After completion of my Ph.D. in Physics at U.C. Berkeley in 1989, I joined the Jet Propulsion Laboratory (JPL) in Pasadena, CA, as a staff scientist, and began working on miniature sensors and instruments for small spacecraft. This work involved the use of silicon microfabrication technologies for miniaturization of the sensors, and served as my introduction to the field of micro-electromechanical systems (MEMS), or the study of very small mechanical sensors powered by electricity and used for detection of physical and chemical signals.

5. While at JPL, we developed accelerometers, uncooled infrared sensors, magnetometers, seismometers, force and displacement sensors, soil chemistry sensors, miniature structures for trapping interstellar dust, and many other miniature devices. Some of these projects led to devices that were launched with spacecraft headed for Mars and for other interplanetary missions. Much of this work involved the use of physical sensors for detection of small forces and displacements using micromechanical sensors.

6. I am presently the Richard Weiland Professor at the Department of Mechanical Engineering at Stanford University, where I have taught for the past 26 years. I am also currently the Senior Associate Dean of Engineering for Student Affairs at Stanford.

7. For 26 years, I have taught courses on Sensors and Mechatronics at Stanford University. The "Introduction to Sensors" course is a broad overview of all

sensing technologies, from thermometers, to inertial sensors, ultrasound devices, flow sensors, optical and IR sensors, chemical sensors, pressure sensors, and many others, and has included sensors based on changes in capacitance, resistance, piezoelectricity. This course specifically included different mechanisms for sensing heart rate, blood pressure, blood chemistry, cardiovascular blood flow and pressure drops, intraocular pressure and other physiological measurements, as well as activity monitoring (step counting, stair-counting, etc). I first taught this course at Stanford in the Spring of 1994, and I offered this course at least annually until 2016, when my duties as Senior Associate Dean made this impractical.

8. The "Introduction to Mechatronics" course is a review of the mechanical, electrical and computing technologies necessary to build systems with these contents, which include everything from cars and robots to cellphones and other consumer electronics devices. In this class, we routinely use IR, LEDs, and photosensors as a way of detecting proximity to objects in the space around miniature robots. We also use inertial sensors to detect movement, and a number of sensors, such as encoders to measure changes in position and trajectory. I was one of the instructors for the first offering of this course in 1995, and this course has been offered at least once each year ever since, with plans already underway for the Winter 2021 offering. The 2020 offering was just completed, and was

highly-successful with 120 undergraduate and graduate students from many engineering and science disciplines.

9. I am co-author of a textbook titled “Introduction to Mechatronic Design,” which broadly covers the topic of integration of mechanical, electronic and computer systems design into “smart products.” This textbook includes chapters on Microprocessors, Programming Languages, Software Design, Electronics, Sensors, Signal Conditioning, and Motors, as well as topics such as Project Management, Troubleshooting, and Synthesis.

10. My research group has focused on the area of microsensors and microfabrication—a domain in which we design and build micromechanical sensors using silicon microfabrication technologies. The various applications for these technologies are numerous.

11. I have advised 69 Ph.D. students that have completed Ph.D. degrees and many more M.S. and B.S. students in Engineering during my time at Stanford.

12. I have published over 250 technical papers in refereed journals and conferences in the field of sensors, MEMS, and measurements. I have further presented numerous conference abstracts, posters, and talks in my field. I am a named inventor on 50 patents in my areas of work.

13. I have previously served as an expert on a patent infringement case involving the mounting and use of pressure sensors on guidewire catheters for

cardiovascular procedures that included a number of sensing aspects, such as recording static and dynamic pressure signals, and compensating for electrical and mechanical errors. I have also previously served as an expert on a patent infringement case involving the design and use of miniature inertial sensors. That case involved the design and operations of micromechanical sensors, and particularly the use of inertial sensors for detection of states of movement and rest. I have also served as an expert in a patent infringement case involving the use of sensors on athletic shoes for determining athletic performance. More recently, I served as an expert in a patent infringement case involving optical proximity sensors in smartphones. My CV, Exhibit 1004, includes a full listing of all cases in which I have testified at deposition or trial in the preceding four years.

14. I have been retained on behalf of Apple Inc. to offer technical opinions relating to U.S. Patent No. 10,588,554 ("the '554 Patent") and prior art references relating to its subject matter. I have reviewed the '554 Patent, relevant excerpts of the prosecution history of the '554 Patent. I have also reviewed the following prior art references:

Prior Art Reference
U.S. Pub. No. 200/0188210 to Aizawa ("Aizawa")
JP Pub. No. 2006/0296564 to Inokawa et al. ("Inokawa")
U.S. Pub. No. 2001/0056243 to Ohsaki et al. ("Ohsaki")

"A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring," Y. Mendelson, et al.; Proceedings of the 28th IEEE EMBS Annual International Conference, 2006; pp. 912-915 ("Mendelson 2006")
U.S. Patent No. 3,789,601 ("Bergey")

15. Counsel has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the '554 Patent at the time of the earliest possible priority date of the '554 Patent, and I have done so during my review of these materials. The application leading to the '554 Patent was filed on August 7, 2019 and claims the benefit of priority to a provisional application filed July 3, 2008 ("the Critical Date"). Counsel has informed me that the Critical Date represents the earliest possible priority date to which the challenged claims of '554 Patent are entitled, and I have therefore used that Critical Date in my analysis below.

16. I have no financial interest in the party or in the outcome of this proceeding. I am being compensated for my work as an expert on an hourly basis. My compensation is not dependent on the outcome of these proceedings or the content of my opinions.

17. In writing this declaration, I have considered the following: my own knowledge and experience, including my work experience in the fields of mechanical engineering, computer science, biomedical engineering, and electrical engineer; my experience in teaching those subjects; and my experience in working

with others involved in those fields. In addition, I have analyzed various publications and materials, in addition to other materials I cite in my declaration.

18. My opinions, as explained below, are based on my education, experience, and expertise in the fields relating to the ’554 Patent. Unless otherwise stated, my testimony below refers to the knowledge of one of ordinary skill in the fields as of the Critical Date, or before. Any figures that appear within this document have been prepared with the assistance of Counsel and reflect my understanding of the ’554 Patent and the prior art discussed below.

II. OVERVIEW OF CONCLUSIONS FORMED

19. This declaration explains the conclusions that I have formed based on my analysis. To summarize those conclusions, based upon my knowledge and experience and my review of the prior art publications listed above, I believe that:

- Claims 1-7 and 20-28 are rendered obvious by Aizawa, Inokawa, Ohsaki, and Mendelson 2006.
- Claims 8-19 are rendered obvious by Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey.

III. LEVEL OF ORDINARY SKILL IN THE ART

20. In my opinion, one of ordinary skill in the art relating to, and at the time of, the invention of the ’554 Patent would have been someone with a working knowledge of physiological monitoring technologies. The person would have had

a Bachelor of Science degree in an academic discipline emphasizing the design of electrical, computer, or software technologies, in combination with training or at least one to two years of related work experience with capture and processing of data or information, including but not limited to physiological monitoring technologies. Alternatively, the person could have also had a Master of Science degree in a relevant academic discipline with less than a year of related work experience in the same discipline.

21. Based on my experiences, I have a good understanding of the capabilities of one of ordinary skill. Indeed, I have taught, participated in organizations, and worked closely with many such persons over the course of my career. Based on my knowledge, skill, and experience, I have an understanding of the capabilities of one of ordinary skill. For example, from my industry experience, I am familiar with what an engineer would have known and found predictable in the art. From teaching and supervising my post-graduate students, I also have an understanding of the knowledge that a person with this academic experience possesses. Furthermore, I possess those capabilities myself.

IV. LEGAL STANDARDS

A. Terminology

22. I have been informed by Counsel and understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood

by one of ordinary skill. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent's history of examination before the Patent Office. Counsel has also informed me, and I understand that, the words of the claims should be interpreted as they would have been interpreted by one of ordinary skill at the time of the invention was made (not today). Because I do not know at what date the invention as claimed was made, I have used the earliest possible priority date of the '554 Patent as the point in time for claim interpretation purposes. That date was July 3, 2008, the Critical Date.

B. Legal Standards for Anticipation

23. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as anticipated. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art.

24. I am informed by Counsel and understand that a challenged claim is unpatentable as "anticipated" under 35 U.S.C. § 102 if it is determined that all the limitations of the claim are described in a single prior art reference. I am informed by Counsel and understand that, to anticipate a claim, a prior art reference must disclose, either expressly or inherently, each and every limitation of that claim and enable one of ordinary skill in the art to make and use the invention.

25. I have been informed by Counsel and understand that in an *inter partes* review, "the petitioner shall have the burden of proving a proposition of unpatentability," including a proposition of anticipation, "by a preponderance of the evidence." 35 U.S.C. §316(e).

C. Legal Standards for Obviousness

26. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as obvious. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art at the time of the invention, and that this viewpoint prevents one from using his or her own insight or hindsight in deciding whether a claim is obvious.

27. I have been informed by Counsel and understand that a claim is unpatentable for obviousness under 35 U.S.C. § 103 (in the pre-AIA form of that statute that applies to the '554 Patent) "if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." I am informed by Counsel and understand that obviousness may be based upon a combination of references. I am informed by Counsel and understand that the combination of familiar elements according to known methods is likely to be obvious when it does no more than

yield predictable results. However, I am informed by Counsel and understand that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.

28. I am informed by Counsel and understand that when a patented invention is a combination of known elements, a court must determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue by considering the teachings of prior art references, the effects of demands known to people working in the field or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art.

29. I am informed by Counsel and understand that a patent claim composed of several limitations is not proved obvious merely by demonstrating that each of its limitations was independently known in the prior art. I am informed by counsel for the Patent Owner and understand that identifying a reason those elements would be combined can be important because inventions in many instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known. I am informed by Counsel and understand that it is improper to use hindsight in an obviousness analysis, and that a patent's claims should not be used as a "roadmap."

30. I am informed by Counsel and understand that an obviousness inquiry requires consideration of the following factors: (1) the scope and content of the

prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the pertinent art; and (4) any objective indicia of non-obviousness, such as commercial success, long-felt but unresolved need, failure of others, industry recognition, copying, and unexpected results. I understand that the foregoing factors are sometimes referred to as the "Graham factors."

31. I have been informed by Counsel and understand that an obviousness evaluation can be based on a combination of multiple prior art references. I understand that the prior art references themselves may provide a suggestion, motivation, or reason to combine, but that the nexus linking two or more prior art references is sometimes simple common sense. I have been informed by Counsel and understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may be supplied by the direction of the marketplace.

32. I have been informed by Counsel and understand that if a technique has been used to improve one device, and a person of ordinary skill at the time of invention would have recognized that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

33. I have been informed by Counsel and understand that practical and common sense considerations should guide a proper obviousness analysis, because familiar

items may have obvious uses beyond their primary purposes. I have been informed by Counsel and understand that a person of ordinary skill looking to overcome a problem will often be able to fit together the teachings of multiple prior art references. I have been informed by Counsel and understand that obviousness analysis therefore takes into account the inferences and creative steps that a person of ordinary skill would have employed at the time of invention.

34. I have been informed by Counsel and understand that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill at the time of invention, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

35. I have been informed by Counsel and understand that a claim can be obvious in light of a single reference, without the need to combine references, if the elements of the claim that are not found explicitly or inherently in the reference can be supplied by the common sense of one of skill in the art.

36. I have been informed by Counsel and understand that secondary indicia of non-obviousness may include (1) a long felt but unmet need in the prior art that was satisfied by the invention of the patent; (2) commercial success of processes covered by the patent; (3) unexpected results achieved by the invention; (4) praise of the invention by others skilled in the art; (5) taking of licenses under the patent

by others; (6) deliberate copying of the invention; (7) failure of others to find a solution to the long felt need; and (8) skepticism by experts. I understand that evidence of secondary indicia of non-obviousness, if available, should be considered as part of the obviousness analysis.

37. I have been informed by Counsel and understand that there must be a relationship between any such secondary considerations and the invention, and that contemporaneous and independent invention by others is a secondary consideration supporting an obviousness determination.

38. In sum, my understanding is that prior art teachings are properly combined where one of ordinary skill having the understanding and knowledge reflected in the prior art and motivated by the general problem facing the inventor, would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the invention, can provide a reason for combining the elements of multiple prior art references in the claimed manner.

39. I have been informed by Counsel and understand that in an *inter partes* review, "the petitioner shall have the burden of proving a proposition of unpatentability," including a proposition of obviousness, "by a preponderance of the evidence." 35 U.S.C. §316(e).

V. THE '554 PATENT

A. Overview of the ’554 Patent

40. Prior to the Critical Date of the ’554 Patent, numerous products, publications, and patents existed that implemented or described the functionality claimed in the ’554 Patent. The methodology of the ’554 Patent was therefore well-known in the prior art as of the Critical Date. Further, to the extent there was any problem to be solved in the ’554 Patent, it had already been solved in the prior art systems before the Critical Date of the ’554 Patent as I discuss below.

41. The ’554 Patent relates to “noninvasive methods, devices, and systems for measuring a blood constituent or analyte … or for measuring many other physiologically relevant patient characteristics.” APPLE-1001, 2:29-37.

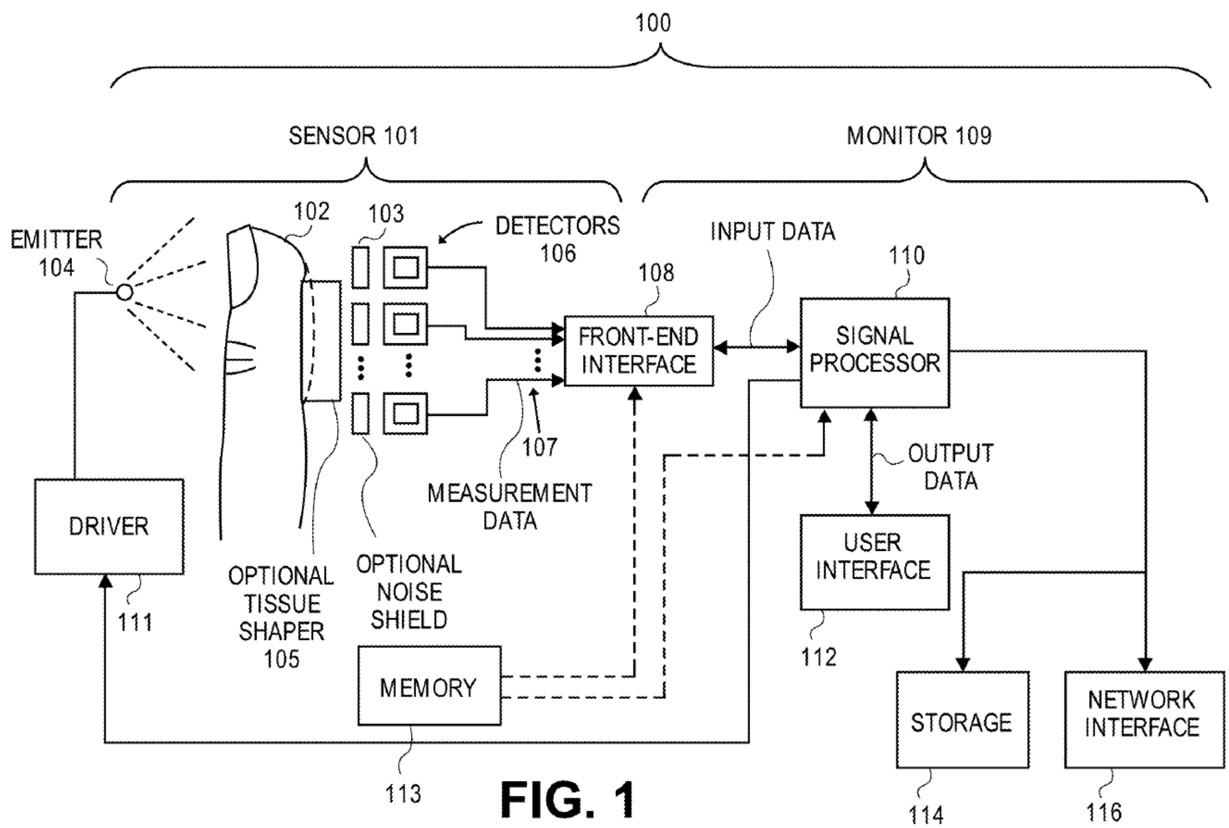
42. In its background section, the ’554 Patent explains that “[t]he standard of care in caregiver environments includes patient monitoring through spectroscopic analysis using, for example, a pulse oximeter,” and that “[d]evices capable of spectroscopic analysis generally include a light source(s) transmitting optical radiation into or reflecting off a measurement site, such as, body tissue carrying pulsing blood.” *Id.*, 2:5-11. “After attenuation by tissue and fluids of the measurement site, a photo-detection device(s) detects the attenuated light and outputs a detector signal(s) responsive to the detected attenuated light.” *Id.*, 2:11-14. “A signal processing device(s)” then “process[es] the detector(s) signal(s) and outputs a measurement indicative of a blood constituent of interest, … other

physiological parameters, or other data or combinations of data useful in determining a state or trend of wellness of a patient." *Id*., 2:14-20.

43. In this way, the '554 Patent confirms that prior art "devices capable of spectroscopic analysis" ("for example, a pulse oximeter"), generally included one or more light sources configured to emit light into user tissue, one or more detectors configured to detect light after attenuation by the user's tissue and to output responsive signal(s), and one or more signal processors configured to process signals and to output measurements of physiological parameters. *Id*., 2:5-20.

44. The system described by the '554 Patent is said to include, in one embodiment, "a noninvasive sensor and a patient monitor communicating with the noninvasive sensor." APPLE-1001, 2:38-40. The '554 Patent explains that "[t]he non-invasive sensor may include different architectures," adding that "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." *Id*., 2:40-44. The "patient monitor" with which the sensor communicates may itself "include a display device," and "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." *Id*., 2:45-48.

45. In more detail, the exemplary physiological measurement system 100 illustrated by the ’554 Patent’s FIG. 1 (reproduced below) includes “a sensor 101 … that is coupled to a processing device or physiological monitor 109.” *Id.*, 5:35-38, 11:47-49.



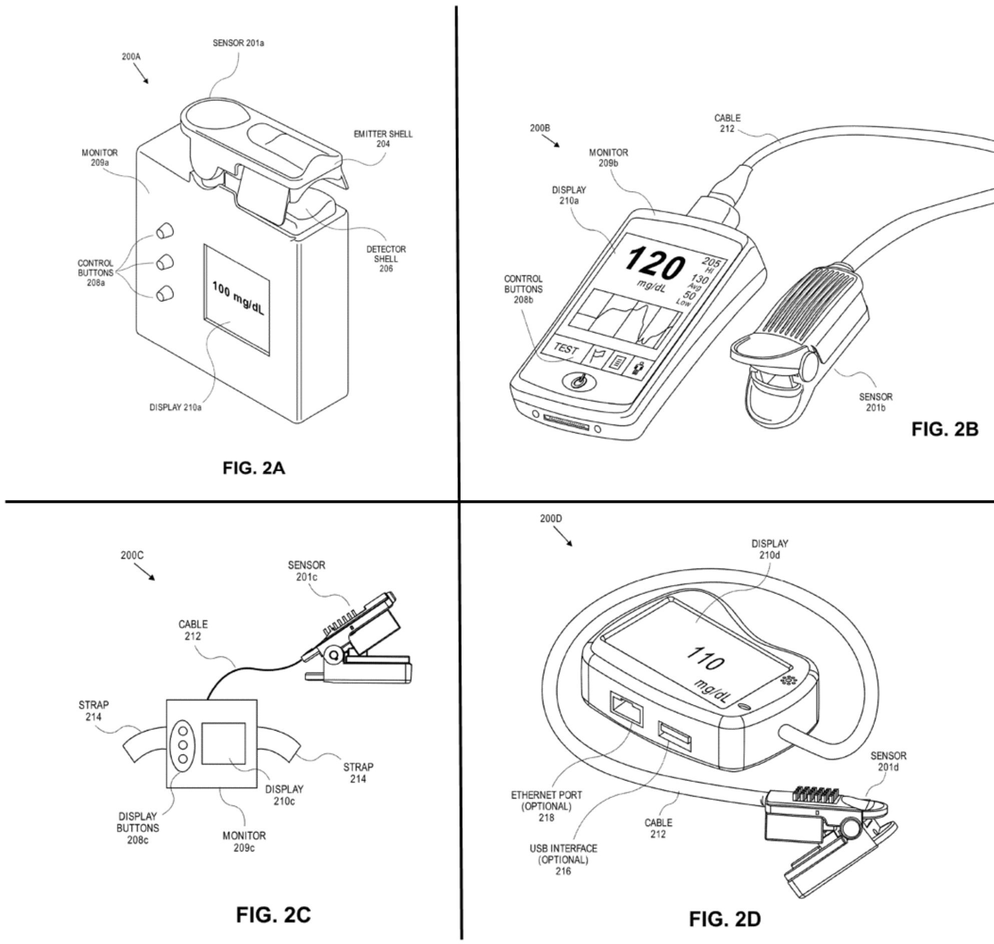
APPLE-1001, FIG. 1.

46. The ’554 Patent explains that “[i]n an embodiment, the sensor 101 and the monitor 109 are integrated together into a single unit.” *Id.*, 11:49-51. “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.” *Id.*, 11:51-54. “The sensor 101 and monitor 109 can be,” for

example, “attachable and detachable from each other for the convenience of the user or caregiver, for ease of storage, sterility issues, or the like.” *Id*., 11:54-57.

47. From this and related description, one of ordinary skill would have understood that the sensor 101 and monitor 109 described by the ’554 Patent together act as components of a physiological sensor device, regardless of whether they are integrated into a single unit, or are instead separated but configured to communicate with each other. APPLE-1001, 2:38-48, 11:49-57, 16:20-18:28, FIGS. 1, 2A-2D.

48. In more detail, the ’554 Patent’s FIGS. 2A-2D (reproduced below) illustrate “example monitoring devices 200 in which the data collection system 100 can be housed.” APPLE-1001, 5:39-42, 16:20-31.



APPLE-1001, FIGS. 2A-2D.

49. Each of the illustrated "monitoring devices 200" include a sensor 201 and a monitor 209. *Id*., FIGS. 2A-2D, 16:20-18:28. "Referring specifically to FIG. 2A," for example, the "monitoring device 200A is shown, in which a sensor 201*a* and a monitor 209*a* are integrated into a single unit." *Id.* 16:32-40. FIG. 2D illustrates a different "monitoring device 200D [that] includes a finger clip sensor 201*d* connected to a monitor 209*d* via a cable 212," in addition to "an optional universal serial bus (USB) port 216 and an Ethernet port 218 [that] can be used, for example,

to transfer information between the monitor 209*d* and a computer (not shown) via a cable." *Id*., 18:9-28.

50. From this and related description, one of ordinary skill would have understood that the sensor 201 and monitor 209 together act as components of a physiological sensor device, and that in at least one embodiment (illustrated in FIG. 2D) that device is part of a larger system including a computer with which the physiological sensor device communicates. APPLE-1001, 2:38-48, 11:49-57, 16:20-18:28, FIGS. 1, 2A-2D.

51. The sensor included in the physiological sensor device "may include different architectures"; the '554 Patent describes several potential architectures with respect to FIGS. 14A-14I. APPLE-1001, 6:38-49, 35:36-38:20. For example, the '554 Patent's FIG. 14C (reproduced below) illustrates a sensor featuring a "detector submount 1400*c* … positioned under [a] protrusion 605*b* in a detector subassembly 1450 illustrated in FIG. 14D" (also reproduced below).

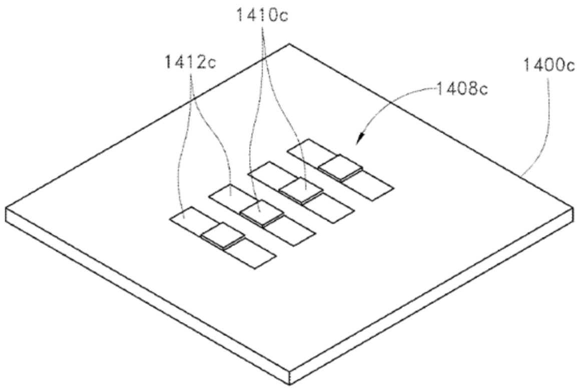


FIG. 14C

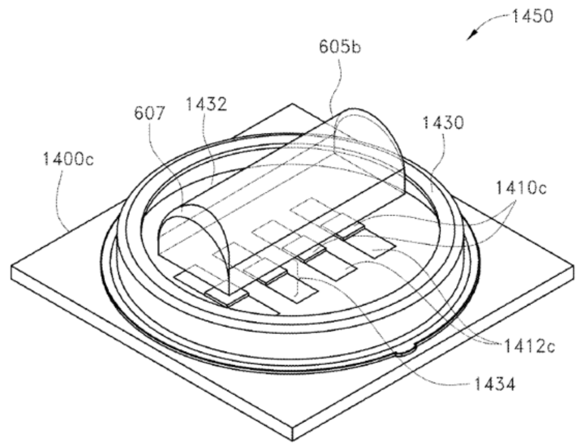


FIG. 14D

APPLE-1001, FIGS. 14C, 14D.

52. As illustrated in FIG. 14D, a cylindrical housing 1430 including "a transparent cover 1432, upon which the protrusion 605b is disposed" surrounds each of the detectors 1410*c*. APPLE-1001, 36:30-41. As the '554 Patent explains with respect to earlier embodiments, the "detectors … can capture and measure light transmitted from [an] emitter … that has been attenuated or reflected from the tissue in [a] measurement site," and can "output a detector signal … responsive to the light …." *Id.*, 14:3-9. The detectors "can be implemented using one or more photodiodes, phototransistors, or the like," and placement of a protrusion "over the photodiodes" is said to offer multiple benefits; the protrusion may, for example, "penetrate[] into the tissue and reduce[] the path length of the light …." *Id.*, 14:3-10, 24:16-35; *see also id.*, 10:61-11:13 ("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").

53. As illustrated in FIG. 14F (reproduced below), the sensor may also include a "shielding enclosure 1490" featuring a window 1492*a* corresponding to each of "the detectors 1410*c*, which allows light to be transmitted onto the detectors 1410*c*." *Id*., 37:9-17; *see also id*., 23:61-63 ("The windows 420, 421, 422, and 423 can also mimic or approximately mimic a configuration of, or even house, a plurality of detectors"), FIGS. 4A-4C.

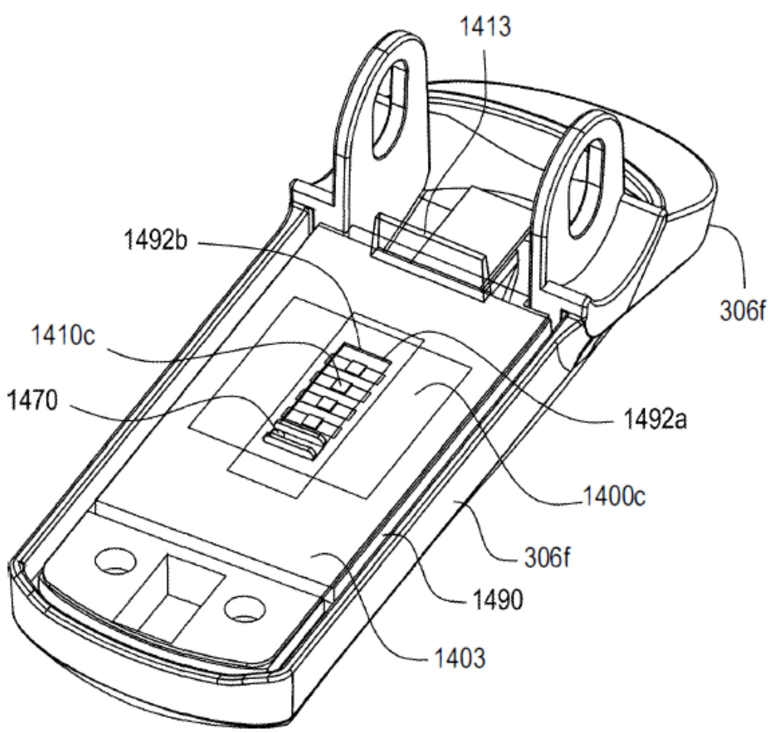


FIG. 14F

APPLE-1001, FIG. 14F.

54. As the ’554 Patent explains with respect to FIG. 1 (reproduced above), a “front end interface 108,” which “can have its components assembled in the sensor 101, in the monitor 109, …. combinations of the same, or the like,” “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.” *Id.*, 14:26-38; *see also id.*, 3:25-63. The “signal processor 110 includes processing logic that determines measurements for desired analytes … based on the signals received from the detectors 106,” and the monitor 109 can include a display 112 in addition to “outputs … such as a storage device 114 and a network interface 116.” *Id.*, 15:16-24.

55. In addition to the “physiological sensor device” described above, the ’554 Patent’s claimed “physiological measurement system” includes “a handheld computing device in wireless communication with the physiological sensor device.” *See*, *e.g.*, *id.*, 45:4-22 (claim 1). The claimed “handheld computing device” is said to include “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” with “an orientation” that “is configurable responsive to a user input;” and “a storage device configured to at least temporarily store … measurements of the physiological parameter.” *Id.*

56. Outside of the claims, the ’554 Patent’s only other reference to a “handheld computing device” occurs in the context of explaining that a patient monitor may include “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.” *Id.*, 2:45-48; *see also* 15:68-16:6 (explaining that monitor 109’s “network interface 116 can be a … wireless interface (e.g., WiFi such as any 802.lx interface, including an internal wireless card) … that allows the monitor 109 to communicate and share data with other devices”).

57. From this and related description, one of ordinary skill would have understood that the claimed “handheld computing device” is a generic computing device, and that each of its recited components (including the “one or more processors,” the “touch-screen display” with configurable orientation, and the “storage device”) are generic computing components. APPLE-1001, 2:45-48, 15:60-16:11, 18:9-28, FIGS. 1, 2D. Indeed, outside of the claims, the ’554 Patent does not specifically describe a processor, touch-screen display, or storage device as being included within a “handheld computing device” that is in wireless communication with a physiological sensor device. *See*, *generally*, ’554 Patent.

58. The ’554 Patent does describe similar components 110, 112, and 114 as being included within the device illustrated in FIG. 1. The ’554 Patent explains, for example, that the physiological sensor device’s “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." APPLE-1001, 15:24-28. Similarly, the '554 Patent states that the "user interface 112 can be implemented as a touch-screen display, an LCD display, an organic LED display, or the like." *Id.*, 15:46-59. Finally, the '554 Patent explains that "storage device 114 can include any computer-readable medium, such as a memory device, hard disk storage, EEPROM, flash drive, or the like." *Id.*, 15:60-68.

59. As such, if one of ordinary skill had consulted the '554 Patent for guidance with respect to the specifics of the components that are claimed as being included within the handheld computing device, one of ordinary skill would have instead found generic description of similar components that are included within the physiological sensor device with which the handheld computing device is said to communicate. *Id.*, 15:60-16:11. From this, one of ordinary skill would have understood the claimed "handheld computing device" to be a generic computing device with generic computing components.

B. Prosecution History of the '554 Patent

60. Only one non-final Office Action was issued during the prosecution of the application from which the '554 patent issued. APPLE-1002, 259-271. The Office

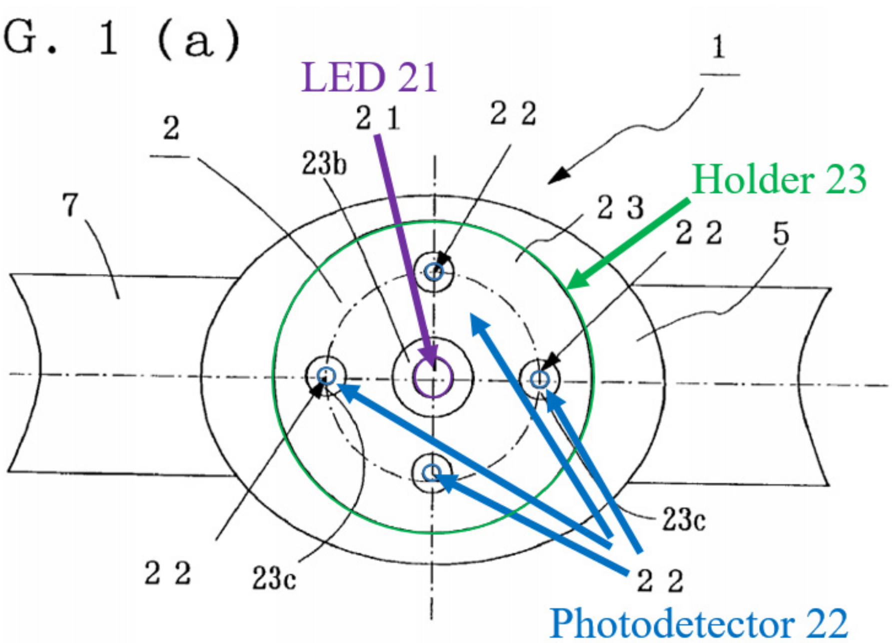
Action contained a single rejection—a double patenting rejection of the sole claim filed with the application over several previously granted patents in the family. *Id*., 330-347. A notice of allowance was issued in response to a terminal disclaimer and a new set of claims. *Id*., 375-387.

VI. SUMMARY OF THE PRIOR ART

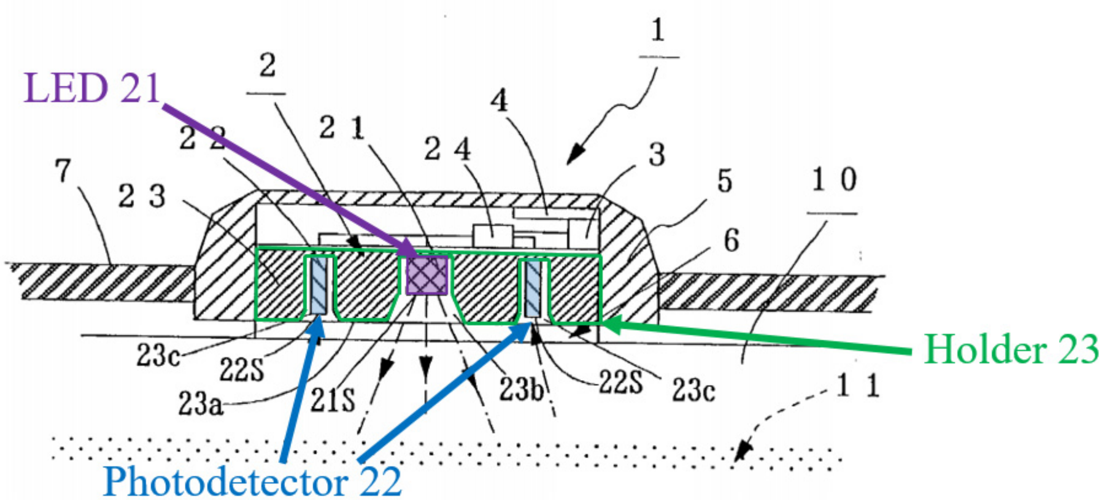
A. Overview of Aizawa

61. Aizawa relates to a "pulse wave sensor…detecting light output from a light emitting diode and reflected from the artery of a wrist of a subject." APPLE-1006, Abstract. Aizawa's sensor includes "four photodetectors disposed around the light emitting diode" and a "holder" that secures the light emitting diode (LED) and photodetectors. *Id*., ¶[0023]; FIGS. 1a, 1b (reproduced below).

F I G. 1 (a)



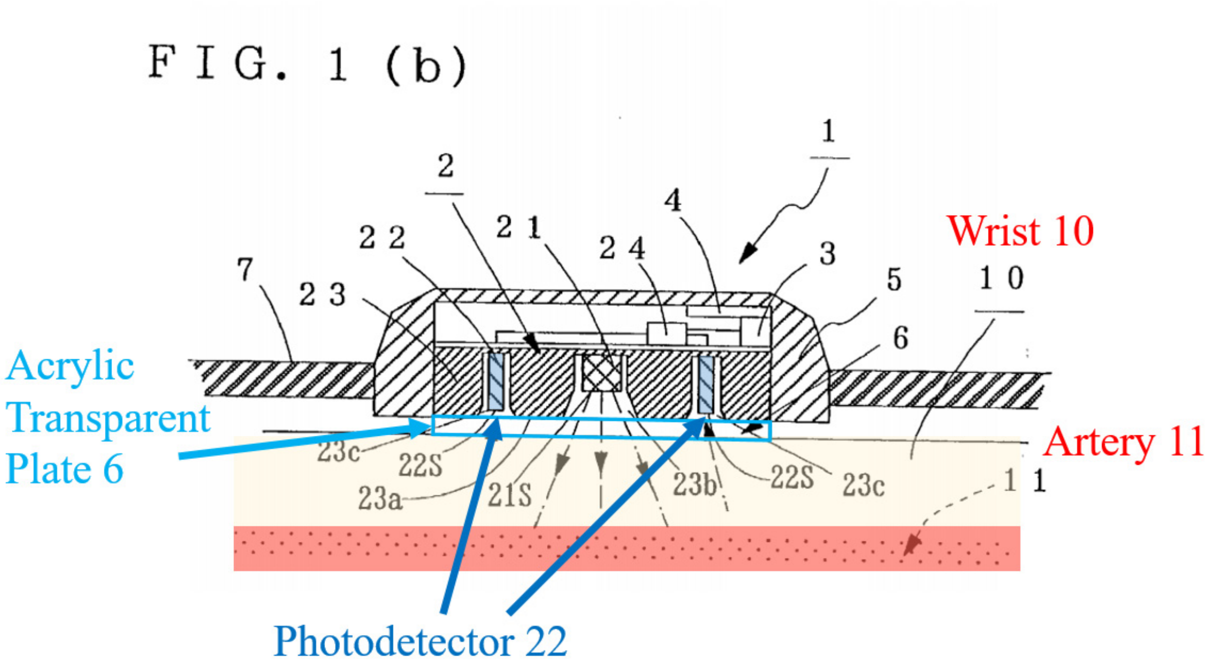
F I G. 1 (b)



APPLE-1006, FIG. 1a (top), FIG. 1b (bottom)

62. The sensor can be worn on a subject's wrist such that LED faces down on the wrist, and is fastened using a belt. *Id*., ¶[0026]. To improve adhesion between the sensor and the subject's wrist, Aizawa's sensor includes an acrylic transparent

plate positioned between the photodetectors and the wrist. For example, Aizawa's FIG. 1b (reproduced below) shows the plate in contact with the user's wrist. *Id.*, FIG. 1b.



APPLE-1006, FIG. 1b

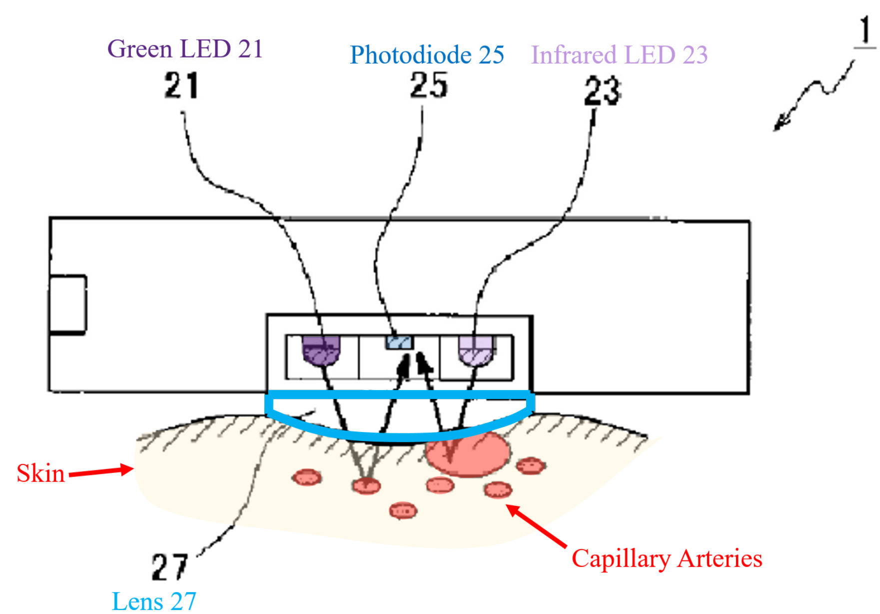
63. Aizawa's pulse wave sensor transmits its data to an "unshown display," and can be "coupled to devices making use of bio signals" and/or a device that performs computations. *Id.*, ¶[0023], [0028], [0035].

B. Overview of Inokawa

64. Inokawa is directed to a wearable optical sensing system that gathers "various kinds of vital sign information such as pulse." APPLE-1008, ¶(0001). Inokawa's system includes a sensor and a base device. *Id.*, ¶¶(0055)-(0066). The sensor includes a "pair of light-emitting elements," the reflected light of which is

used to "sense the pulse" of the subject by detecting "change in the amount of hemoglobin in the capillary artery" and to sense "body motion," and a "single photodiode" that "receives the reflected light" from the light-emitting elements. *Id.*, ¶¶(0058)-(0059); FIG. 2 (reproduced below). A convex lens is placed between the photodiode and the subject's skin; the lens is sufficiently rigid to make the tissue conform to the convex surface of the lens. *Id.*, ¶(0058).

(FIG. 2)

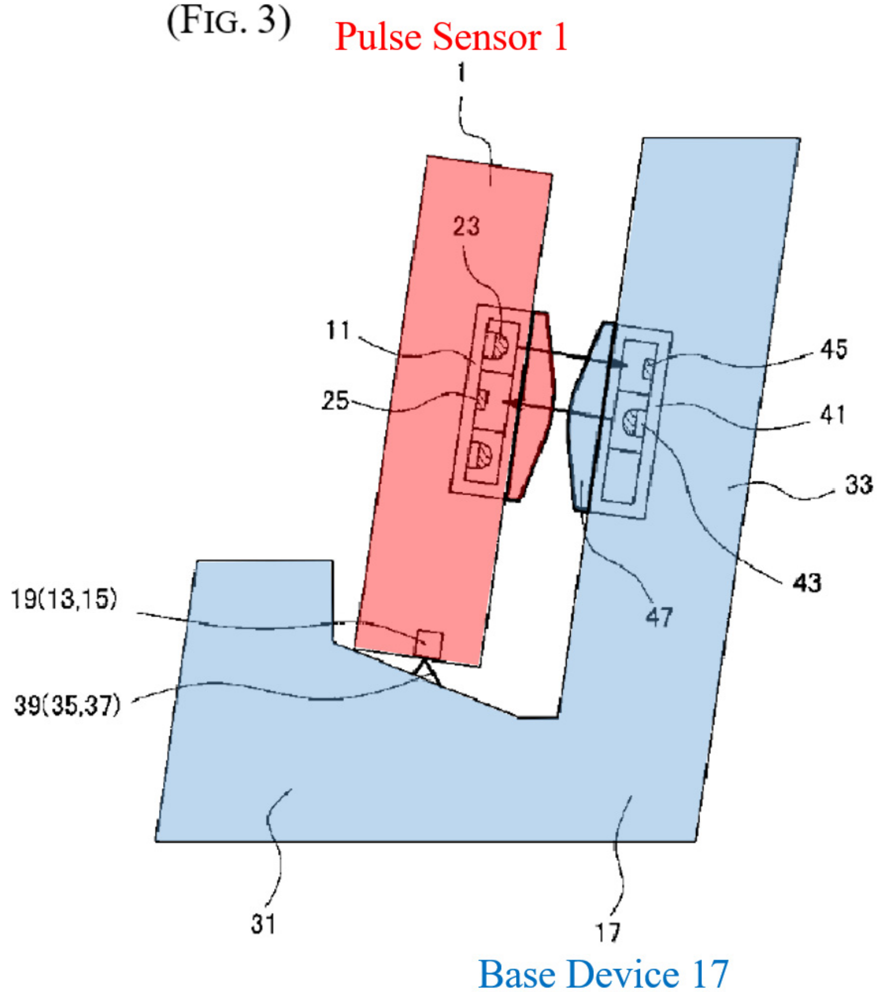


APPLE-1008, FIG. 2

65. The base device is "a charger with communication functionality that is used when the pulse sensor…is mounted." *Id.*, ¶(0060); FIG. 3. When the sensor is mounted onto the base device, "vital sign information…such as pulse and body motion, is transmitted to the base device…using the…infrared LED." *Id.*, ¶(0076). In other words, the sensor component transmits the collected data to a computer

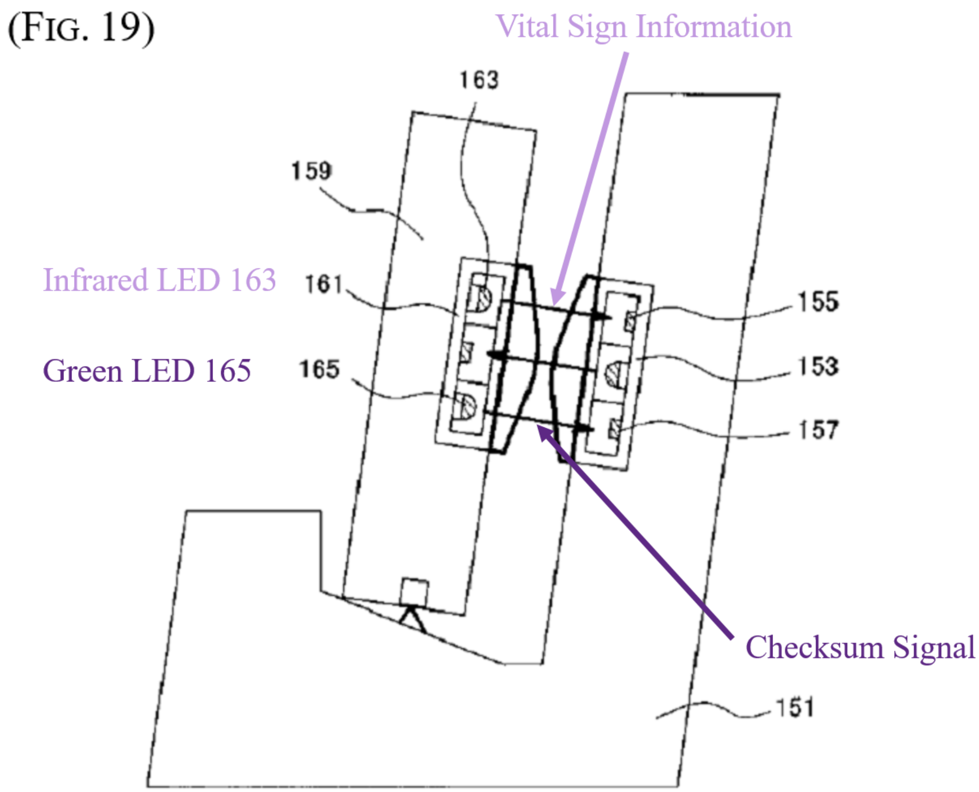
through the base device, using an optical communications interface implemented through the infrared LED. Additionally, with reference to FIG. 19 below, Inokawa teaches that two LEDs, instead of one, improve data transmission accuracy. In particular, Inokawa describes that "the presence of two pairs of light-emitting and light-receiving elements makes it possible to efficiently transmit information," including increasing the "**accuracy of data**…by transmitting and receiving a **checksum signal** using, for example, the S-side green LED 165 and the other B-side PD 157." APPLE-1008, ¶¶[0111], [0044], [0048].

(FIG. 3)



32

APPLE-1008, FIG. 3



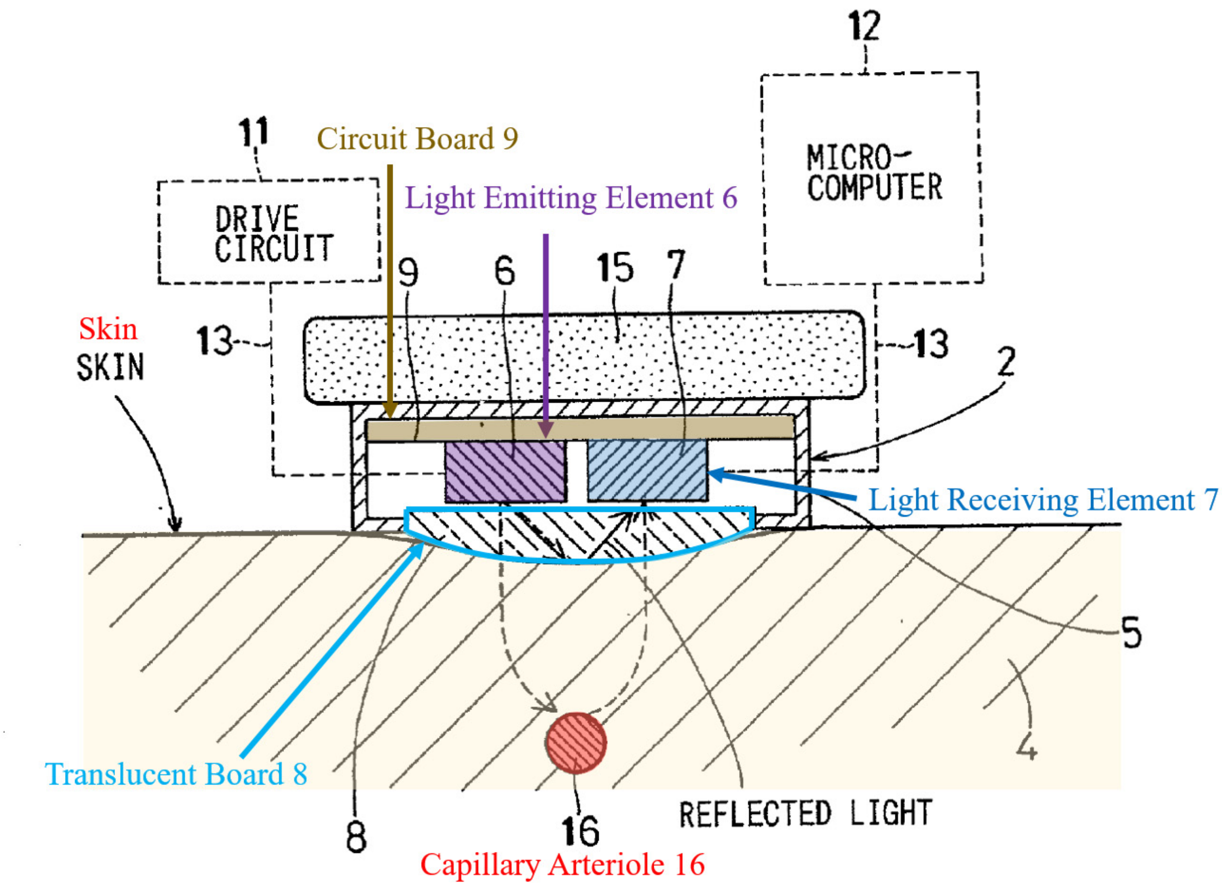
APPLE-1008, FIG. 19 (annotated)

C. Overview of Ohsaki

66. Ohsaki discloses a wrist-worn "pulse wave sensor" (APPLE-1009, ¶[0016]) having a "light emitting element" and a "light receiving element." *Id.*, ¶[0017]. Ohsaki's sensor addresses problems such as user discomfort and movement of the sensor by using a "translucent board" with a convex surface that is "in intimate contact with the surface of the user's skin" to prevent slippage. *Id.*, ¶¶[0009]-[0010]. Because the intensity of the light received by the detecting element "largely varies depending on the shift amount," or amount of movement of the

detecting element, Ohsaki's convex surface reduces the "amount of reflected light which is emitted" from the LED and reaches the detecting element "by being reflected by the surface of the user's skin." *Id.*, ¶[0025], FIG. 2 (reproduced below).

FIG. 2



APPLE-1009, FIG. 2

D. Overview of Mendelson 2006

67. Mendelson 2006 details the structure and testing of a "wireless wearable pulse oximeter" system. APPLE-1010, Abstract. Mendelson 2006's system uses a

pulse oximetry, a "widely accepted method that is used for noninvasive monitoring of SpO_2 and [heart rate]," to monitor a subject's physiological signals. *Id.*, 1. By wirelessly transmitting the collected data wirelessly, Mendelson 2006's system provides "numerous advantages," including the ability to determine the condition of a subject "remotely" without requiring the healthcare provider to be physically present. *Id.*

68. The system includes a sensor module, a receiver module, and a PDA. *Id.*, 913. As shown in FIGS. 1 and 2 of Mendelson 2006, the sensor module includes an "optical reflectance transducer" having two LEDs and a photodiode that "receives and processes the [photoplethysmographic (PPG)] signals" and transmits these signals wirelessly to the PDA through the receiver module. *Id.*; FIGS. 1 and 2 (reproduced below).

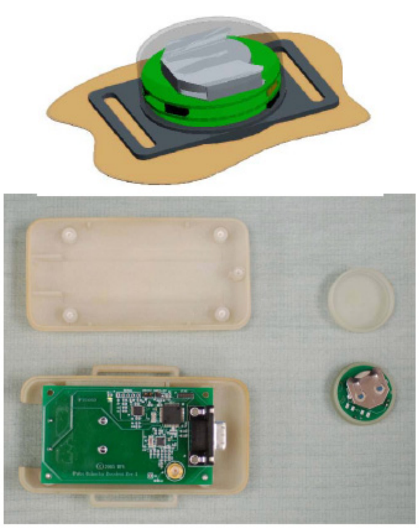


Fig. 1. (Top) Attachment of Sensor Module to the skin; (Bottom) photograph of the Receiver Module (left) and Sensor Module (right).

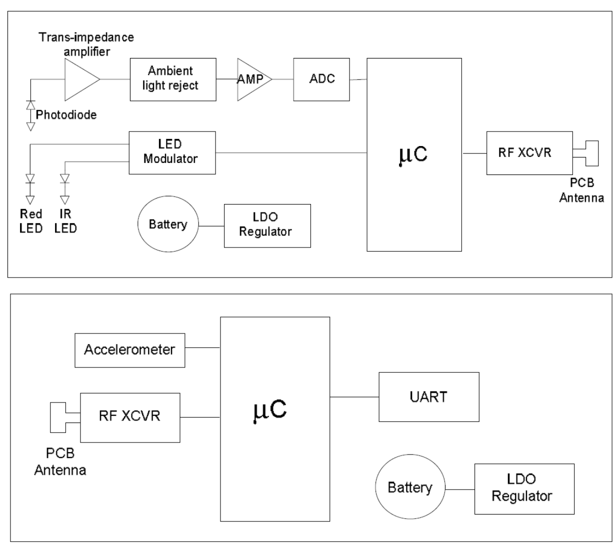


Fig. 2. System block diagram of the wearable, wireless, pulse oximeter. Sensor Module (top), Receiver Module (bottom).

APPLE-1010, FIG. 1 (left) and FIG. 2 (right)

69. The PDA is a handheld device that provides a "touch screen" interface and a simple graphical user interface (GUI) "configured to present the input and output information to the user and allow[for] easy activation of various functions." APPLE-1010, FIG. 3 (reproduced below); *see also* APPLE-1021, Cover, xvii-xviii, 10-12, 17, 63, 363; APPLE-1022, 4-11, 30-31.

Fig. 3. Sample PDA Graphical User Interface (GUI).

APPLE-1010, FIG. 3

E. Overview of Bergey

70. Bergey discloses a wristwatch in which the "electronics are hermetically sealed in the watch case to be free of dust and moisture." APPLE-1016, Abstract.

The components are "sealed to produce a unit that is shockproof and waterproof, regardless of the environment in which it is placed." *Id*., 2:56-67.

VII. GROUND 1 – Claims 1-7 and 20-28 are Rendered Obvious by Aizawa, Inokawa, Ohsaki, and Mendelson 2006

A. Combination of Aizawa, Inokawa, Ohsaki, and Mendelson 2006

1. *Plurality of emitters*

71. As I have described in Section VI.A, Aizawa discloses a pulse wave sensor in which multiple detectors are disposed around a centrally located LED/emitter. APPLE-1006, ¶[0023]. Aizawa explains that "[t]he arrangement of the light emitting diode 21 and the photodetectors 22 is not limited" to that shown or described in connection with any particular embodiment. APPLE-1006, ¶[0032]. Although Aizawa emphasizes the desirability of disposing photodetectors "on a circle concentric to" a light source, so as to enable accurate pulse wave detection "even when the attachment position of the pulse rate detector 1 is dislocated," Aizawa describes alternative arrangements in which "a plurality of light emitting diodes 21" are employed. *Id*., ¶¶[0032]-[0033].

72. One of ordinary skill would have combined the teachings of Aizawa and Inokawa such that Aizawa's pulse wave sensor would be modified to include an additional LED as taught by Inokawa to improve the detected pulse wave by distinguishing between blood flow detection and body movement. APPLE-1008, ¶(0059) (describing the use of the "S-side green LED 21…to sense the pulse from

the light reflected off of the body (i.e. change in the amount of hemoglobin in the capillary artery), while the S-side infrared LED 23 serves to sense body motion from the change in this reflected light"); APPLE-1006, ¶[0006] (recognizing the problem of weak signals from a wearable sensor because the sensor "detects the motion of a red corpuscle…and is easily affected by noise caused by the shaking of the body of the subject), ¶[0028] (describing a device for "computing the amount of motion load" such that the motion can be compensated for).

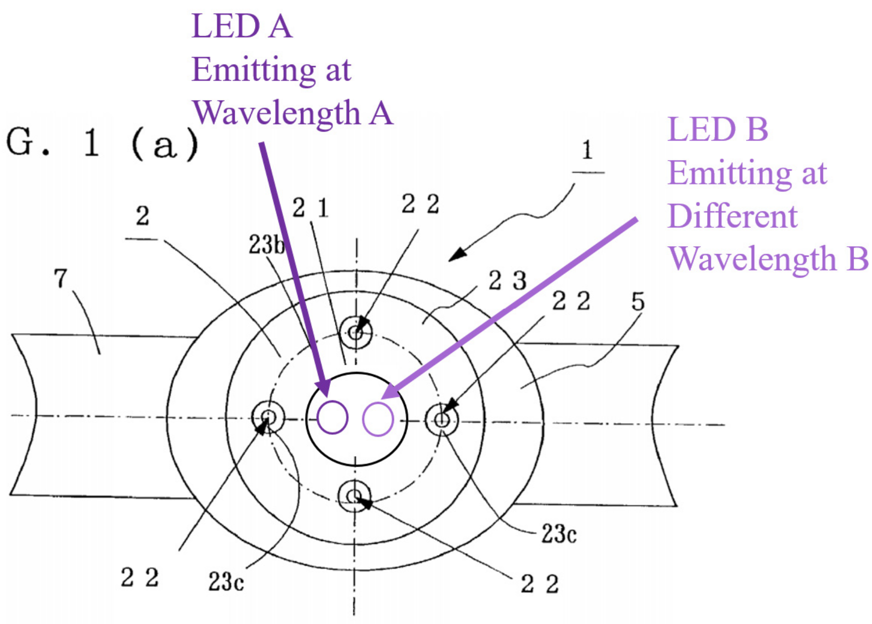
73. One of ordinary skill would also have looked to Inokawa's disclosure of two LEDs emitting light of different wavelengths, in part, because it provides additional functionality, including that of a wireless communication method. *Id*. Inokawa's base device 17 receives, for example, "pulse and body motion" data through "the S-side infrared LED 23 of the pulse sensor 1 and the B-side PD 45 of the base device 17." *Id*., ¶(0076). "As a result, there is no need to use a special wireless communication circuit or a communication cable as previously, which makes it possible to transmit vital sign information to the base device 17 accurately, easily, and without malfunction." *Id*., ¶[0077]. In other words, the LEDs provided on the sensor can be used not only to detect pulse rate but also to "accurately, easily, and without malfunction" transmit the sensed data to a base station.

74. Intrinsic and extrinsic records confirm that one of ordinary skill would have naturally looked to another wearable physiological sensor, as disclosed in Inokawa, for transmission details. Aizawa's device contemplates uploading data to a base device yet is silent about how such transmission would be implemented. APPLE-1006, ¶[0023] (describing its "transmitter for transmitting the above pulse rate data to an unshown display"), ¶[0028] (describing that the transmitter also transmits data to "a device for computing the amount of motion load"). One of ordinary skill would have recognized that the LED of Aizawa could be used for data communication to a personal computer for further analysis in a way that is wireless, eliminating problems associated with a physical cable, and that does not require a separate RF circuit, as taught by Inokawa. One of ordinary skill would have further recognized that the use of two distinct LEDs to perform such communication would result in enhanced accuracy of the transmitted information.

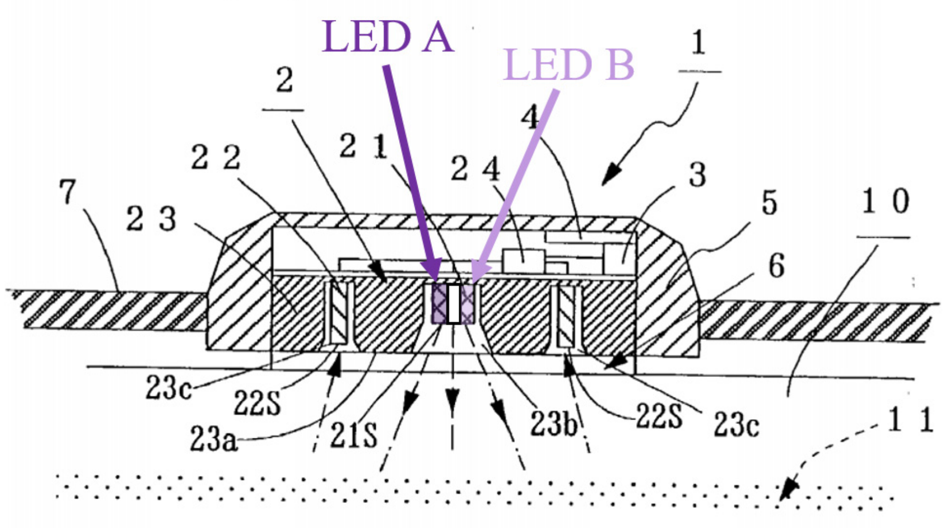
75. To obtain the advantages described by Inokawa (e.g., to improve the detected pulse wave by enabling the sensor to distinguish between blood flow detection and body movement, in addition to enabling wireless communication between the sensor and a base station), one of ordinary skill would have been motivated to modify Aizawa's pulse wave sensor to include an additional LED. APPLE-1008, ¶¶[0058]-[0059]; APPLE-1006, ¶¶[0006], [0028].

76. As illustrated below, the Aizawa-Inokawa sensor would have featured two LEDs in place of Aizawa's LED 21.

F I G. 1 (a)



F I G. 1 (b)



APPLE-1006, FIGS. 1(a) (top, annotated) and 1(b) (bottom, annotated)

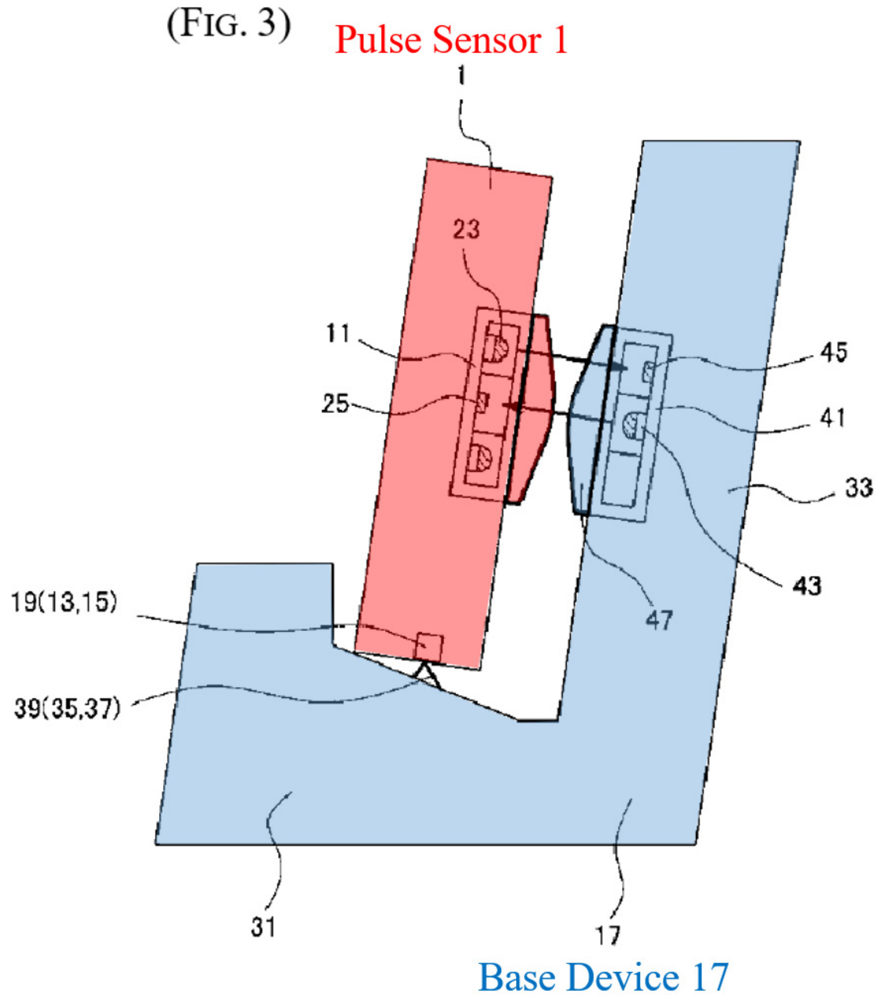
77. Aizawa-Inokawa would utilize two LEDs that emit two different wavelengths. Aizawa's LED 21 would simply be replaced with two LEDs. In this manner, Aizawa's sensor is improved through the implementation of a separate LED to account for motion load which the system already records and accounts for. APPLE-1006, ¶¶[0006], [0028], [0035].

78. One of ordinary skill would have combined the teachings of Aizawa and Inokawa as doing so would have amounted to nothing more than the use of a known technique to improve similar devices in the same way and combining prior art elements according to known methods to yield predictable results. *KSR v. Teleflex*, 550 U.S. 398, 417 (2007). Here, the combination is nothing more than improving Aizawa's pulse wave sensor that uses a single LED with the use of a known technique disclosed by Inokawa to detect and record body motion in addition to blood flow. Furthermore, the elements of the combined system would each perform similar functions they had been known to perform prior to the combination. *Id*. For instance, in Aizawa-Inokawa, Aizawa's photodetectors would still detect light emitted by the LEDs and reflected by the subject's wrist, and Inokawa's two LEDs would still be used to emit light at different wavelengths. *Id*. Furthermore, one of ordinary skill would have readily understood how to select different photodiodes with different sensitivities to detect the different wavelengths of light emitted by the two LEDs. *Id*.

79. Although Inokawa shows its two emitters emitting light toward a centrally located detector, one of ordinary skill would have recognized that the same effect can be achieved by having the emitters located centrally instead and emitting radially outward. Indeed, Aizawa itself recognizes this reversibility, stating that while the configurations depicted include a central emitter surrounded by detectors, the "same effect can be obtained when…a plurality of light emitting diodes 21 are disposed around the photodetector 22." APPLE-1006, ¶[0033].

2. *Transmission of information*

80. When Inokawa's sensor is mounted onto the base station, "vital sign information…such as pulse and body motion, is transmitted to the base device…using the…infrared LED." *Id.*, ¶[0076]. The "base device 17 is connected to a PC 59, and information transmitted from the pulse sensor 1 is downloaded to the PC 59 via the base device 17." *Id.*; *see also id.*, ¶¶[0074] ("in transmission mode, **data stored in the memory 63, such as pulse, is transmitted to the base device 17**. In short, data is downloaded"), [0075]("when the pulse sensor 1 is mounted onto the base device 17, information about pulse, etc. is automatically transmitted from the pulse sensor 1 to the base device 17. **The base device 17, meanwhile, upon receiving the information transmitted from the pulse sensor 1, transmits this information to the PC 59**"), [0077] ("Hence, the PC 59 is able to obtain vital sign information by downloading it from the base device 17").



APPLE-1008, FIG. 3

81. In other words, in Inokawa, the physiological sensor device's sensor component transmits physiological measurement data to an included base station via an optical communications interface, and the physiological sensor device's base station transmits signals responsive to a physiological parameter to a computer, via a network interface. APPLE-1008, ¶¶[0002], [0003], [0067], [0074]-[0077].

82. Inokawa does not explicitly describe wireless communication between the base station and a computer, but one of ordinary skill would have found it obvious to implement the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, and Ohsaki as part of a physiological measurement system including a handheld computing device, and to enable the physiological sensor device to communicate wirelessly with the handheld computing device. APPLE-1006, Abstract, [0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1008, ¶¶[0002], [0003], [0067], [0074]-[0077]; APPLE-1010, 1-4, FIG. 3.

83. Furthermore, while Inokawa does not explicitly describe wireless communication between the base station and a computer, one of ordinary skill would have found it obvious to implement the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, and Ohsaki as part of a physiological measurement system including a handheld computing device, and to enable the physiological sensor device to communicate wirelessly with the handheld computing device. APPLE-1006, Abstract, [0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1008, ¶¶[0002], [0003], [0067], [0074]-[0077]; APPLE-1010, 1-4, FIG. 3.

84. Indeed, by the ’554 patent’s 2008 earliest effective filing date, physiological monitoring devices commonly employed touch-screen displays. Yitzhak

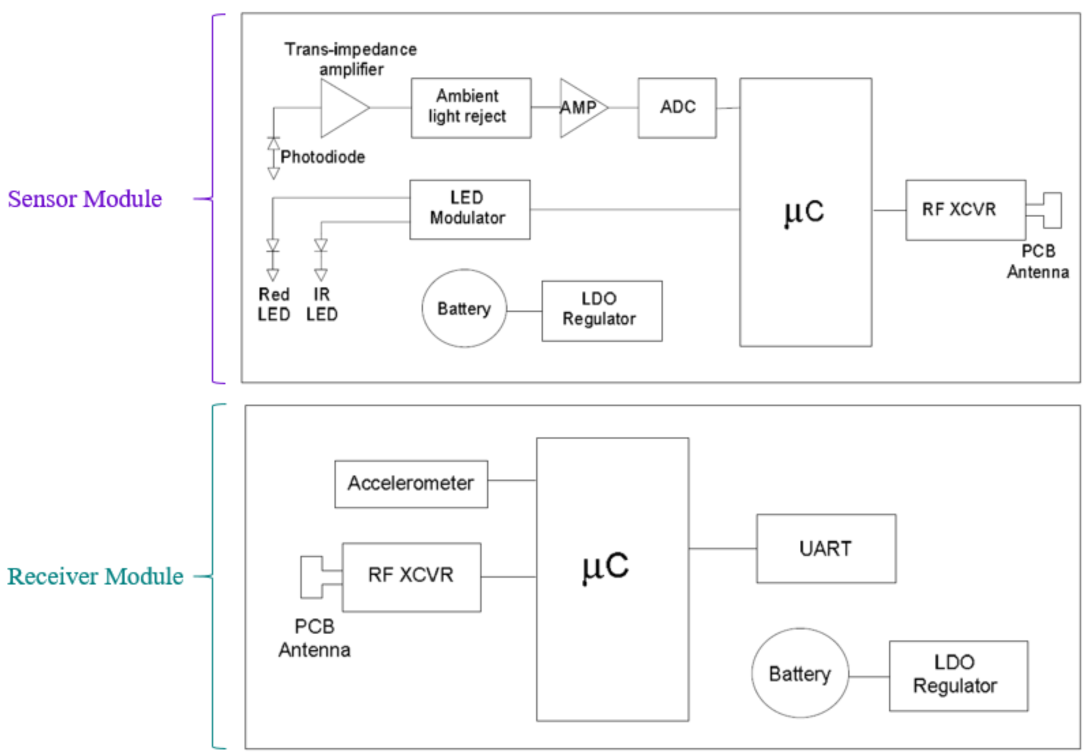
Mendelson's 2006 paper "A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring," for example, describes a "body-worn" pulse oximetry system that includes a sensor module, a receiver module, and a PDA. APPLE-1010, 3.

85. As discussed above in Section VI.D and incorporated herein, Mendelson-2006's system includes a sensor module that transmits signals wirelessly to a PDA through a receiver module. *Id.*, 913, FIGS. 1-3.

86. The PDA is said to "provide[] a low-cost touch screen interface." *Id.*, 3-4; *see also* APPLE-1020, 1-4 (depicting and describing the touch-screen display included within the HP iPAQ h4150 Pocket PC PDA utilized in Mendelson-2006's system); APPLE-1021, Cover, xvii-xviii, 10-12, 17, 63, 363; APPLE-1022, 4-11, 30-3. In more detail, and as shown in Mendelson-2006's FIG. 3 (reproduced below), the PDA's "simple GUI" is "configured to present … input and output information to the user" and to allow "easy activation of various functions." *Id.*, 4.

87. One of ordinary skill would have been motivated to look to other physiological sensor systems, such as Mendelson-2006, for details regarding data transmission and display of the data collected using the Aizawa-Inokawa-Ohsaki sensor. *See*, *e.g.*, APPLE-1020, 1-4; APPLE-1021, xvii-xviii, 10-12, 17, 63, 73-101, 176, 190-193, 363; APPLE-1022, 4-11, 30-31, 56-67, 72-92

88. In more detail, and as shown in Mendelson-2006's FIG. 2, the sensor module includes an "optical reflectance transducer" for measuring photoplethysmographic (PPG) signals, and the receiver module includes "an embedded microcontroller." *Id.*, 1-2. "Signals acquired by the Sensor Module are received by the embedded microcontroller which synchronously converts the corresponding PD output to R and IR PPG signals," and "[d]edicated software is used to filter the signals and compute [arterial oxygen saturation (SpO_2)] and [heart rate (HR)] based on the relative amplitude and frequency content of the reflected PPG signals." *Id.*



APPLE-1010, FIG. 2 (annotated)

89. “[I]nformation acquired by the Sensor Module is transmitted wirelessly via an RF link over a short range to a body-worn Receiver Module,” and data processed by the receiver module is “transmitted wirelessly to a PDA.” *Id*., 2, FIG. 2. Mendelson-2006’s system uses “the HP iPAQ h4150 PDA because it can support both 802.11b and Bluetooth™ wireless communication.” *Id*., 3. The PDA is used “as a local terminal,” and it “also provides a low-cost touch screen interface.” *Id.*; *see also* APPLE-1020, 1-4 (depicting and describing the HP iPAQ h4150 Pocket PC PDA utilized in Mendelson-2006’s system); APPLE-1021, Cover, xvii-xviii, 10-12, 17, 63, 73-101, 176, 190-193, 363; APPLE-1022, 4-11, 30-31, 56-67, 72-92, 284-297.

90. Wireless communication with the handheld PDA is, moreover, said to enable transfer of information pertaining to physiological and wellness parameters such as “SpO_2, HR, body acceleration, and posture information” to the PDA; and, when the PDA is “carried by medics or first responders,” this information is said to enhance their ability “to extend more effective medical care, thereby saving the lives of critically injured persons.” *Id*.

APPLE-1010, FIG. 3 (left) and APPLE-1020, 1 (right)

91. To obtain these and other advantages described by Mendelson-2006, one of ordinary skill would have been motivated to implement Aizawa's pulse wave sensor as part of a physiological measurement system including a handheld computing device, and to enable a physiological sensor device including sensor 1 to communicate wirelessly with the handheld computing device. APPLE-1006, Abstract ("a pulse wave sensor for detecting a pulse wave by detecting light output from a light emitting diode and reflected from the artery of a wrist of a subject "), ¶¶[0002], [0005], [0008]-[0016], [0023] (describing transmitting "pulse rate data to

an unshown display”), [0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1010, 1-4, FIG. 3; *see also* APPLE-1020, 1-4.

92. Indeed, by the Critical Date, physiological monitoring devices commonly included touch-screen displays configured to provide user interfaces. APPLE-1009, 1-4, FIG. 3; APPLE-1024, Abstract, ¶¶[0026], [0044], FIGS. 1-6. One of ordinary skill would have recognized that applying Mendelson-2006’s teachings to the Aizawa-Inokawa-Ohsaki sensor would have led to predictable results without altering or hindering the functions performed by the sensor. In fact, one of ordinary skill would have been motivated to implement the well-known technique of connecting a physiological sensor to a handheld device to cause Aizawa-Inokawa-Ohsaki’s sensor to include such features to achieve the predictable benefits offered by Mendelson-2006’s description of the same. *Id*. For example, one of ordinary skill would have incorporated Mendelson-2006’s disclosure of a PDA with a touch-screen display and “simple GUI” to present “information to the user” and provide “easy activation of various functions.” APPLE-1010, 4. Indeed, one of ordinary skill would have had a reasonable expectation of success in making this modification, and would have reasonably expected to reap benefits of displaying a measured waveform representative of a patient’s pulse. *Id*.

93. For at least these reasons, one of ordinary skill would have found it obvious to implement Aizawa’s unshown display as a PDA featuring a touch-screen display

and/or mobile phone functionality[1] using either or both of 802.11b and Bluetooth™. APPLE-1006, ¶[0015], [0023], [0028], [0035]; *see also* APPLE-1020, 1-4; APPLE-1009, ¶[0020]; APPLE-1012, Abstract, 8:37-41, 9:22-10:30, FIGS. 7, 8; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1021, xvii-xviii, 10-12, 17, 63, 73-101, 176, 190-193, 363; APPLE-1022, 4-11, 30-31, 56-67, 72-92.

3. *Convex surface*

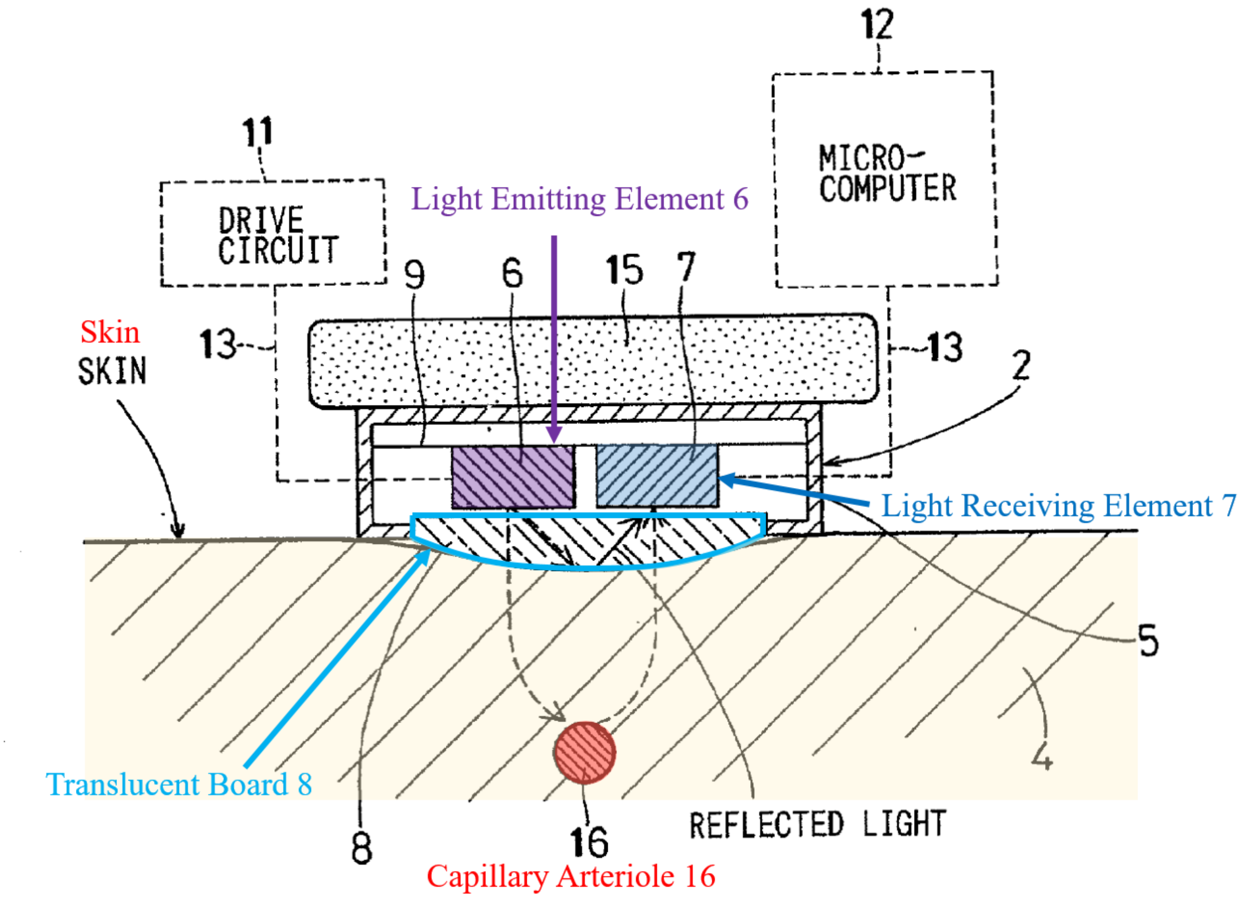
94. Additionally, one of ordinary skill would have combined the teachings of Aizawa-Inokawa with the teachings of Ohsaki such that the cover of Aizawa-Inokawa's wrist-worn sensor would include a convex surface, improving adhesion between a subject's wrist and a surface of the sensor. APPLE-1009, ¶[0025] (the convex surface prevents slippage of the detecting element from its position on the

[1] Mendelson-2006 does not explicitly disclose its PDA to be a mobile phone. Yet it was well-known before the Critical Date that a PDA device was often paired with cellular communication technology to provide a combined PDA/phone device that acts a mobile phone. APPLE-1025, Title ("Cellular Phone/PDA Communication System"), Abstract, 1:6-15, 7:6-10:11 (describing "a small handheld cellular phone/PDA communications system" featuring "an LCD display 16 that is also a touch screen system"), FIGS. 1-3.

subject's wrist, and the convex nature of the surface suppresses the "variation of the amount of the reflected light" that reaches the detecting element).

95. In more detail, Ohsaki describes a "detecting element" that includes "a package 5, a light emitting element 6 (e.g., LED), a light receiving element 7 (e.g., PD), and a translucent board 8." APPLE-1009, ¶[0017]. "The package 5 has an opening and includes a" substrate in the form of "circuit board 9," on which light emitting element 6 and light receiving element 7 are arranged. *Id*.. As shown in Ohsaki's FIG. 2, translucent board 8 is arranged such that, when the sensor is worn "on the user's wrist … the convex surface of the translucent board … is in intimate contact with the surface of the user's skin"; this contact between the convex surface and the user's skin is said to prevent slippage, which increases the strength of the signals obtainable by Ohsaki's sensor. APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

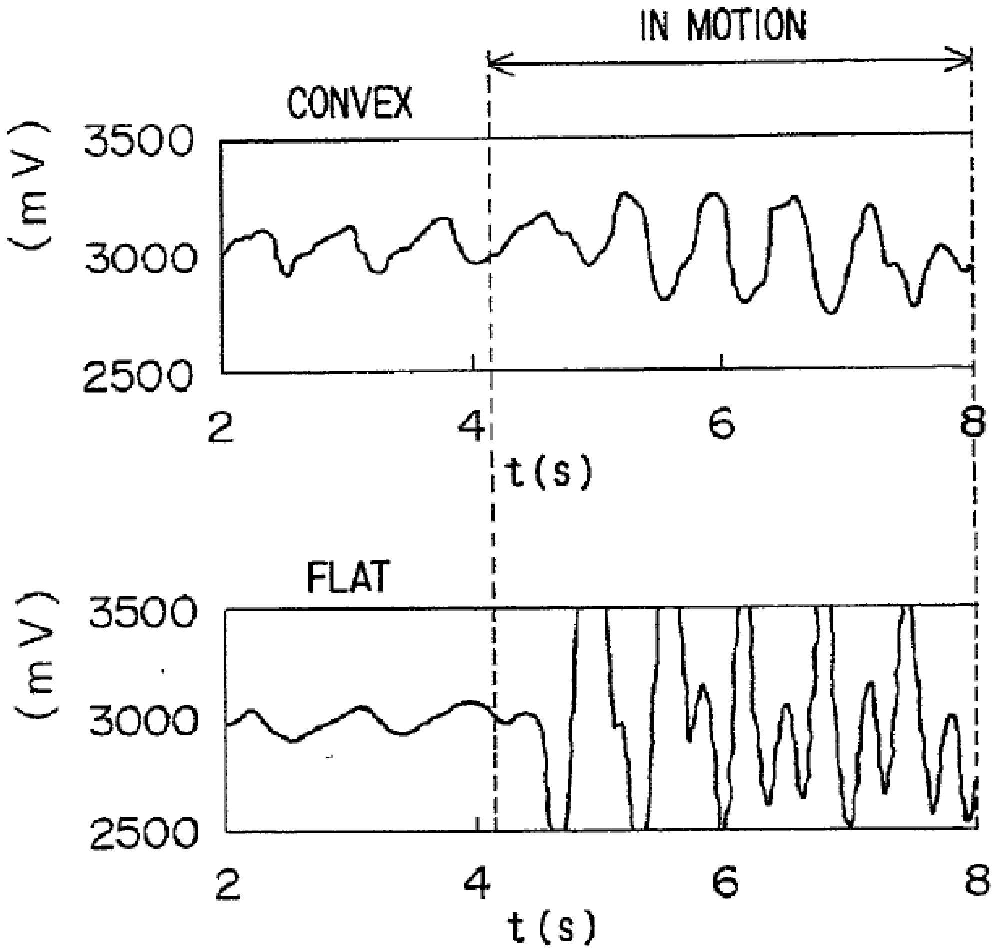
FIG. 2



APPLE-1009, FIG. 2 (annotated)

96. Ohsaki explains that "if the translucent board 8 has a flat surface, the detected pulse wave is adversely affected by the movement of the user's wrist as shown in FIG. 4B," but that if "the translucent board 8 has a convex surface…variation of the amount of the reflected light…that reaches the light receiving element 7 is suppressed." APPLE-1009, [0025]. The convex surface is also said to prevent "disturbance light from the outside" from penetrating translucent board 8. *Id*. Thus, when a convex cover is used, "the pulse wave can

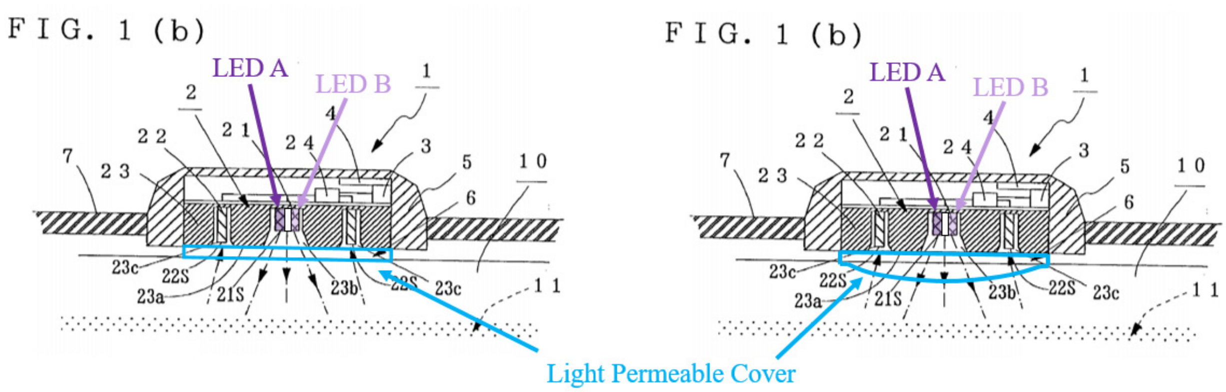
be detected without being affected by the movement of the user's wrist 4 as shown in FIG. 4A." *Id*.



APPLE-1009, FIGS. 4A, 4B

97. As shown below, one of ordinary skill would have found it obvious to modify the sensor's flat cover (left) to include a lens/protrusion (right), similar to Ohsaki's translucent board 8, so as to improve adhesion between the user's wrist and the sensor's surface, improve detection efficiency, and protect the elements within the sensor housing. APPLE-1009, ¶[0025] (explaining that the convex

surface of translucent board 8 prevents slippage of a detecting element from its position on the wrist, and suppresses the “variation of the amount of the reflected light” that reaches the detecting element); APPLE-1024, ¶¶[0033], [0035], FIG. 6 (depicting an LED featuring a convex lens).



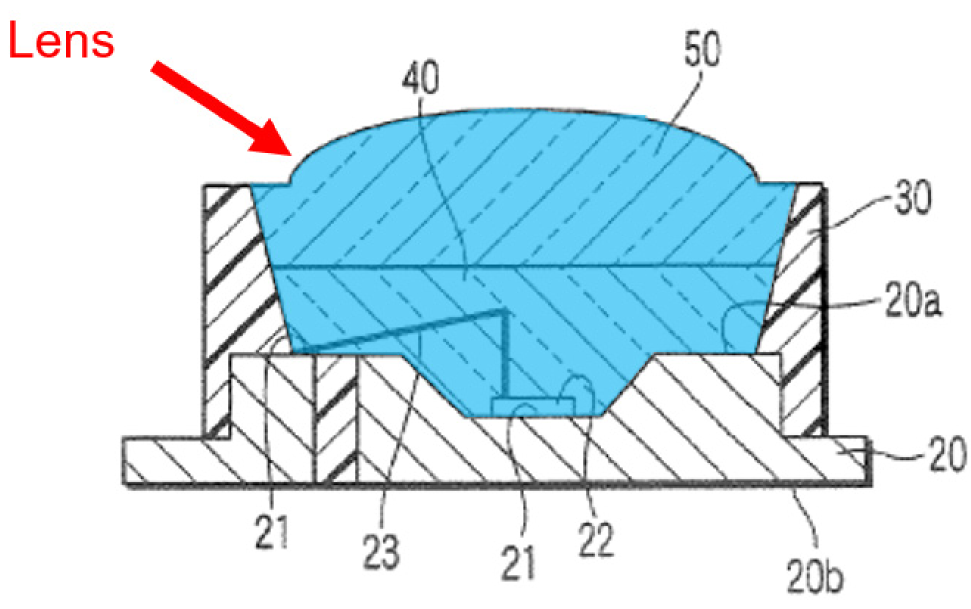
APPLE-1006, FIG. 1(b) (annotated)

98. One of ordinary skill would have combined the teachings of Aizawa-Inokawa and Ohsaki as doing so would have amounted to nothing more than the use of a known technique to improve similar devices in the same way. One of ordinary skill would have recognized that incorporating Ohsaki’s convex surface is simply improving Aizawa-Inokawa’s transparent plate 6 that has a flat surface to improve adhesion to a subject’s skin and reduce variation in the signals detected by the sensor. *Id*. Furthermore, the elements of the combined system would each perform similar functions they had been known to perform prior to the combination—Aizawa-Inokawa’s transparent plate 6 would remain in the same

position, performing the same function, but with a convex surface as taught by Ohsaki. *Id*.

99. One of ordinary skill would have further recognized that the material used to make Ohsaki's translucent board could be, for example, a translucent plastic material that can be easily formed to include a convex protrusion. APPLE-1006, 3:46-41, FIG. 1; APPLE-1026, ¶¶[0022], [0032], [0035], FIG. 6. Indeed, many prior art references of this period, such as Nishikawa (shown below) demonstrate exactly how such a convex shape may be incorporated into a molded cover. APPLE-1026, ¶¶[0022], [0032], [0035], FIG. 6.

FIG. 6

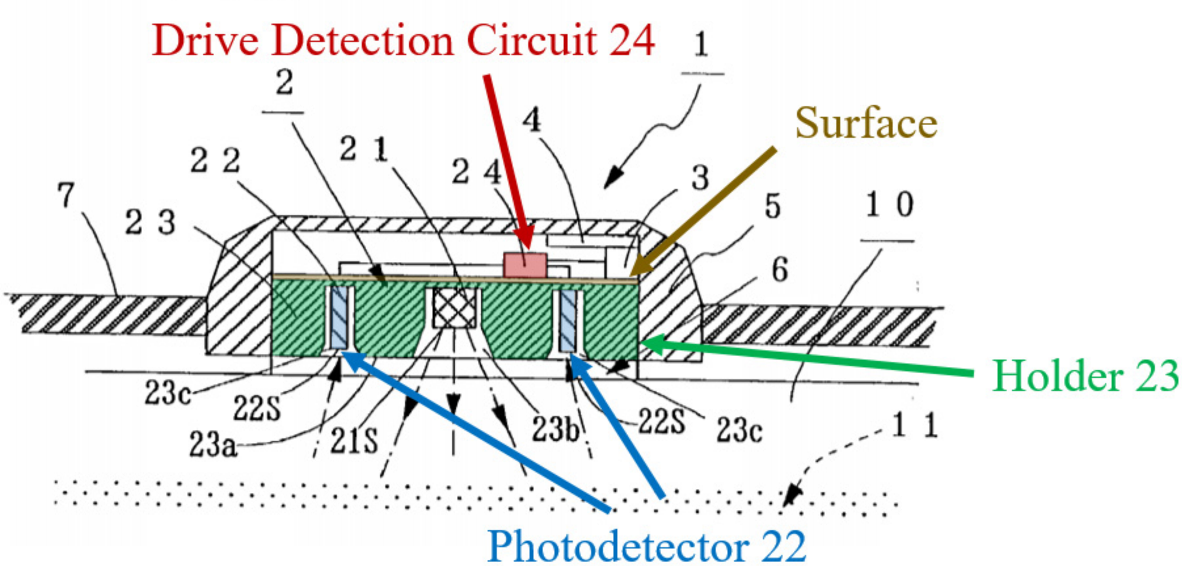


APPLE-1026, FIG. 6 (annotated)

4. *Substrate*

100. One of ordinary skill would have found it obvious that Aizawa's photodetectors are arranged on a substrate. For example, one of ordinary skill would have understood that Aizawa's photodetectors are secured to the sensor device, provided with power by a power source (also not shown), and can transmit signals to other portions of the sensors through such a structure. One of ordinary skill would have understood that the substrate provides physical support and electrical connectivity and is connected to the holder 23. Indeed, one of ordinary skill would have found it obvious to use such a substrate because it provides a simpler manufacturing process and more compact design than using and routing wires would allow. As shown in FIG. 1(b), Aizawa illustrates a substrate, but does not label or describe such a structure.

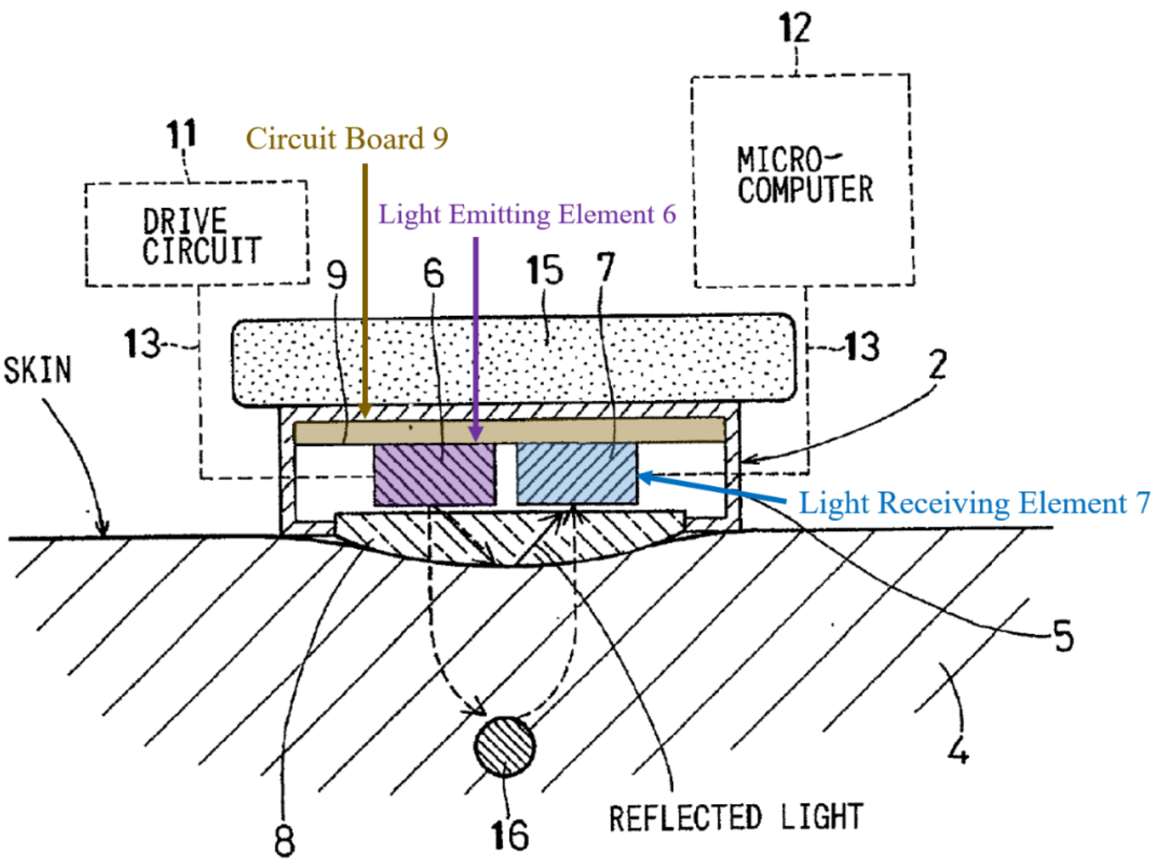
F I G. 1 (b)



APPLE-1006, FIG. 1(b) (annotated)

101. To the extent that the surface of holder 23 does not explicitly disclose a substrate, one of ordinary skill would have been motivated to modify Aizawa to incorporate a substrate, such as Ohsaki's circuit board 9 to secure photodetectors 22 and enable photodetectors 22 to send signals to other portions of the sensor.

FIG. 2



APPLE-1009, FIG. 2 (annotated)

102. One of ordinary skill would have been motivated to modify Aizawa to incorporate Ohsaki's circuit board 9 to enable photodetectors 22 to send signals to other portions of the sensor. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-

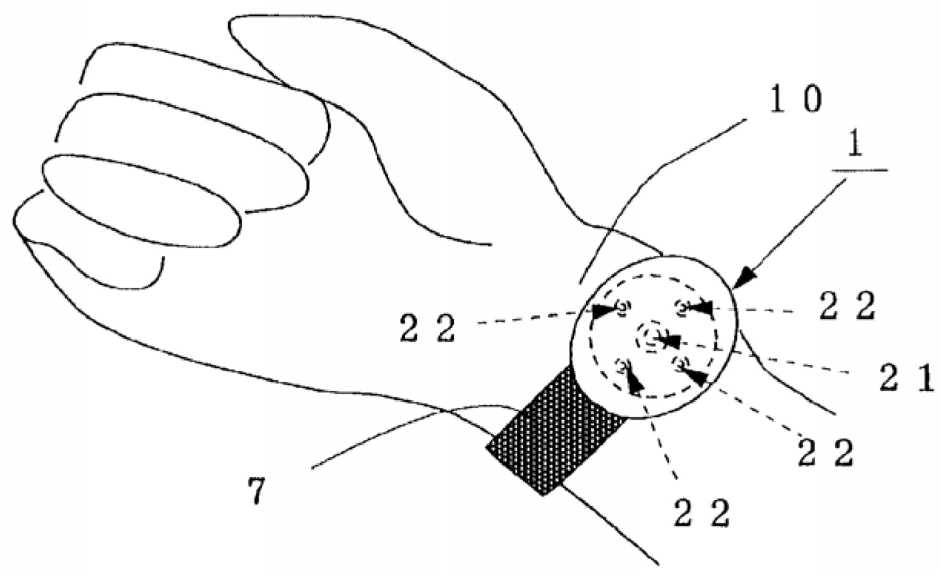
[0016], [0023], [0027]-[0029], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶[0017], FIG. 2.

B. Claim 1

[1pre] A physiological measurement system comprising:

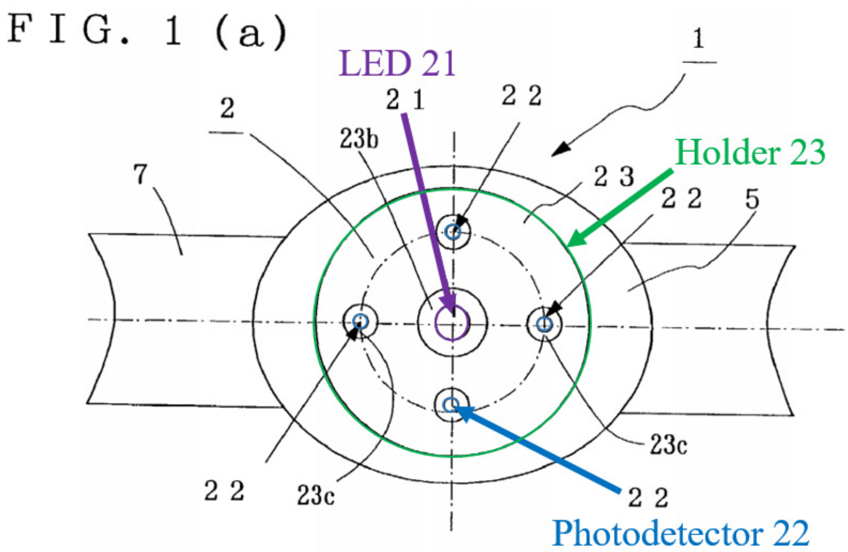
103. To the extent the preamble is limiting, Aizawa discloses "a pulse wave sensor for detecting a pulse wave by detecting light output from a light emitting diode and reflected from the artery of a wrist of a subject." APPLE-1006, Abstract, FIGS. 1(a), 1(b), 2. Aizawa's "optical pulse wave sensor" is configured to be worn "on the inner side" of a subject's wrist "with a belt" such that the light emitting diode faces toward the wrist. APPLE-1006, ¶¶[0005], [0026]. In operation, the light emitting diode irradiates an artery of the wrist "with light having a wavelength of an infrared range," and the optical sensor noninvasively detects "the pulse wave … from light reflected from a red corpuscle in the artery …" APPLE-1006, ¶¶[0002], [0008]-[0016]. Aizawa's FIG. 2 (reproduced below) shows the structure of the optical pulse wave sensor and its placement on the subject's wrist. *Id*., ¶[0018].

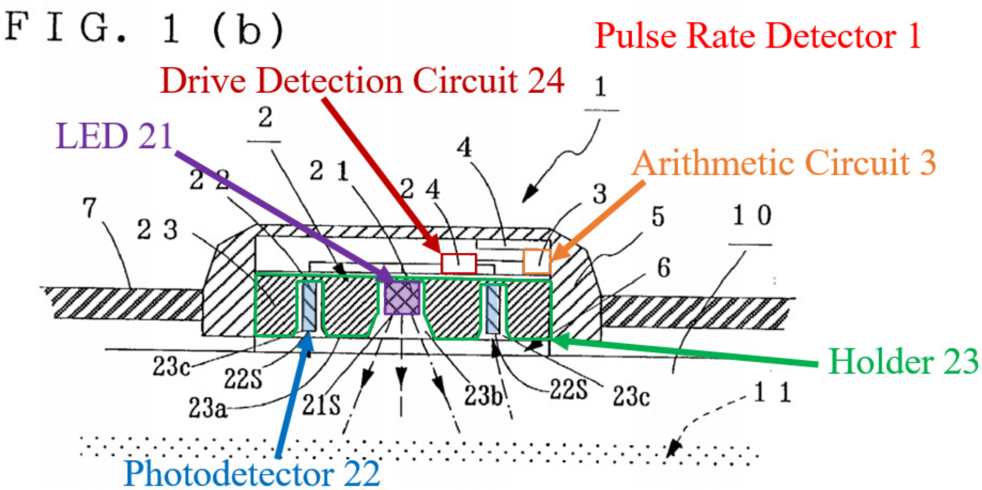
FIG. 2



APPLE-1006, FIG. 2

104. In more detail, and as shown in Aizawa's FIGS. 1(a) and 1(b) (reproduced below), Aizawa's "pulse wave detector" includes an optical sensor featuring "an **LED** 21 (to be referred to as 'light emitting diode' hereinafter) for emitting light having a wavelength of a near infrared range, **four phototransistors** 22 (to be referred to as 'photodetectors' hereinafter) disposed around the light emitting diode 21symmetrically on a circle concentric to the light emitting diode 21, a **holder** 23 for storing the above light emitting diode 21 and the photodetectors 22," and "an **acrylic transparent plate** [6] mounted to the detection face 23*a* of the holder 23 …." APPLE-1006, ¶[0023] (throughout my declaration, emphasis in quotations is added, unless otherwise indicated).





APPLE-1006, FIGS. 1(a), 1(b) (annotated)

105. As shown, Aizawa's detector also includes "a **drive detection circuit** 24 for detecting a pulse wave by amplifying the outputs of the photodetectors 22," "an **arithmetic circuit** [3] for computing a pulse rate from the detected pulse wave data," and "a **transmitter** [4] for transmitting the above pulse rate data to an unshown **display**." APPLE-1006, ¶[0023].

106. In at least this way, Aizawa depicts and describes a noninvasive optical physiological measurement system that includes pulse rate detector 1, its attachment belt 7, and an unshown display. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], FIGS., 1(a), 1(b), 2.

107. Accordingly, [1pre] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[1a] a physiological sensor device comprising:

108. As explained above with respect to [1pre], Aizawa depicts and describes a physiological measurement system featuring a pulse rate detector 1 that includes an optical sensor featuring "an **LED** 21 (to be referred to as 'light emitting diode' hereinafter) for emitting light having a wavelength of a near infrared range, **four phototransistors** 22 (to be referred to as 'photodetectors' hereinafter) disposed around the light emitting diode 21symmetrically on a circle concentric to the light emitting diode 21, a **holder** 23 for storing the above light emitting diode 21 and the photodetectors 22," and "an **acrylic transparent plate** [6] mounted to the detection face 23*a* of the holder 23 …." APPLE-1006, ¶[0023]. Aizawa's sensor also includes "a transmitter [4] for transmitting the above pulse rate data to an unshown display." *Id*. Additionally, one of ordinary skill would have been motivated to add Inokawa's base station to Aizawa's physiological sensor device such that the sensor device includes a sensor and a base station with which the

sensor communicates and through which the sensor communicates with a handheld device.

FIG. 1 (a)

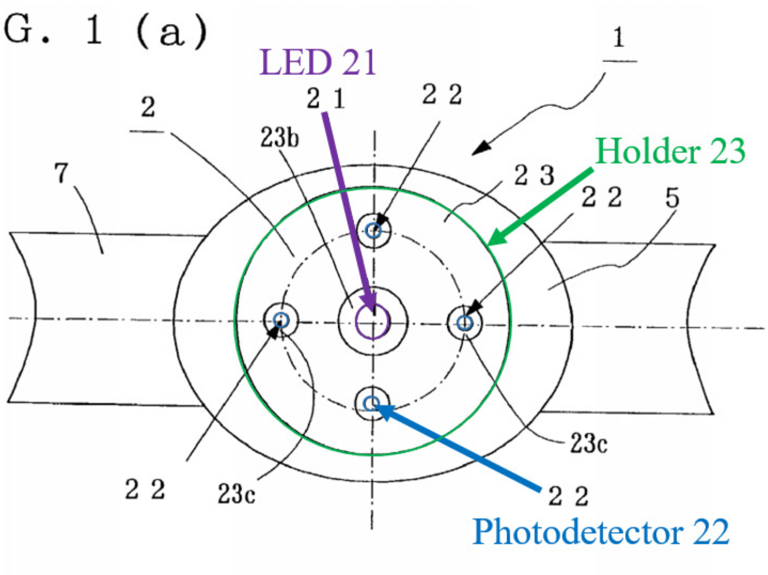
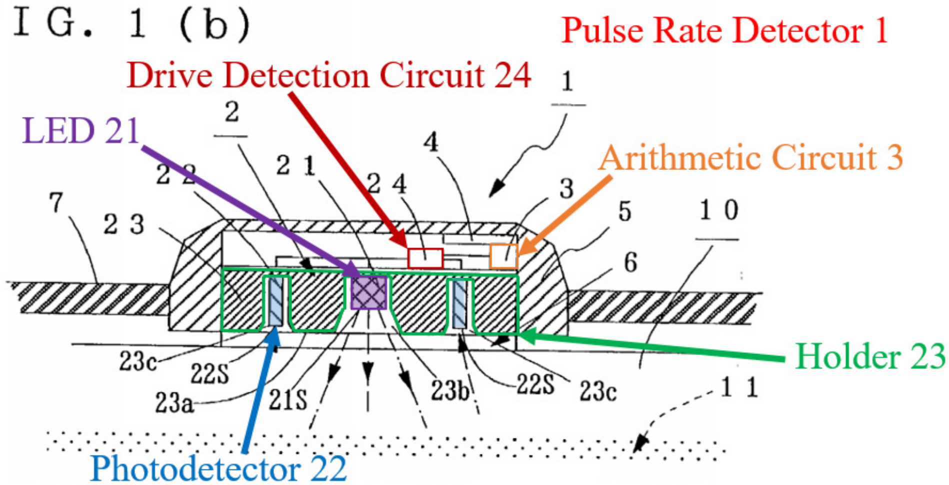


FIG. 1 (b)

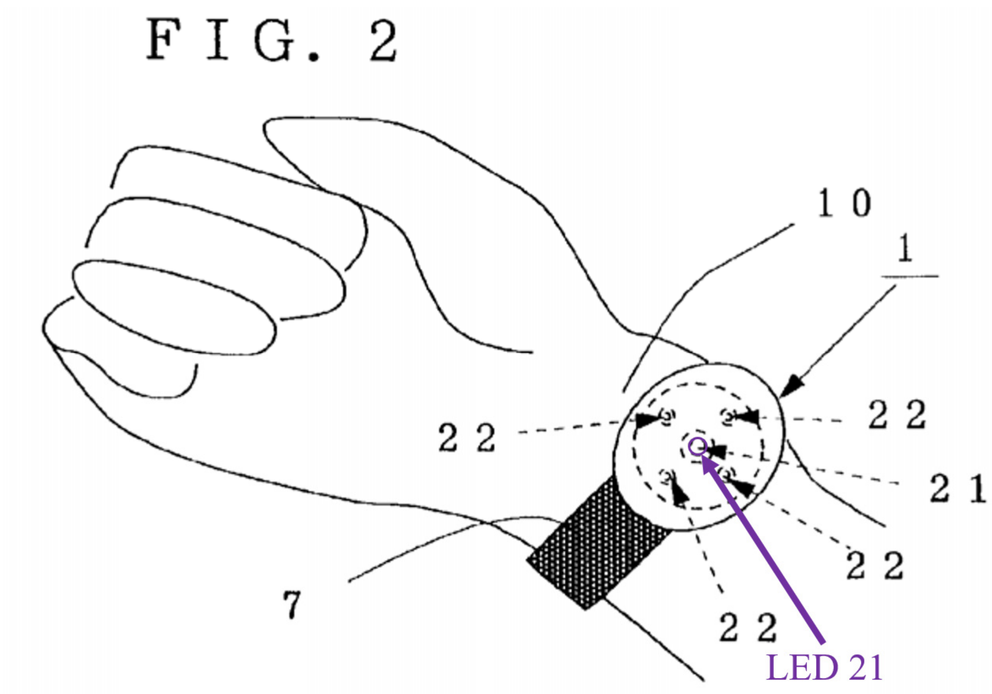


APPLE-1006, FIGS. 1(a), 1(b) (annotated)

109. Accordingly, [1a] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[1b] a plurality of emitters configured to emit light into tissue of a user;

110. As explained above with respect to [1pre], Aizawa depicts and describes a noninvasive optical physiological sensor that includes an "LED 21" that is configured to emit light into tissue of a user. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], FIGS. 1(a), 1(b), 2.



APPLE-1006, FIG. 2 (annotated)

111. In more detail, and as shown in Aizawa's FIGS. 1(a) and 1(b) (reproduced below) Aizawa discloses "an LED 21 (to be referred to as 'light emitting diode' hereinafter) for emitting light having a wavelength of a near infrared range." APPLE-1006, ¶[0023]. The light emitting diode outputs "[n]ear infrared radiation…**toward the wrist**" of the user, and this radiation is "reflected by a red

corpuscle running through [an] artery" and detected by a "plurality of photodetectors 22 …." *Id.*, ¶[0027].

FIG. 1 (a)

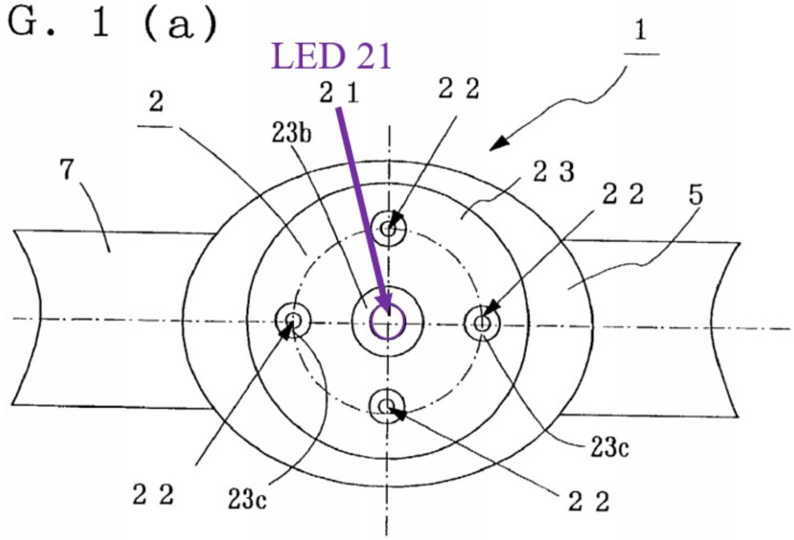
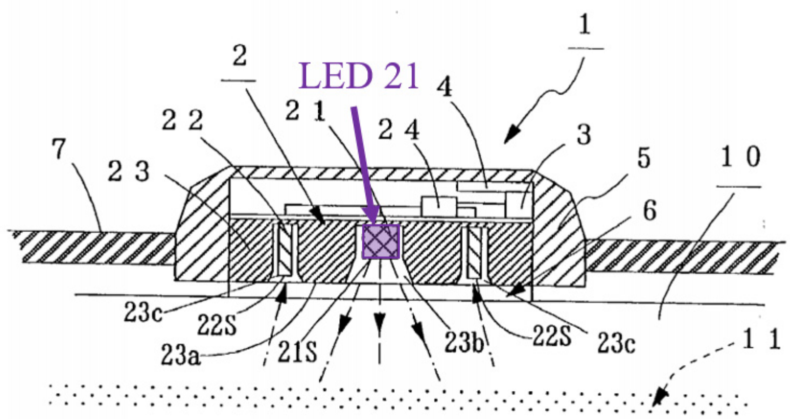


FIG. 1 (b)



APPLE-1006, FIGS. 1(a) (top, annotated) and (1b) (bottom, annotated)

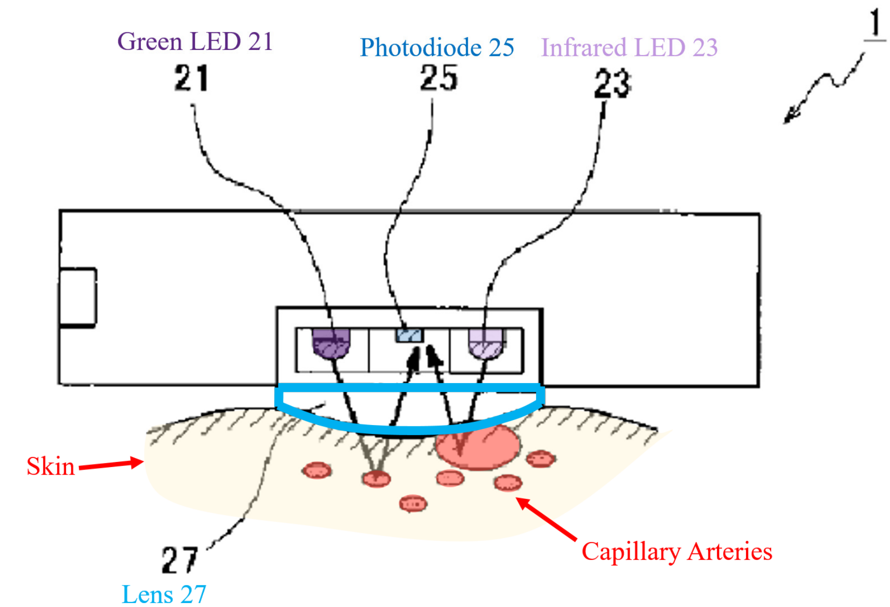
112. As Aizawa explains, "[t]he arrangement of the light emitting diode 21 and the photodetectors 22 is not limited" to that shown or described in connection with any particular embodiment. APPLE-1006, ¶[0032]. Indeed, and although Aizawa

emphasizes the desirability of disposing photodetectors "on a circle concentric to" a light source, so as to enable accurate pulse wave detection "even when the attachment position of the pulse rate detector 1 is dislocated," Aizawa describes alternative arrangements in which "a plurality of light emitting diodes 21" are employed. *Id.*, ¶¶[0032]-[0033].

113. To the extent that Aizawa does not explicitly disclose a plurality of emitters, one of ordinary skill would have found it obvious to modify Aizawa to incorporate a plurality of emitters. Indeed, various prior art in the relevant timeframe disclose the use of multiple emitters in pulse-measuring sensors similar to Aizawa's. *Id.*

114. Inokawa, for example, is directed to a wearable optical sensing system that gathers "various kinds of vital sign information such as pulse." APPLE-1008, ¶[0001]. Inokawa's physiological sensor device includes a sensor and a base station. *Id.*, ¶¶[0055]-[0066]. The sensor includes a "pair of light-emitting elements," the reflected light of which is used to "sense the pulse" of the subject by detecting "change in the amount of hemoglobin in the capillary artery" and to sense "body motion," and further includes a "single photodiode" that "receives the reflected light" from the light-emitting elements. *Id.*, ¶¶[0058]-[0059]; FIG. 2 (reproduced below). A convex lens is placed between the photodiode and the subject's skin; the lens is sufficiently rigid to make the tissue conform to the convex surface of the lens. *Id.*, ¶[0058].

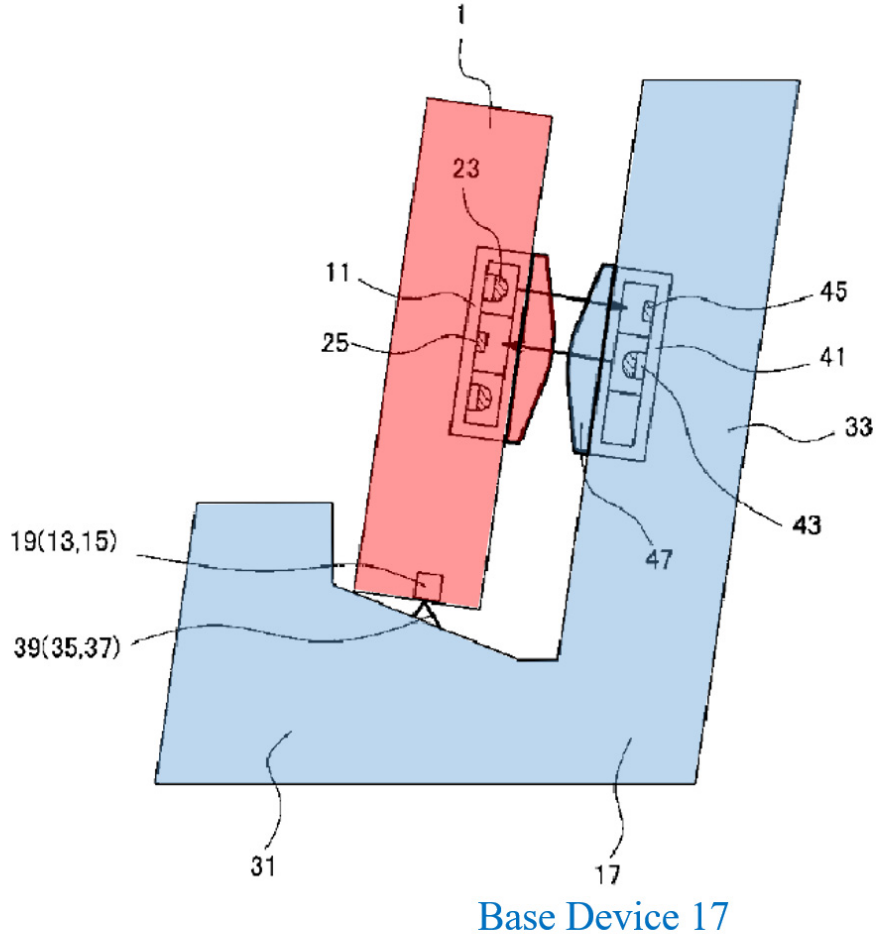
(FIG. 2)



APPLE-1008, FIG. 2

115. The base station is "a charger with communication functionality that is used when the pulse sensor…is mounted." *Id.*, ¶[0060]; FIG. 3. When the sensor is mounted onto the base station, "vital sign information…such as pulse and body motion, is transmitted to the base device…using the…infrared LED." *Id.*, ¶[0076]. This enables the sensor component to transmit collected data to a computer through the base station, using an optical communications interface implemented through Inokawa's infrared LED. *Id.*, ¶¶[0002], [0003], [0067], [0074]-[0077].

(FIG. 3)



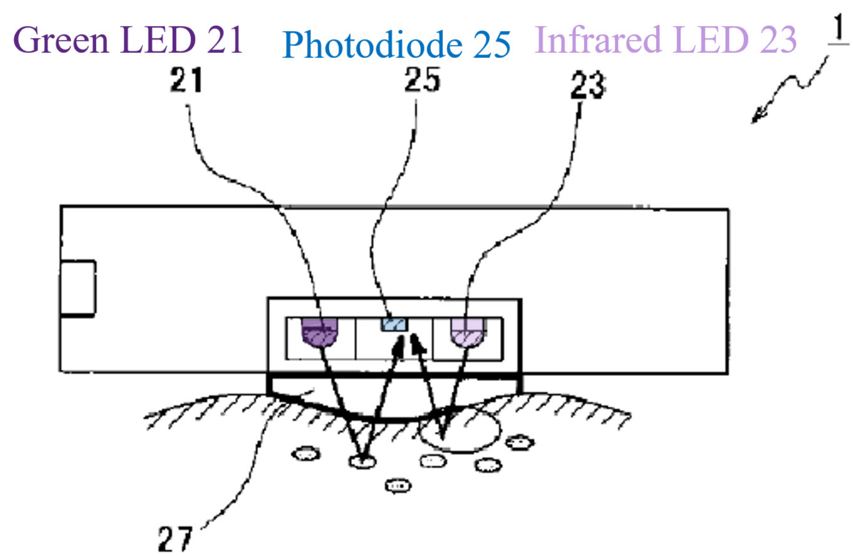
APPLE-1008, FIG. 3

116. In addition to enabling optical communication, the use of multiple LEDs emitting light at different wavelengths—e.g. infrared and green LEDs—enables Inokawa's sensor to detect body motion. APPLE-1008, ¶[0014]. As Inokawa explains, "when using sensor-side light-emitting means of various kinds…the manner of use can be adjusted according to the properties of each respective means" such that "work can be divided between the various means, with an

infrared LED used to **detect vital signs** and **transmit** vital sign information, and a green LED used to **detect pulse**." APPLE-1008, ¶¶[0014], [0040].

117. More specifically, and as shown in Inokawa's FIG. 2 (reproduced below), Inokawa's pulse sensor includes "a green light-emitting diode (S-side green LED) 21 and an infrared light-emitting diode (S-side infrared LED) 23, [and] a single photodiode (S-side PD) 25 that receives the reflected light from these." *Id.*, ¶[0058]. The green LED senses "the pulse from the light reflected off of the body (i.e. change in the amount of hemoglobin in the capillary artery)" and the infrared LED senses "body motion from the change in this reflected light." *Id.*, ¶[0059].

(FIG. 2)



APPLE-1008, FIG. 2 (annotated)

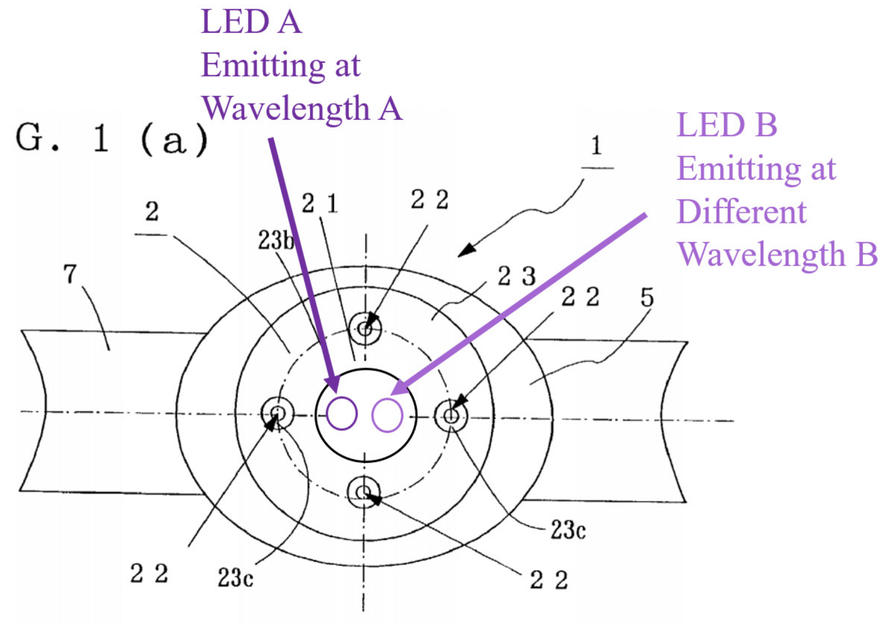
118. To obtain the advantages described by Inokawa (e.g., to improve the detected pulse wave by enabling the sensor to distinguish between blood flow

detection and body movement, in addition to enabling wireless communication between the sensor and a base station), one of ordinary skill would have been motivated to modify Aizawa's pulse wave sensor to include an additional LED. APPLE-1008, ¶¶[0058]-[0059] (describing the use of the "S-side green LED 21…to sense the pulse from the light reflected off of the body (i.e. change in the amount of hemoglobin in the capillary artery), while the S-side infrared LED 23 serves to sense body motion from the change in this reflected light"); APPLE-1006, ¶¶[0006] (recognizing the problem of weak signals from a wearable sensor because the sensor "detects the motion of a red corpuscle…and is easily affected by noise caused by the shaking of the body of the subject"), [0028] (describing a device for "computing the amount of motion load" such that the motion can be compensated for).

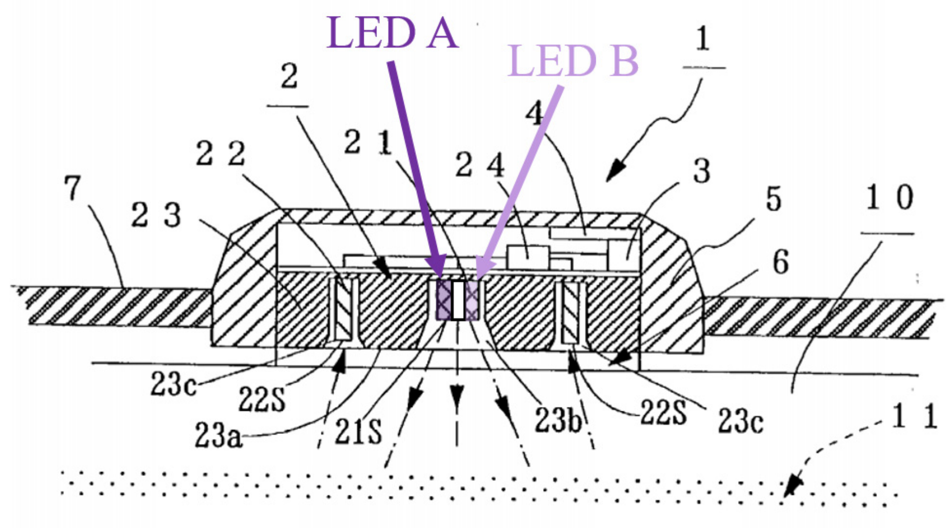
119. As shown below, the sensor that would have resulted from the combination of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have featured two LEDs in place of Aizawa's LED 21.

LED A
Emitting at
Wavelength A

F I G. 1 (a)



F I G. 1 (b)



APPLE-1006, FIGS. 1a (top, annotated) and 1b (bottom, annotated)

120. More specifically, one of ordinary skill would have replaced Aizawa's LED 21 with two LEDs, each emitting a different wavelength. As suggested by Inokawa, one of ordinary skill would have recognized that this would improve

Aizawa's sensor by enabling it to account for motion load through use of the second LED, by detecting and recording body motion in addition to blood flow. APPLE-1008, ¶¶[0006], [0028], [0035].

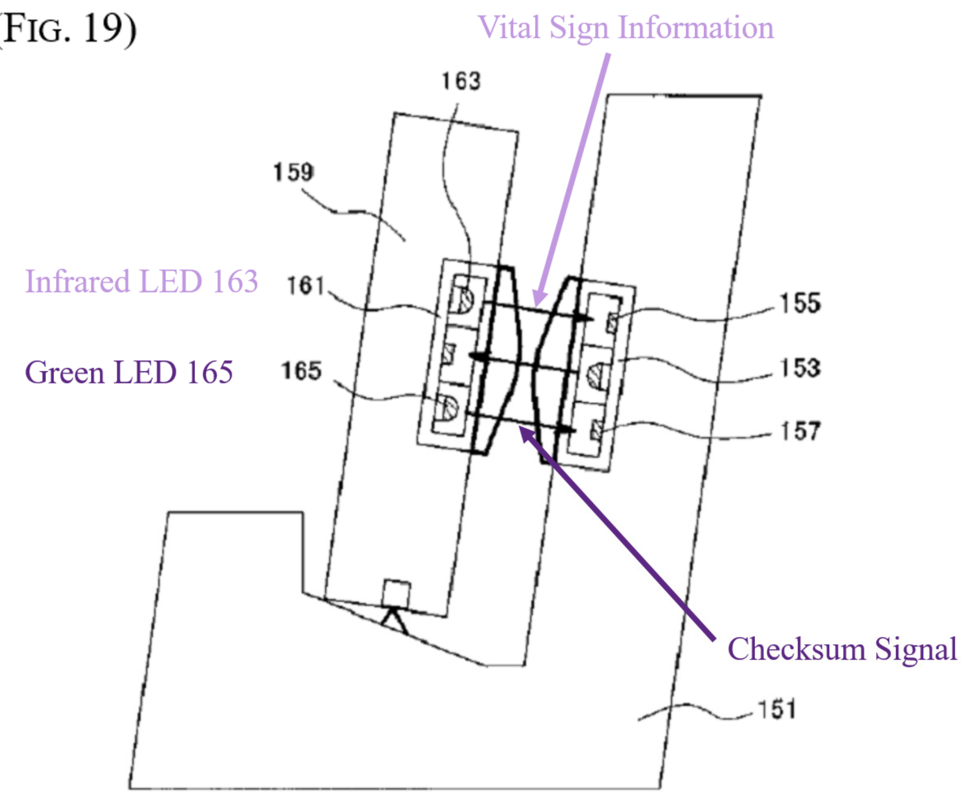
121. Indeed, combining the teachings of Aizawa and Inokawa in this manner would have amounted to nothing more than the use of a known technique to improve similar devices in the same way, and would have yielded predictable results. Furthermore, the elements of the combined system would each perform similar functions that they had been known to perform prior to the combination. For instance, Aizawa's photodetectors would still detect light emitted by the LEDs and reflected by the subject's wrist, and Inokawa's two LEDs would still be used to emit light at different wavelengths. *Id*. Furthermore, one of ordinary skill would have readily understood how to select different photodiodes with different sensitivities to detect the different wavelengths of light emitted by the two LEDs. *Id*.

122. Moreover, one of ordinary skill would have looked to Inokawa's disclosure of two LEDs emitting light of different wavelengths, in part, because it provides additional functionality, including that of a wireless communication method. *Id*. Inokawa teaches that its base station has "communication functionality that is used when the pulse sensor 1 is mounted" on to it (APPLE-1008, ¶[0060]) such that information is "transmitted to the base device 17 using the S-side infrared LED 23

of the pulse sensor 1 and the B-side PD 45 of the base device 17." *Id*., ¶[0076]. "As a result, there is no need to use a special wireless communication circuit or a communication cable as previously, which makes it possible to transmit vital sign information to the base device 17 accurately, easily, and without malfunction." *Id*., ¶[0077]. In other words, and as one of ordinary skill would have recognized, the LEDs provided on the sensor can be used not only to detect pulse rate, but also to "accurately, easily, and without malfunction" transmit sensed data to a base station.

123. Additionally, and with reference to FIG. 19 (reproduced below), Inokawa teaches that the use of two LEDs instead of one further helps improve data transmission accuracy by using the second LED to transmit checksum information. For example, Inokawa describes that "the presence of two pairs of light-emitting and light-receiving elements makes it possible to efficiently transmit information," including increasing the "**accuracy of data**…by transmitting and receiving a **checksum signal** using, for example, the S-side green LED 165 and the other B-side PD 157." APPLE-1008, [0111]; *see also id*., [0044], [0048].

(FIG. 19)



APPLE-1008, FIG. 19 (annotated)

124. Intrinsic and extrinsic records confirm that one of ordinary skill would have naturally looked to another wearable physiological sensor, as disclosed in Inokawa, for transmission details. Aizawa's device contemplates uploading data to a base device yet is silent about how such transmission would be implemented. APPLE-1006, ¶[0023] (describing its "transmitter for transmitting the above pulse rate data to an unshown display"), ¶[0028] (describing that the transmitter also transmits data to "a device for computing the amount of motion load"). One of ordinary skill would have recognized that the LED of Aizawa could be used for data communication to a personal computer for further analysis in a way that is

wireless, eliminating problems associated with a physical cable, and that does not require a separate RF circuit within the sensor, as taught by Inokawa. One of ordinary skill would have further recognized that the use of two distinct LEDs to perform such communication would result in enhanced accuracy of the transmitted information.

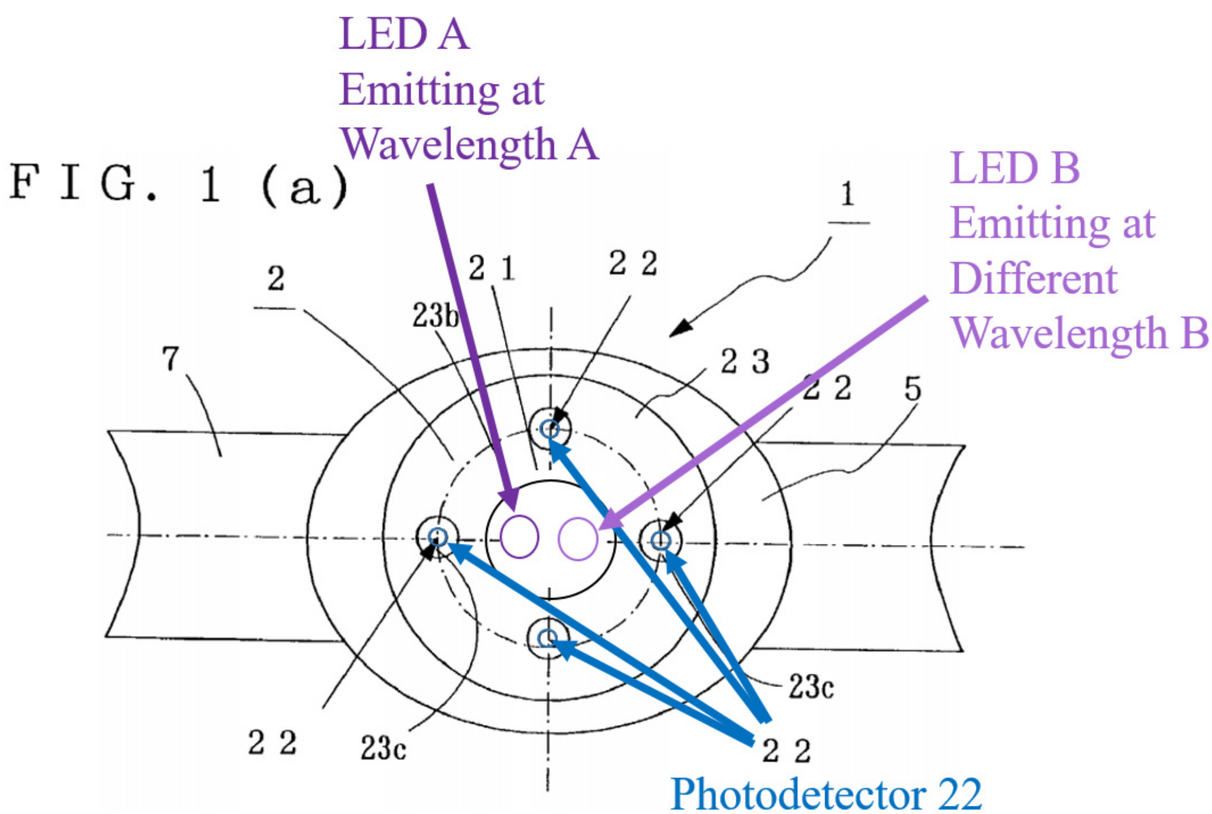
125. Moreover, as discussed above, Inokawa recognizes that using multiple LEDs emitting light at different wavelengths—e.g. infrared and green LEDs—results in additional benefits, such as dividing work between the various LEDs "with an infrared LED used to **detect vital signs** and **transmit** vital sign information, and a green LED used to **detect pulse**" (APPLE-1008, ¶(0014)) or detect "signals indicating body motion." *Id*., ¶(0007), (0040).

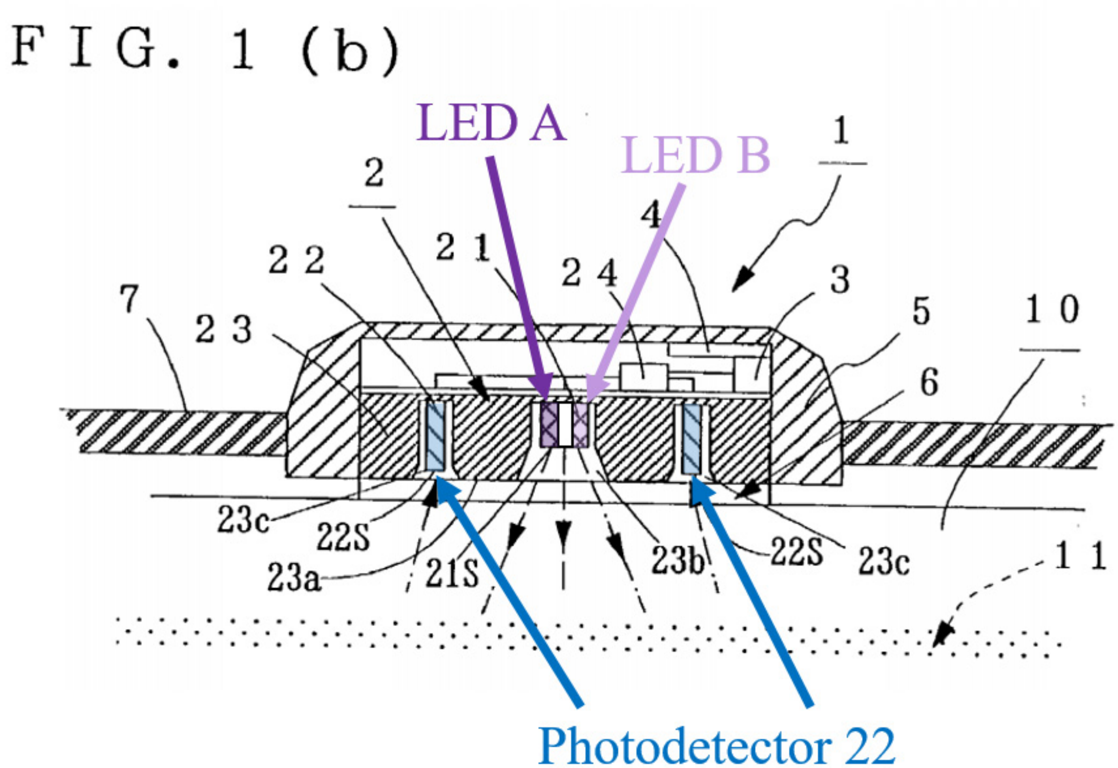
126. Thus, one of ordinary skill would have found it obvious to modify the wrist-worn sensor disclosed in Aizawa to incorporate two LEDs as disclosed in the wrist-worn sensor of Inokawa. Indeed, as per Inokawa, one of ordinary skill would have recognized that replacing the single LED 21 of Aizawa with two distinct emitters, such as the green and IR LEDs 21 and 23 disclosed in Inokawa, would allow Aizawa to measure, and correct for, body movement. *Id.*

127. Although Inokawa shows its two emitters emitting light toward a centrally located detector, one of ordinary skill would have recognized that the same effect can be achieved by having the emitters located centrally instead and emitting

radially outward. Indeed, Aizawa itself recognizes this reversibility, stating that while the configurations depicted include a central emitter surrounded by detectors, the "same effect can be obtained when…a plurality of light emitting diodes 21 are disposed around the photodetector 22." APPLE-1006, ¶[0033].

128. Images of such a modification are provided below:





APPLE-1006, FIGS. 1(a) (top, annotated), 1(b) (bottom, annotated)

129. Accordingly, [1b] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1008, ¶¶[0014], [0040], [0058]-[0059], FIGS. 2, 3, 19.

[1c] 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;

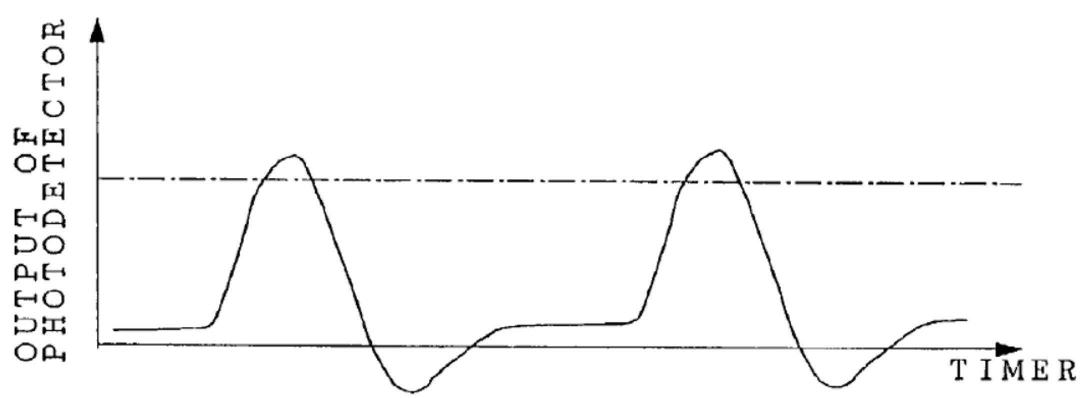
130. As explained above with respect to [1pre]-[1b], the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included a plurality of light emitting diodes, and four photodetectors disposed around the light emitting diodes symmetrically on a circle

concentric to the light emitting diodes. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033].

131. In more detail, Aizawa discloses that its sensor "**detect[s] light** output from a light emitting diode and **reflected from the artery of a wrist** of a subject." APPLE-1006, ¶[0009]. In order to reach the arteries within the wrist of a subject and be reflect back, the light emitted by the light emitting diode is necessarily attenuated by the tissue of the subject. In particular, "[n]ear infrared radiation output toward the wrist 10 from the light emitting diode 21 is reflected by a red corpuscle running through the artery 11 of the wrist 10 and this reflected light is detected by the plurality of photodetectors 22 so as to detect a pulse wave." *Id.*, ¶[0027].

132. For example, "the waveform of a pulse wave" detected by Aizawa's photodetectors 22 can be displayed as represented by FIG. 3. *Id.*, ¶¶[0028]-[0029].

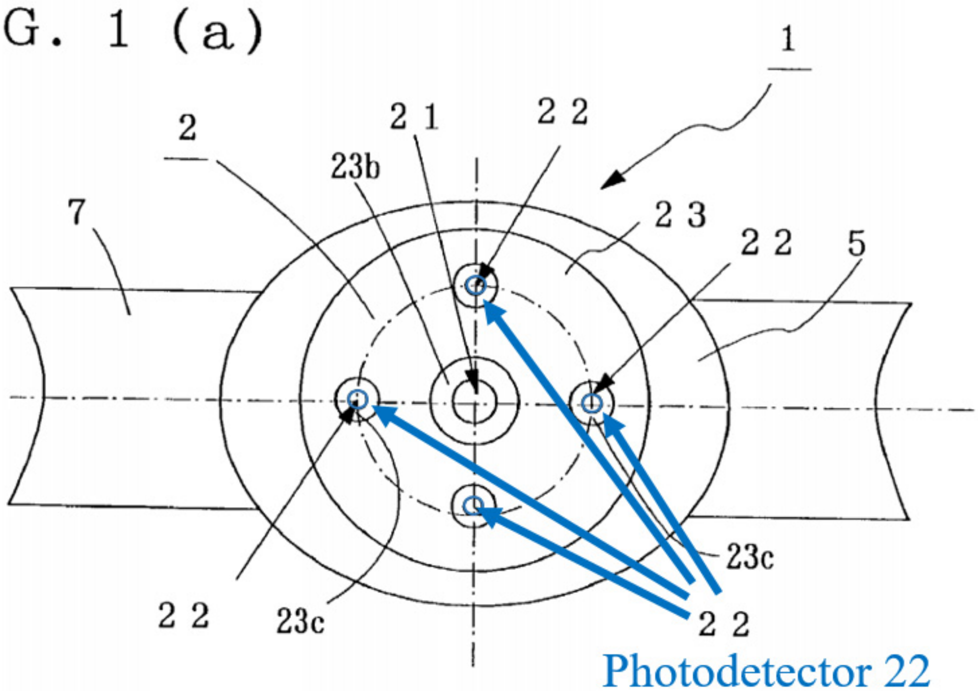
FIG. 3



APPLE-1006, FIG. 3

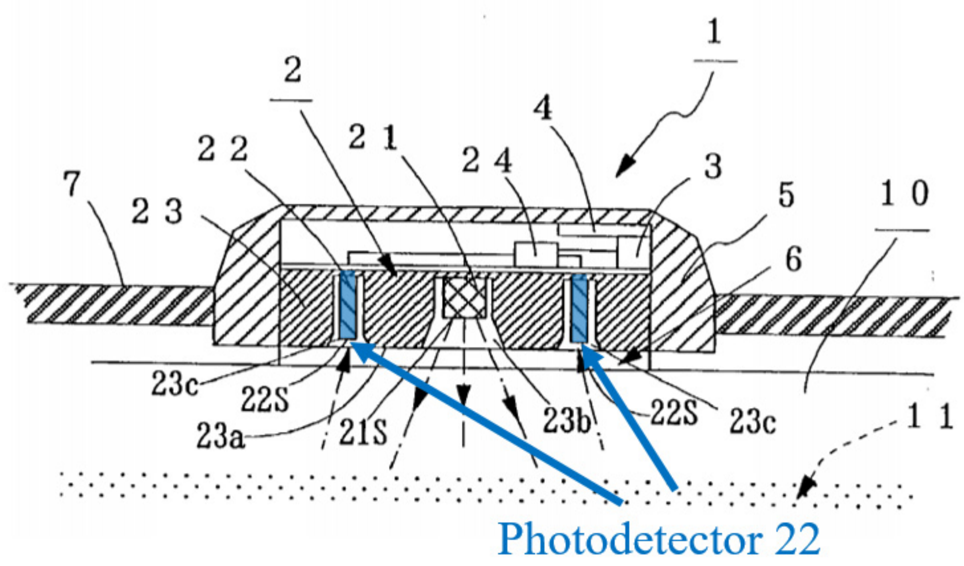
133. The photodetectors 22 are "disposed at an **equal distance** from the light emitting diode" (APPLE-1006, ¶[0011]) and arranged such that "even when the attachment position of the pulse rate detector 1 is dislocated, one of the photodetectors 22 is located near the artery 11, thereby making it possible to detect a pulse wave accurately." *Id.*, ¶[0027]. This arrangement allows for some movement of the detector assembly as it is worn on the subject's wrist while still providing accurate readings. As shown in Aizawa's FIGS. 1(a), 1(b), 2, and 4(a) (reproduced below), the photodetectors are "disposed symmetrically" and used "to detect the pulse wave of the wrist," although the "arrangement of the light emitting diode 21 and the photodetectors 22 is not limited to this." *Id.*, ¶[0032].

FIG. 1 (a)



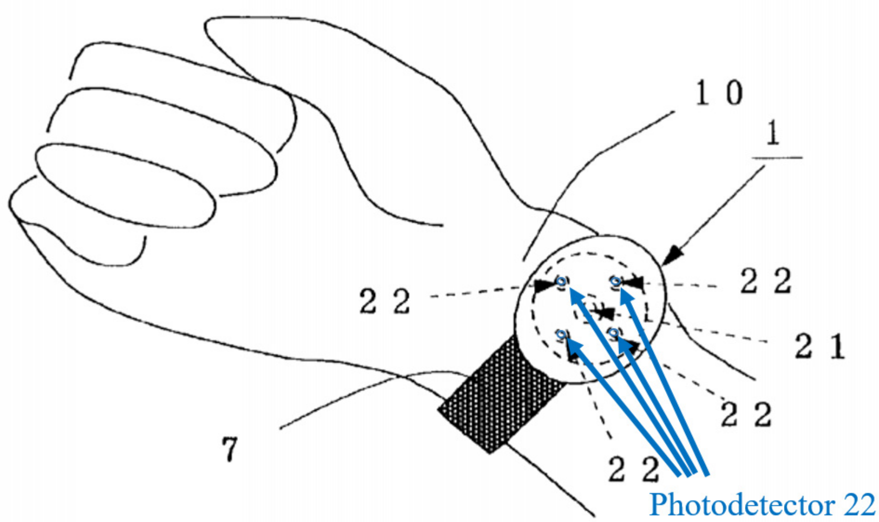
APPLE-1006, FIG. 1(a) (annotated)

F I G. 1 (b)



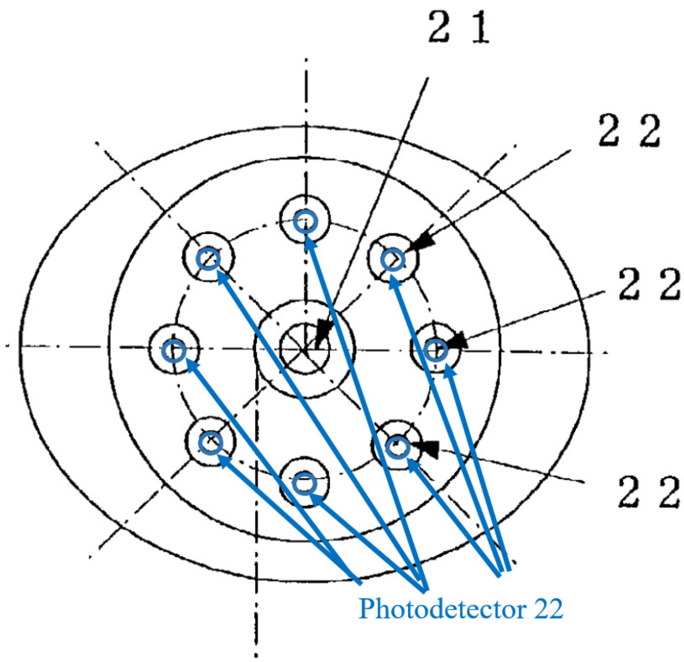
APPLE-1006, FIG. 1(b) (annotated)

F I G. 2



APPLE-1006, FIG. 2 (annotated)

FIG. 4 (a)



APPLE-1006, 4(a) (annotated)

134. Aizawa's "light emitting diode 21 and the photodetectors 22, and a drive detection circuit 24 for detecting a pulse wave by amplifying the outputs of the photodetectors 22" are housed within holder 23. APPLE-1006, ¶[0023]. The light emitting diode and the photodetectors are "**stored in cavities** 23b and 23c **formed in the detection face** 23*a* which is a contact side between the holder 23and a wrist 10, respectively, at positions where the light emitting face 21*s* of the light emitting diode 21 and the light receiving faces 22*s* of the photodetectors 22 are set back from the above detection face 23*a*. In this embodiment, to expand the light emitting area of the light emitting diode 21 and the light receiving areas of the

photodetectors 22, the sectional forms of the above cavities 23*b* and 23*c* are tapered such that their widths increase toward the contact face." *Id*., ¶[0024].

135. In more detail, and as illustrated in Aizawa's FIGS. 1(a) and 1(b) (reproduced below), holder 23 forms a wall that circumscribes photodetectors 22.

FIG. 1 (a)

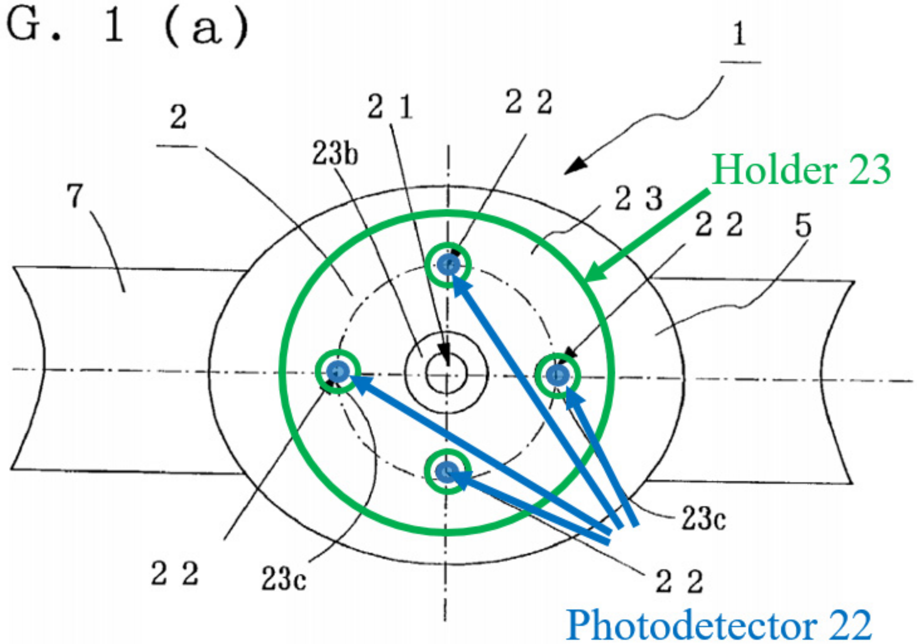
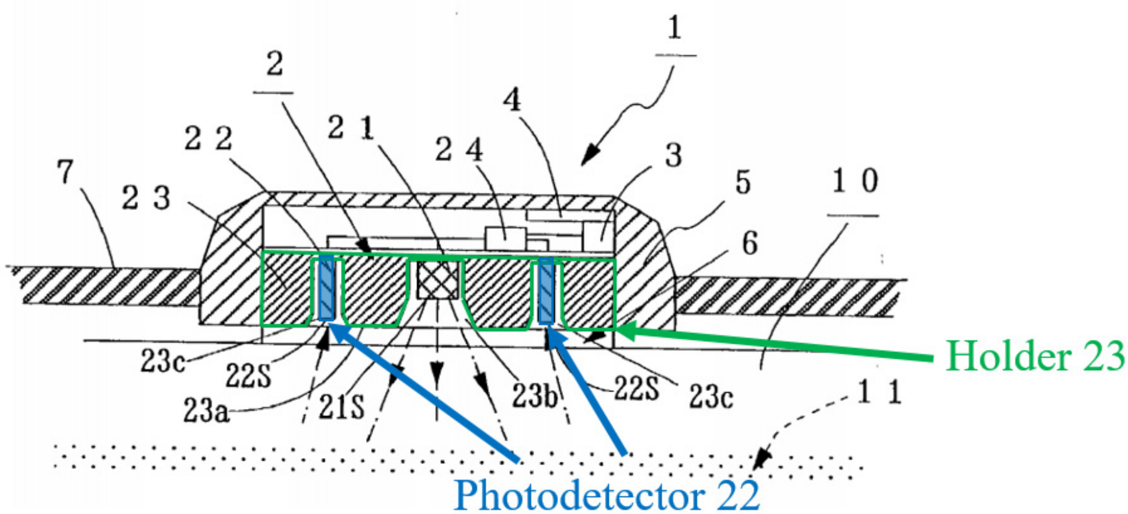


FIG. 1 (b)



APPLE-1006, FIG. 1 (annotated)

136. From this and related description, one of ordinary skill would have understood Aizawa's holder 23 to function as a guide for light from the light emitting diode 21 and to the photodetectors 22. In other words, the "sectional forms of the above cavities 23b and 23c" function as the "light emitting area of the light emitting diode 21 and the light receiving areas of the photodetectors 22" respectively and the openings of these cavities are "tapered such that their widths increase toward the contact face" in order to "expand" the light emitting and light receiving areas. APPLE-1006, ¶[0024].

137. Additionally, one of ordinary skill would have readily understood that Aizawa's holder 23, the wall circumscribing the photodetectors, itself is opaque, and any surface of the wall, including the detection face 23a of the holder 23 would be an opaque layer. One of ordinary skill would have thus found it obvious that Aizawa's holder 23 discloses, or at least suggests, an opaque layer.

138. The '554 patent itself describes that such an opaque layer can be integral to the contact area of the sensor. APPLE-1001, 19:28-48 (describing that the "contact area 370 of the protrusion 305 can include openings or windows 320, 321, 322, and 323" and "the windows 320, 321, 322, and 323 mirror specific detector placements layouts such that light can impinge through the protrusion 305 onto the photodetectors.") One of ordinary skill would have understood that Aizawa's

cavities 23b and 23c are openings or windows that mirror specific detector placement layouts "such that light can impinge…onto the photodetectors" that are formed in the contact face of holder 23.

139. Indeed, by the '554 patent's 2008 Critical Date, optical sensors commonly employed opaque layers with windows corresponding to detectors. APPLE-1013, ¶[0073] (describing a pulse oximetry sensor featuring "a thin sheet of opaque material" placed inside the sensor's housing, with "a window in the opaque material provid[ing] an aperture for transmission of optical energy to or from the tissue site"), FIGS. 19A-19C; APPLE-1006, ¶¶[0012], [0013], [0023], [0024], [0030], FIGS. 1(a), 1(b).

140. Thus, one of ordinary skill would have understood that each of the cavities included in the holder of the sensor resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 is an opening that allows light to travel from the plurality of LEDs and to the at least four photodetectors.

141. Furthermore, one of ordinary skill would have understood that holder 23 is an opaque layer, and that the cavities within holder 23 are windows in the opaque material of holder 23 that allow light through, while avoiding saturation of each of the sensor's detectors. APPLE-1006, ¶¶[0012], [0023], [0024], FIGS. 1(a), 1(b); *see also* APPLE-1013, ¶[0073], FIGS. 19A-19C; APPLE-1019, 79, 86, 94 ("Ambient light from sources such as sunlight, surgical lamps etc may cause errors

in SaO2 readings. In order to prevent this, the simple solution is to cover the sensor site with opaque material which can prevent ambient light from reaching the photodiode”).

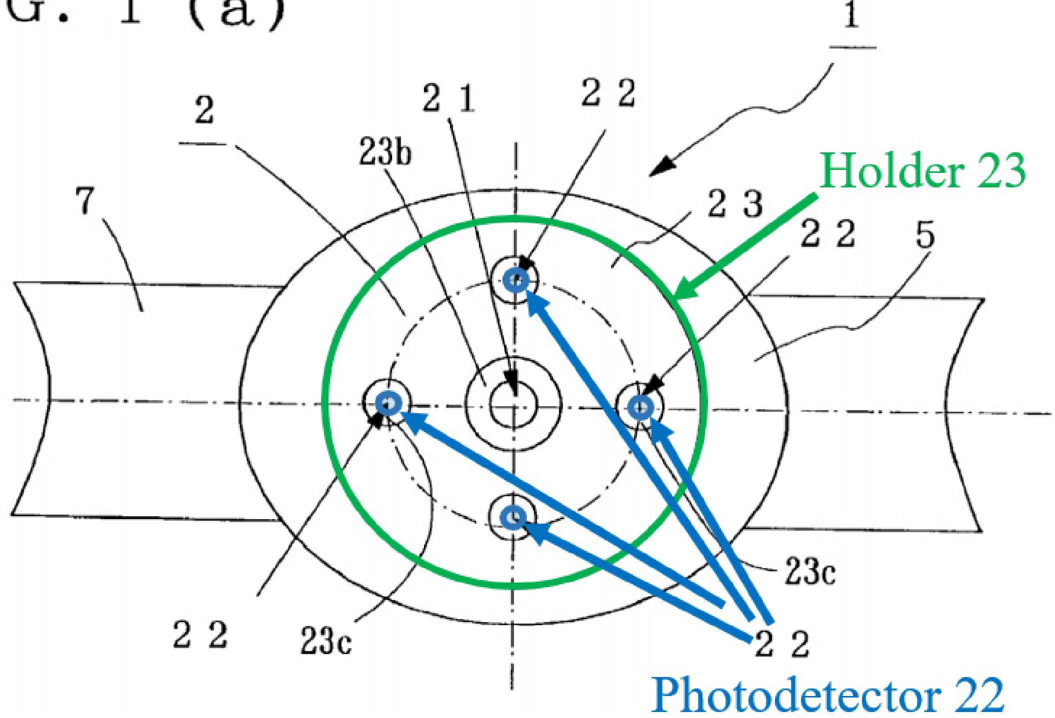
142. Thus, one of ordinary skill would have understood that each of Aizawa’s detectors has a corresponding window that allows light to pass through to the detector.

143. Accordingly, [1c] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[1d] a wall that surrounds at least the at least four detectors; and

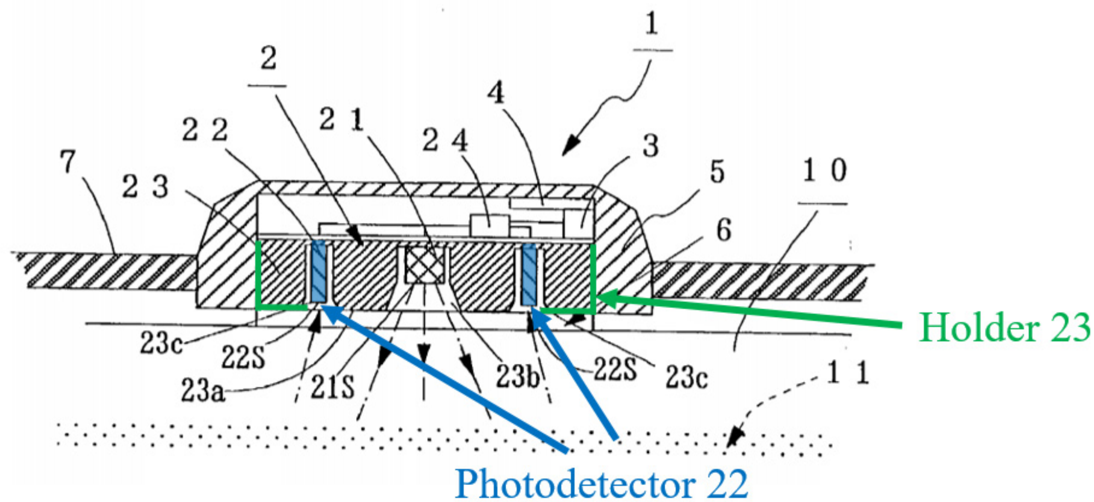
144. As explained above with respect to [1pre]-[1c], Aizawa depicts and describes a noninvasive optical physiological sensor that includes “holder 23 for storing…the photodetectors 22,” in addition to other structural elements. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027]-[0029], [0032]-[0033], FIGS. 1, 2, 3, 4(a).

FIG. 1 (a)



APPLE-1006, FIG. 1a (annotated)

FIG. 1 (b)



APPLE-1006, FIG. 1(b) (annotated)

145. For at least these reasons, one of ordinary skill would have understood that Aizawa in view of Inokawa discloses a wall configured to circumscribe at least the at least four detectors. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0029], [0032]-[0033], FIGS. 1, 2, 3, 4(a).

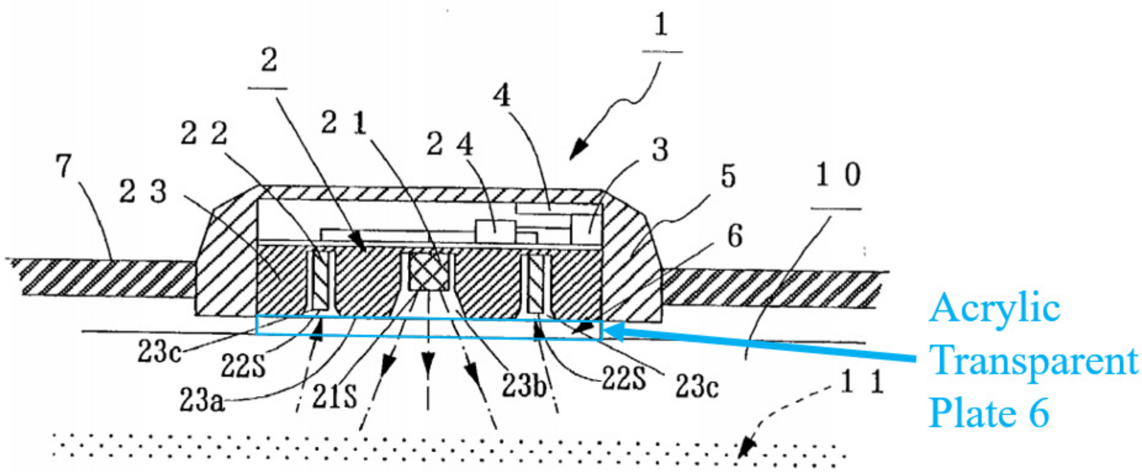
146. Accordingly, [1d] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[1e] 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:

147. As explained above with respect to [1pre]-[1d], the physiological sensor device resulting from the combined teachings of Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006 would have included a noninvasive optical physiological sensor with a holder 23 that is configured to circumscribe the plurality of light emitting diodes and photodetectors 22. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0029], [0032]-[0033], FIGS. 1, 2, 3, 4(a).

148. Aizawa further discloses "an acrylic transparent plate 6" that "becomes close to the artery 11 of the wrist 10" of a user when Aizawa's sensor is worn, improving "adhesion between the wrist 10 and the pulse rate detector 1." APPLE-1006, ¶[0026].

FIG. 1 (b)

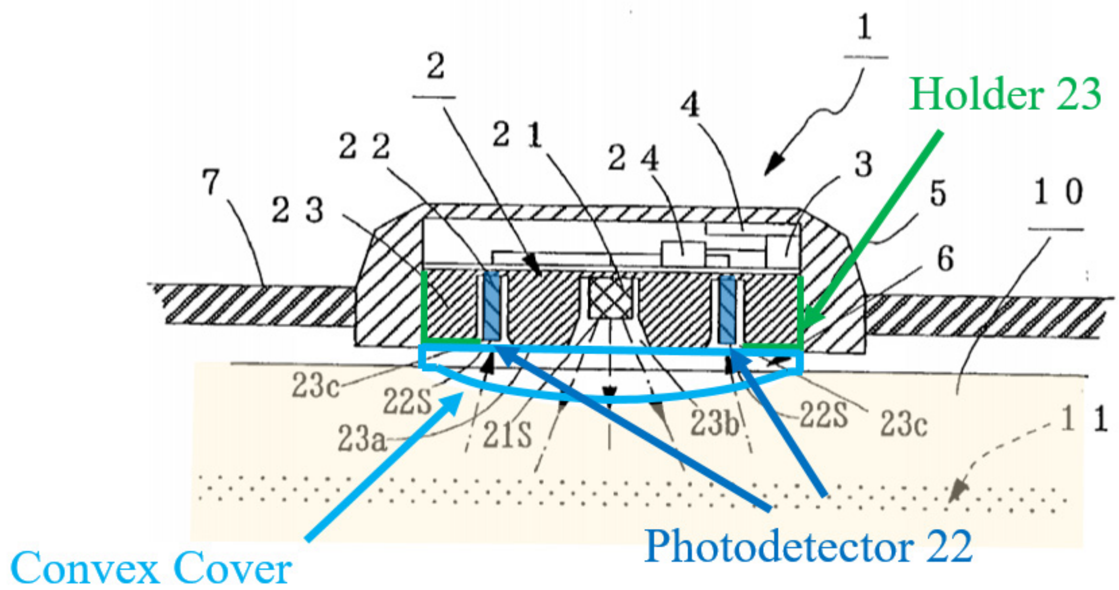


APPLE-1006, FIG. 1(b) (annotated)

149. In more detail, Aizawa discloses that acrylic transparent plate 6 is "mounted to the detection face 23a of the holder 23," such that it is located between tissue of the user and the plurality of detectors when the sensor is worn by the user, and such that the detectors receive light that passes through the plate after attenuation by the user's tissue. *Id.*, ¶[0023]. Because the acrylic transparent plate 6 is "provided **on the detection face 23a of the holder 23**, adhesion between the pulse rate detector 1 and the wrist 10 can be improved, thereby further improving the detection efficiency of a pulse wave." APPLE-1006, ¶[0030]. One of ordinary skill would have understood this placement of the transparent plate 6 to render obvious a cover that is operably connected to the wall, or holder 23 of Aizawa, and that is configured to be located between the tissue of the user and the at least four detectors.

150. Moreover, as illustrated in Aizawa's FIG. 1(b) (reproduced below), holder 23 connects the surface on which detectors 22 are arranged to acrylic transparent plate 6.

FIG. 1 (b)



APPLE-1006, FIG. 1(b) (annotated)

151. One of ordinary skill would have understood that, because Aizawa's attachment belt 7 is wrapped around the user's wrist, acrylic transparent plate 6 would have been pressed against the user's skin. And because acrylic is a rigid material, acrylic transparent plate 6 would have necessarily caused tissue of the user to conform to at least a portion of transparent glass when the sensor is worn by the user during its operation. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0029], [0032]-[0033], FIGS. 1, 2, 3, 4(a).

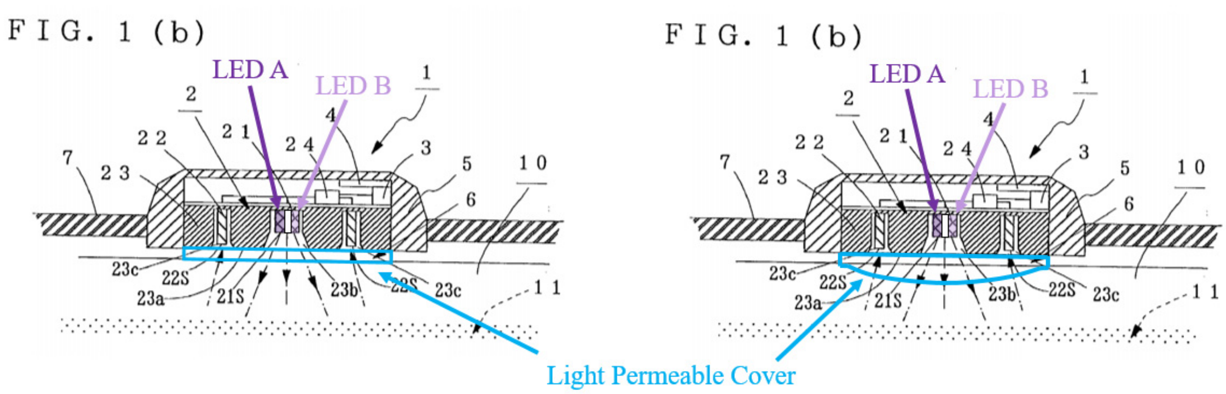
152. From this and related description, one of ordinary skill would have understood that the transparent plate 6 that is operably connected to the opaque walls of Aizawa's holder 23 improves adhesion between Aizawa's sensor and the user's wrist, improves detection efficiency, and provides further protection to the elements stored within holder 23's cavities. For at least these reasons, the sensor resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included 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 sensor is worn by the user.

153. Accordingly, [1e] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[1f] the cover comprises a single protruding convex surface, and

154. As explained above with respect to [1pre]-[1e], the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included a sensor with a holder 23 that is configured to circumscribe the plurality of light emitting diodes and photodetectors, and a single acrylic transparent plate 6 placed between the tissue of the user and the photodetectors. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0029], [0032]-[0033], FIGS. 1, 2, 3, 4(a).

155. One of ordinary skill would have found it obvious to modify Aizawa's acrylic transparent plate 6 in view of Ohsaki. More specifically, and as shown below, one of ordinary skill would have found it obvious to modify the sensor's flat cover (left) to include a lens/protrusion (right), similar to Ohsaki's translucent board 8, so as to improve adhesion between the user's wrist and the sensor's surface, improve detection efficiency, and protect the elements within the sensor housing. APPLE-1009, ¶[0025] (explaining that the convex surface of translucent board 8 prevents slippage of a detecting element from its position on the wrist, and suppresses the "variation of the amount of the reflected light" that reaches the detecting element); APPLE-1024, ¶¶[0033], [0035], FIG. 6 (depicting an LED featuring a convex lens)

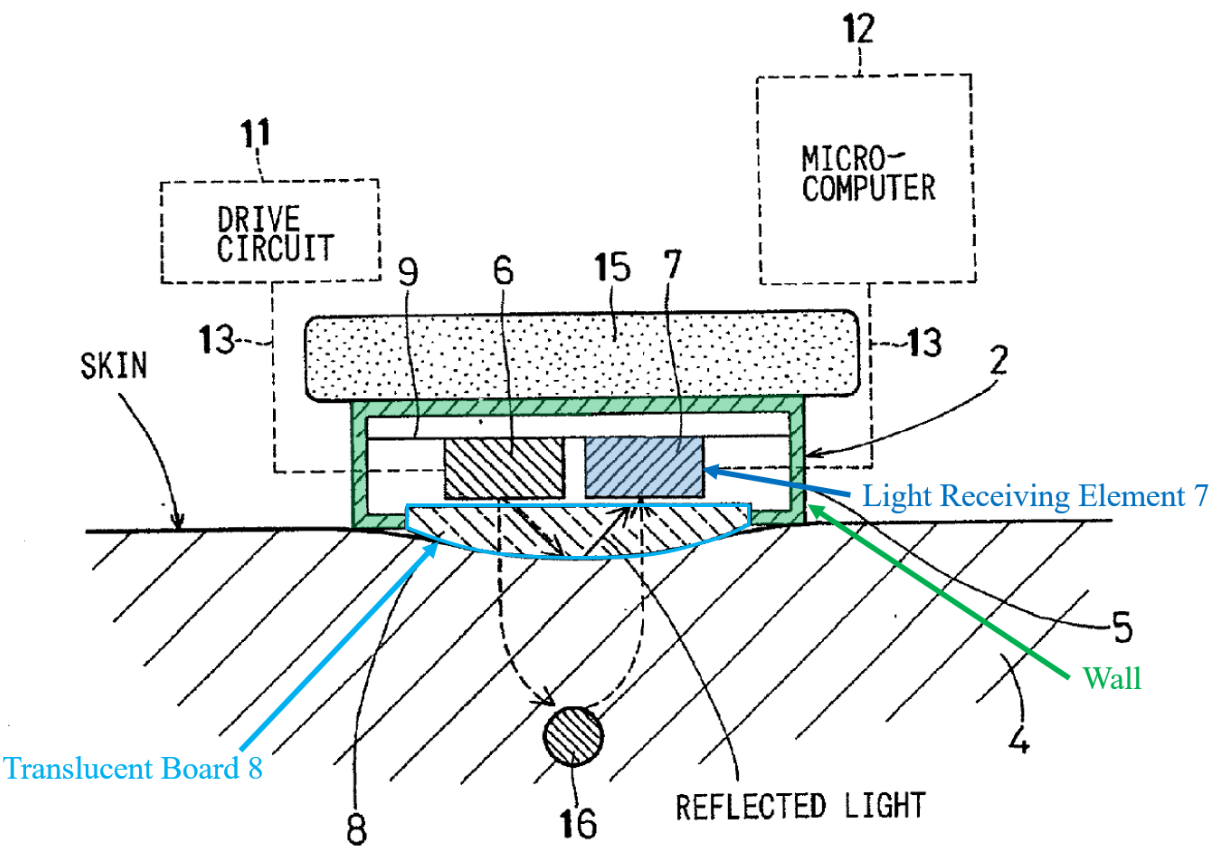


APPLE-1006, FIG. 1(b) (annotated)

156. In more detail, Ohsaki describes a "detecting element" that includes "a package 5, a light emitting element 6 (e.g., LED), a light receiving element 7 (e.g.,

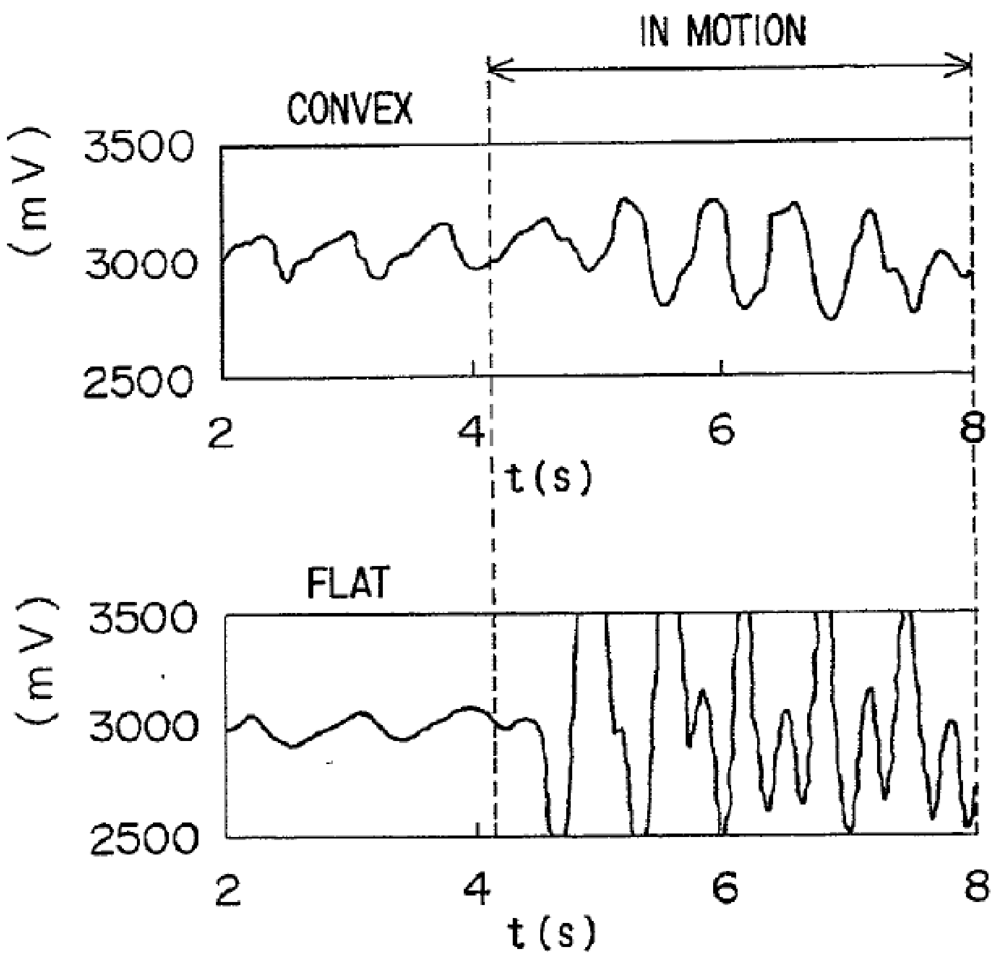
PD), and a translucent board 8." APPLE-1009, ¶[0017]. "The package 5 has an opening and includes a" substrate in the form of "circuit board 9," on which light emitting element 6 and light receiving element 7 are arranged. *Id.*. As shown in Ohsaki's FIG. 2 (reproduced below), translucent board 8 is arranged such that, when the sensor is worn "on the user's wrist … the convex surface of the translucent board … is in intimate contact with the surface of the user's skin"; this contact between the convex surface and the user's skin is said to prevent slippage, which increases the strength of the signals obtainable by Ohsaki's sensor. APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

FIG. 2



APPLE-1009, FIG. 2 (annotated)

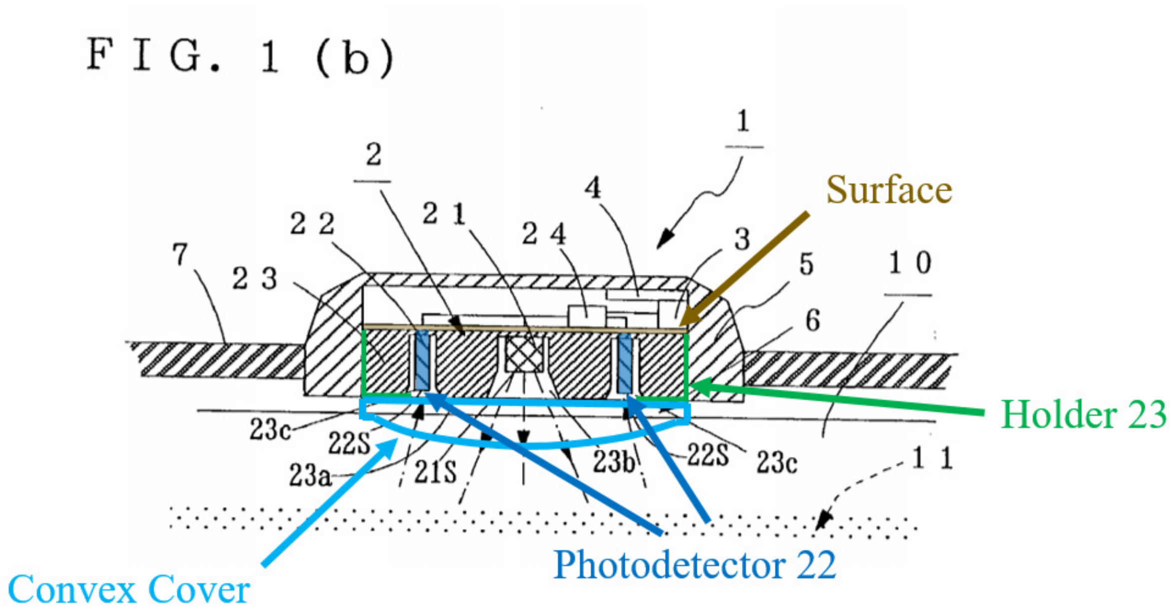
157. Ohsaki explains that "if the translucent board 8 has a flat surface, the detected pulse wave is adversely affected by the movement of the user's wrist as shown in FIG. 4B," but that if "the translucent board 8 has a convex surface … variation of the amount of the reflected light … that reaches the light receiving element 7 is suppressed." APPLE-1009, ¶[0025]. The convex surface is also said to prevent "disturbance light from the outside" from penetrating translucent board 8. *Id*. Thus, when a convex cover is used, "the pulse wave can be detected without being affected by the movement of the user's wrist 4 as shown in FIG. 4A." *Id*.



APPLE-1009, FIGS. 4A, 4B

158. From this and related description, one of ordinary skill would have understood that the translucent board 8 that is operably connected to the walls of Ohsaki's package 5 improves adhesion between Ohsaki's sensor and the user's wrist, improves detection efficiency, and provides protection to the elements accommodated within package 5.

159. As shown below, it would have been obvious to one of ordinary skill to modify Aizawa's wrist-worn sensor to incorporate the shape of Ohsaki's translucent board 8.



APPLE-1006, FIG. 2 (annotated)

160. Such a modification would have amounted to nothing more than the use of a known technique to improve similar devices in the same way, and combining prior art elements according to known methods to yield predictable results. Indeed, the modification involves nothing more than adjusting transparent plate 6's shape to include a convex protrusion/lens surface similar to that disclosed by Ohsaki, and one of ordinary skill would have understood that this adjustment would improve adhesion to the user's skin and reduce variation in the signals detected by the sensor. *Id*. Furthermore, the elements of the combined system would each

perform similar functions they had been known to perform prior to the combination—Aizawa's transparent plate 6 would remain in the same position, performing the same function, but with a convex/lens protrusion as taught by Ohsaki. *Id.*

161. Accordingly, [1f] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

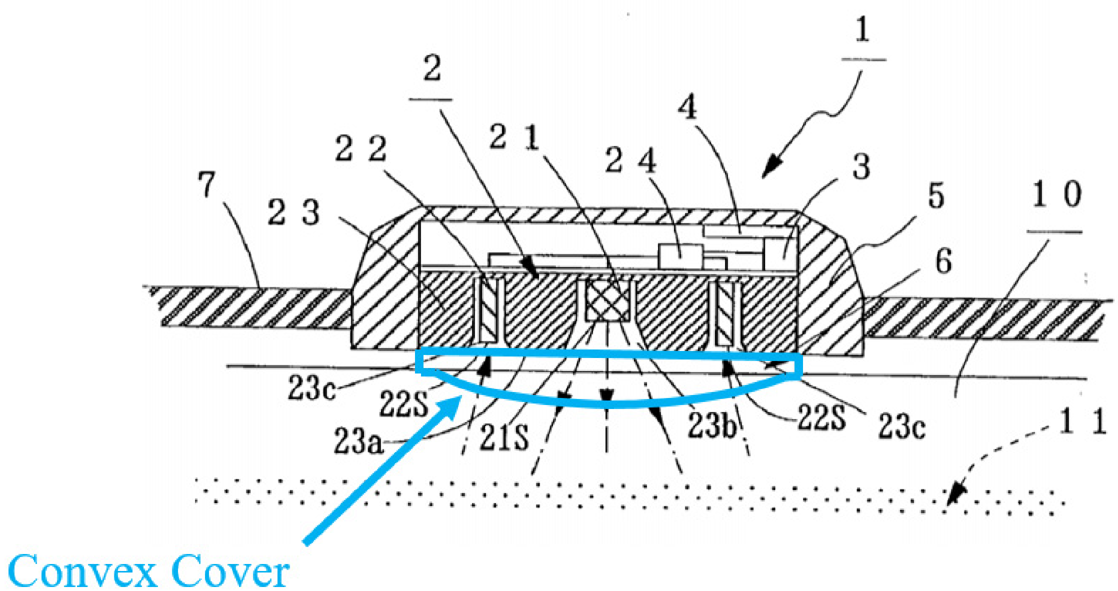
[1g] at least a portion of the cover is sufficiently rigid to cause tissue of the user to conform to at least a portion of a shape of the single protruding convex surface when the physiological sensor device is worn by the user; and

162. As explained above with respect to [1pre]-[1f] the sensor resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included a transparent protruding convex cover operable to conform tissue of the user to at least a portion of the cover's single protruding convex surface when worn by the user. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, Abstract, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

163. In more detail, as shown in Aizawa's FIG. 2 (reproduced below), and as described by Ohsaki, the convex surface of the modified cover would have been in **intimate contact** with the surface of the user's skin when worn, such that slippage

of the detecting element "off the detecting position of the user's wrist" is prevented. APPLE-1009, ¶[0025], FIGS. 1, 2.

FIG. 1 (b)



APPLE-1006, FIG. 2 (annotated)

164. From this and related disclosure, one of ordinary skill would have understood that Ohsaki's translucent board 8 is sufficiently rigid to conform tissue of the user to its convex shape, and would have been motivated to ensure that the transparent protruding convex cover included in the sensor resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have been sufficiently rigid to be operable to conform tissue of the user to at least a portion of a shape of the cover. APPLE-1006, ¶¶[0012], [0013], [0023], [0024], [0030], FIGS. 1(a), 1(b); APPLE-1009, Abstract, ¶¶[0015], [0017], [0025],

FIGS. 1, 2, 4A, 4B; *see also* APPLE-1008, ¶¶[0058]-[0059]; FIG. 2 (depicting a convex lens placed between a photodiode and the user's skin; the lens is sufficiently rigid to make the tissue conform to the convex surface of the lens).

165. Accordingly, [1g] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

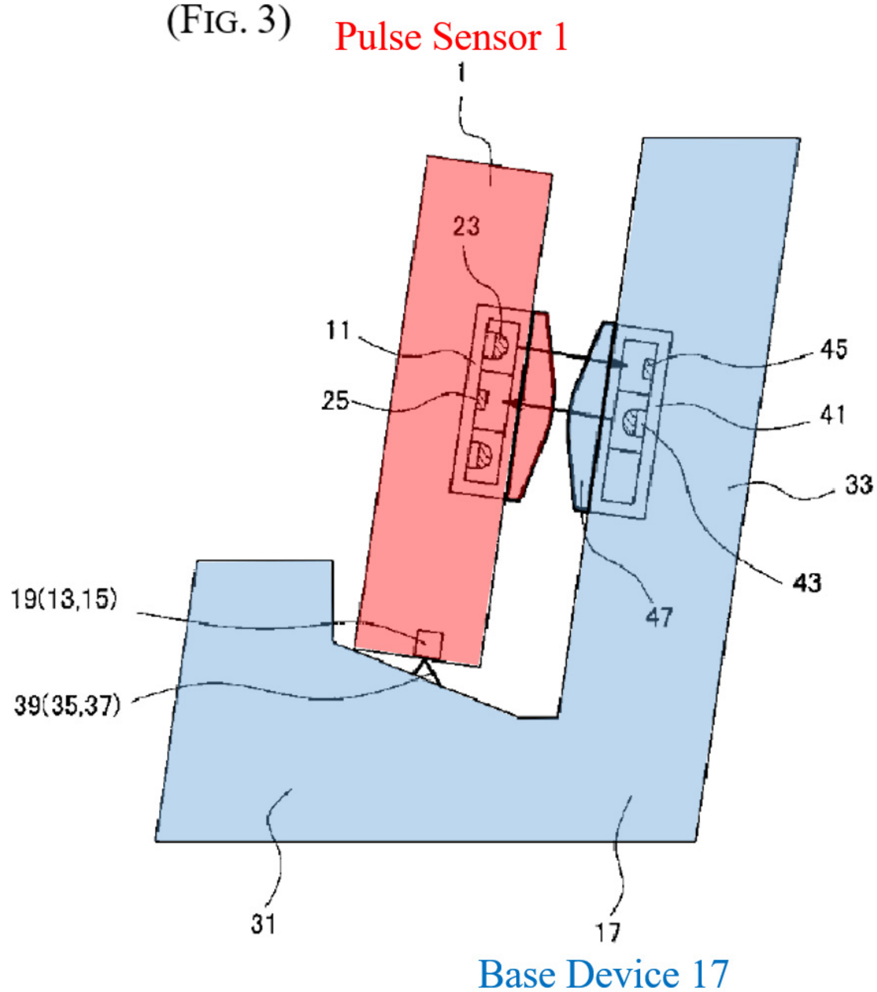
[1h] a handheld computing device in wireless communication with the physiological sensor device, wherein the handheld computing device comprises:

166. As explained above with respect to [1pre]-[1g], the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included a sensor and a base station, with the sensor being configured to communicate optically with the base station. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1008, ¶¶[0014], [0040], [0055]-[0066], FIGS. 2, 3, 19.

167. In more detail, and as explained above with respect to [1b], one of ordinary skill would have modified Aizawa's sensor to include two LEDs, in part because, as described by Inokawa, doing so would have enabled the sensor to wirelessly transmit physiological measurements to a base station, "accurately, easily, and without malfunction." APPLE-1008, ¶¶[0060], [0076]-[0077], FIG. 3; APPLE-1006, ¶¶[0015], [0023], [0028], [0035].

168. As shown in Inokawa's FIG. 3 (reproduced below), the base station is "a charger with communication functionality that is used when the pulse sensor…is mounted." APPLE-1008, ¶[0060]. More specifically, when the sensor is mounted onto the base station, "vital sign information…such as pulse and body motion, is transmitted to the base device…using the…infrared LED." *Id.*, ¶[0076]. The "base device 17 is connected to a PC 59, and information transmitted from the pulse sensor 1 is downloaded to the PC 59 via the base device 17." *Id.*; *see also id.*, ¶¶[0074] ("in transmission mode, **data stored in the memory 63, such as pulse, is transmitted to the base device 17**. In short, data is downloaded"), [0075]("when the pulse sensor 1 is mounted onto the base device 17, information about pulse, etc. is automatically transmitted from the pulse sensor 1 to the base device 17. **The base device 17, meanwhile, upon receiving the information transmitted from the pulse sensor 1, transmits this information to the PC 59**"), [0077] ("Hence, the PC 59 is able to obtain vital sign information by downloading it from the base device 17").

(FIG. 3)



APPLE-1008, FIG. 3

169. In other words, in Inokawa, the physiological sensor device's sensor component transmits physiological measurement data to an included base station via an optical communications interface, and the physiological sensor device's base station transmits signals responsive to a physiological parameter to a computer, via a network interface. APPLE-1008, ¶¶[0002], [0003], [0067], [0074]-[0077].

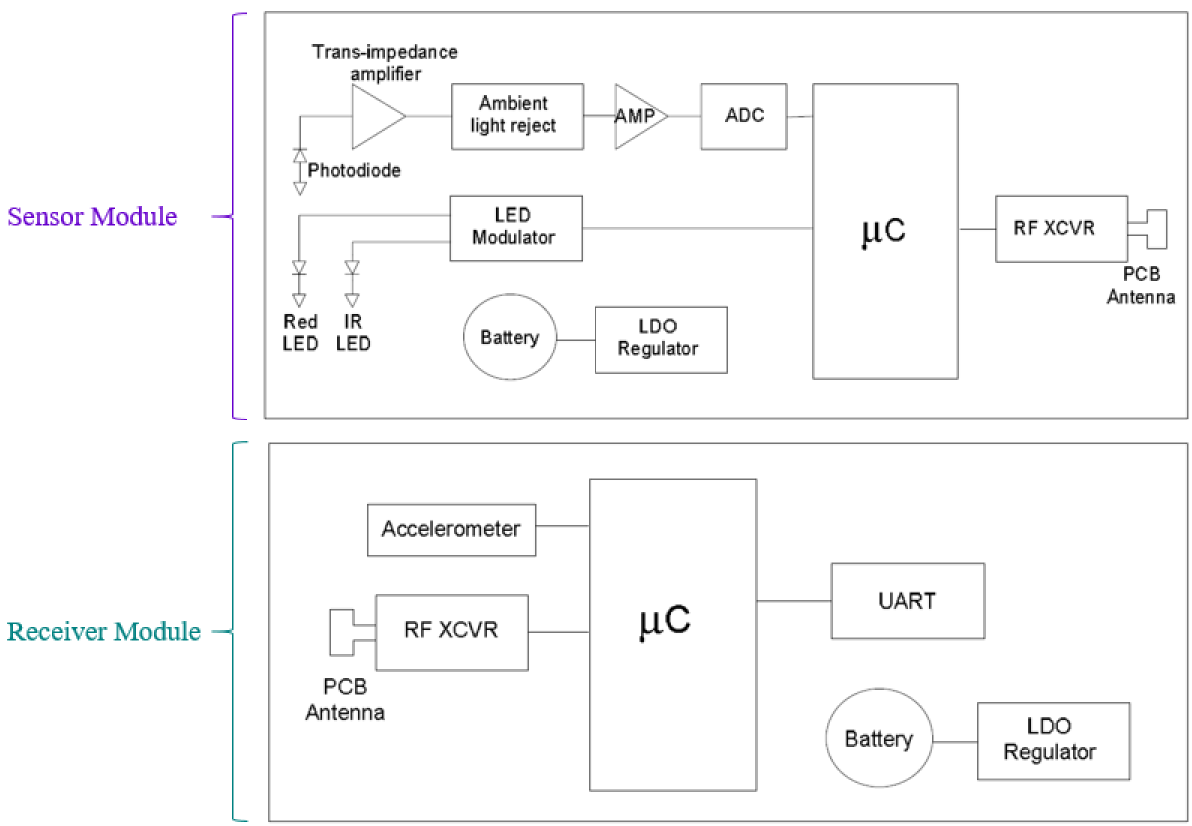
170. Inokawa does not explicitly describe wireless communication between the base station and a computer, but one of ordinary skill would have found it obvious to implement the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, and Ohsaki as part of a physiological measurement system including a handheld computing device, and to enable the physiological sensor device to communicate wirelessly with the handheld computing device. APPLE-1006, Abstract, [0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1008, ¶¶[0002], [0003], [0067], [0074]-[0077]; APPLE-1010, 1-4, FIG. 3.

171. Indeed, by the ’554 patent’s 2008 Critical Date, physiological sensor devices commonly communicated wirelessly with handheld computing devices.

172. Yitzhak Mendelson’s 2006 paper “A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring,” for example, describes a “body-worn” pulse oximetry system that includes a physiological sensor device featuring a sensor module and a receiver module, and a handheld computing device – a PDA. APPLE-1010, 1-4, FIGS. 1-3.

173. In more detail, and as shown in Mendelson 2006’s FIG. 2 (reproduced below), the sensor module includes an “optical reflectance transducer” for measuring photoplethysmographic (PPG) signals, and the receiver module includes “an embedded microcontroller.” *Id.*, 1-2. “Signals acquired by the Sensor Module

are received by the embedded microcontroller which synchronously converts the corresponding PD output to R and IR PPG signals," and "[d]edicated software is used to filter the signals and compute [arterial oxygen saturation (SpO_2)] and [heart rate (HR)] based on the relative amplitude and frequency content of the reflected PPG signals." *Id.* Similar to the sensor of the physiological sensor device resulting from the combination of Aizawa, Inokawa, and Ohsaki, which would have transmitted physiological measurement data to a base station for further processing and transmission, Mendelson 2006's sensor module provides acquired signals to the receiver module for processing and transmission. APPLE-1006, ¶¶[0002], [0003], [0067], [0074]-[0077].



APPLE-1010, FIG. 2 (annotated)

174. "[I]nformation acquired by the Sensor Module is transmitted wirelessly via an RF link over a short range to a body-worn Receiver Module," and data processed by the receiver module is "transmitted wirelessly to a PDA." *Id*., 2, FIG. 2. Mendelson 2006's system uses "the HP iPAQ h4150 PDA because it can support both 802.11b and Bluetooth™ wireless communication." *Id*., 3. The PDA is used "as a local terminal," and it "also provides a low-cost touch screen interface." *Id.*; *see also* APPLE-1020, 1-4 (depicting and describing the HP iPAQ h4150 Pocket PC PDA utilized in Mendelson 2006's system).

175. In more detail, and as shown in Mendelson 2006's FIG. 3 (reproduced below), the handheld PDA's "simple GUI" is "configured to present … input and output information to the user" and to allow "easy activation of various functions." *Id*., 4. Wireless communication with the handheld PDA is, moreover, said to enable transfer of information pertaining to physiological and wellness parameters such as "SpO_2, HR, body acceleration, and posture information" to the PDA; and, when the PDA is "carried by medics or first responders," this information is said to enhance their ability "to extend more effective medical care, thereby saving the lives of critically injured persons." *Id*.

APPLE-1010, FIG. 3 (left) and APPLE-1020, 1 (right)

176. To obtain these and other advantages described by Mendelson 2006, one of ordinary skill would have been motivated to implement the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, and Ohsaki as part of a physiological measurement system including a handheld computing device, and to enable the physiological sensor device's base station to communicate wirelessly with the handheld computing device. APPLE-1006, ¶¶[0015], [0023], [0028], [0035]; APPLE-1008, ¶¶[0002], [0003], [0067], [0074]-[0077]; APPLE-1010, 1-4, FIG. 3; *see also* APPLE-1020, 1-4.

177. One of ordinary skill would, for example, have found it obvious to wirelessly transmit information or data acquired or processed by the physiological sensor device's base station to a PDA such as the HP iPAQ h4150, using either or both of 802.11b and Bluetooth™. APPLE-1006, ¶¶[0002], [0003], [0067], [0074]-[0077]; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-4.

178. One of ordinary skill would have recognized that applying Mendelson 2006's teachings in this manner would have led to predictable results without altering or hindering the functions performed by the physiological sensor device. In fact, one of ordinary skill would have been motivated to implement the well-known technique of wirelessly transmitting data from Aizawa-Inokawa-Ohsaki's physiological sensor device to a handheld computing device such as the HP iPAQ h4150 to achieve the predictable benefits described by Mendelson 2006. *Id*.

179. One of ordinary skill would, for example, have been motivated by Mendelson 2006's disclosure of a wireless transmission method and PDA with a touch-screen display that provides a "simple GUI" to present "information to the user" and provide "easy activation of various functions." *Id*., 4. Indeed, one of ordinary skill would have had a reasonable expectation of success in making this modification, and would have reasonably expected to reap benefits of displaying a measured waveform representative of a patient's arterial pulse. *Id*.

180. Accordingly, [1h] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[1i] 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;

181. As explained above with respect to [1pre]-[1h], one of ordinary skill would have found it obvious to place a handheld computing device such as the HP iPAQ h4150 PDA in wireless communication with the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, and Ohsaki. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033]; APPLE-1008, ¶¶[0002], [0003], [0067], [0074]-[0077]; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-4.

182. In implementing this physiological measurement system, one of ordinary skill would have configured a processor of the PDA to wirelessly receive signals from the physiological sensor device, the signals being responsive to physiological parameters of the user. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033]; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-3, 6-8.

183. In more detail, Mendelson 2006 describes the wireless transmission of "vital physiological information" acquired and processed by a "body-worn pulse oximeter" to the HP iPAQ h4150 PDA, which is utilized "as a local terminal" with

a "low-cost touch screen interface" featuring a "simple GUI" "configured to present … input and output information to the user." APPLE-1010, 1-2, FIGS. 1-3. Mendelson 2006's FIG. 3, for example, is a photograph of an HP iPAQ h4150 PDA being used to display indicia responsive to measurements of SpO_2 and HR, the PDA having wirelessly received signals responsive to the user's SpO2 and HR from the body-worn pulse oximeter. APPLE-1010, 2-3, FIG. 3.

184. The iPAQ h4150 PDA is said by Mendelson 2006 to include "sufficient computational resources for the intended application," and the PDA's user manual confirms that it typically included a "400 MHz Intel Xscale™ technology-based processor." *Id.*, 3; APPLE-1020, 1-3. The iPAQ h4150 PDA is said by Mendelson 2006 to support both 802.11b and Bluetooth™ wireless communication, and the PDA's user manual confirms that it typically included "Integrated WLAN 802.11b" and "Integrated Bluetooth™." APPLE-1010, 3; APPLE-1020, 1-3, 6-8.

185. For at least these reasons, one of ordinary skill would have found it obvious to configure a processor of the PDA to wirelessly receive signals from the physiological sensor device, the signals being responsive to physiological parameters of the user. APPLE-1006, 9:23-10:37, FIGS. 7, 8; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-3, 6-8.

186. Accordingly, [1i] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[1j] 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

187. As explained above with respect to [1pre]-[1h], one of ordinary skill would have found it obvious to place a handheld computing device such as the HP iPAQ h4150 PDA in wireless communication with the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033]; APPLE-1008, ¶¶[0002], [0003], [0067], [0074]-[0077]; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-4.

188. In implementing this physiological measurement system, one of ordinary skill would have configured a touch-screen display of the PDA to provide a user interface, the user interface being configured to display indicia responsive to measurements of the physiological parameter, and an orientation of the user interface being configurable responsive to a user input.

189. In more detail, Mendelson 2006 describes the wireless transmission of "vital physiological information" acquired and processed by a "body-worn pulse oximeter" to the HP iPAQ h4150 PDA, which is utilized "as a local terminal" with a "low-cost touch screen interface" featuring a "simple GUI" "configured to present … input and output information to the user" and to allow "easy activation of various functions." APPLE-1010, 1-2, FIGS. 1-3; *see also* APPLE-1020, 3

(confirming that the HP iPAQ h4150 typically included a touch screen display). As Mendelson 2006 explains, a "dedicated National Instruments LabVIEW program was developed to control all interactions between the PDA and the wearable unit via a graphical user interface (GUI)," with "[o]ne part of the LabVIEW software [being] used to control the flow of information through the 802.11b radio system on the PDA." APPLE-1010, 3; APPLE-1027, 186 ("You can use the Report Generation VIs to … Set the report orientation—portrait or landscape").

190. As shown below, Mendelson 2006's FIG. 3, for example, is a photograph of an HP iPAQ h4150 PDA being used to display indicia responsive to measurements of SpO_2 and HR, the PDA having wirelessly received signals responsive to the user's SpO_2 and HR from the body-worn pulse oximeter. APPLE-1010, 1-3 ("The GUI also displays the subject's vital signs, activity level, body orientation, and a scrollable PPG waveform that is transmitted by the wearable device"), FIG. 3.

APPLE-1010, FIG. 3

191. Mendelson 2006 does not explicitly state that an orientation of the GUI provided by the PDA is configurable responsive to a user input, but one of ordinary skill would have understood that the LabVIEW software that was used "to control all interactions between the PDA and the wearable unit via [t]he graphical user interface" included the option to configure an orientation of a user interface as a standard feature.

192. Additionally, the HP iPAQ h4150 user manual describes the PDA's operating system as the "Microsoft® Windows® Mobile™ 2003 software for Pocket PC." APPLE-1020, 2, 6. One of ordinary skill would have understood that, as a standard feature, that operating system enabled users to "change the screen orientation" between portrait and landscape "on the fly."

193. Consistent with Mendelson 2006's description of the PDA's "simple GUI" being configured to allow for "easy activation of various functions," one of ordinary skill would have found it obvious to make an orientation of the PDA's user interface configurable responsive to a user input, for the sake of user convenience. APPLE-1010, 3; APPLE-1020, 2, 6.

194. For at least these reasons one of ordinary skill would have found it obvious to configure a touch-screen display of the PDA to provide a user interface, the user interface being configured to display indicia responsive to measurements of the physiological parameter, and an orientation of the user interface being configurable responsive to a user input. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033]; APPLE-1010, 1-4, FIG. 3; APPLE-1020, 1-4; *see also* APPLE-1009, ¶¶[0005] ("The information of pulse wave detected by the detecting element is displayed on the display of the sensor body fixed on the back side of the user's wrist"), [0020] ("The sensor body 3 is connected to the detecting element 2 by a signal line 13, and includes … a monitor

display … the monitor display shows the calculated pulse rate and the like"); APPLE-1021, xvii-xviii, 10-12, 17, 63, 73-101, 176, 190-193, 363; APPLE-1022, 4-11, 30-31, 56-67, 72-9.

195. Accordingly, [1j] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[1k] a storage device configured to at least temporarily store at least the measurements of the physiological parameter.

196. As explained above with respect to [1pre]-[1j], one of ordinary skill would have found it obvious to place a handheld computing device such as the HP iPAQ h4150 PDA in wireless communication with the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1008, ¶¶[0002], [0003], [0067], [0074]-[0077]; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-4.

197. In implementing this physiological measurement system, one of ordinary skill would have configured a storage device of the PDA to at least temporarily store measurements of physiological parameters (e.g., SpO_2 and HR). APPLE-1010, 3, FIG. 3 ("The PDA can also serve to temporarily store vital medical information received from the wearable unit"); APPLE-1020, 3, 10 (noting that the

HP iPAQ h4150 typically included 64-MB of SDRAM, 32-MB of ROM, and an SD slot for additional storage).

198. As Mendelson 2006 explains, the "PDA can also serve to temporarily store vital medical information received from the wearable unit." APPLE-1010, 3. One of ordinary skill would have understood that the vital medical information would have included measurements of the physiological parameters obtained by the physiological sensor device (e.g., SpO2 and HR). APPLE-1010, 1-4, FIG. 3.

199. Accordingly, [1k] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

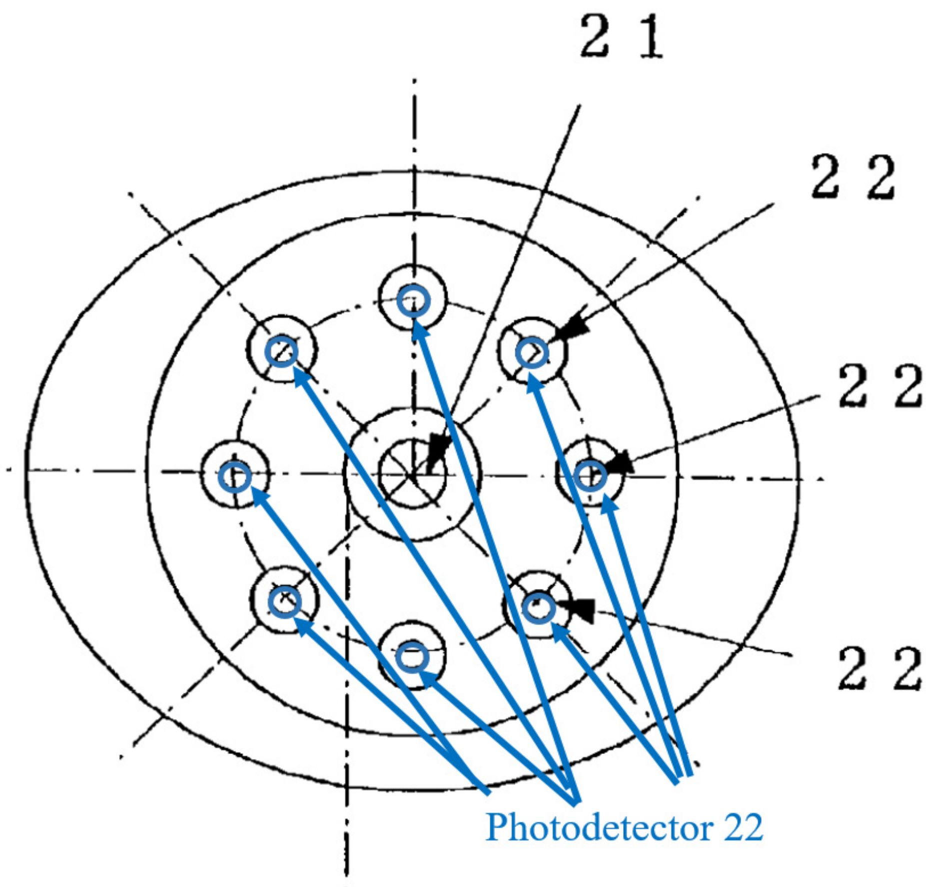
C. Claim 2

[2] The physiological measurement system of claim 1, wherein the at least four detectors comprise at least eight detectors.

200. As explained above with respect to [1pre]-[1k], one of ordinary skill would have found it obvious that the sensor resulting from the combination of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would include at least four detectors. APPLE-1006, Abstract, [0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, [0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

201. Indeed, as shown in FIG. 4(a) of Aizawa (reproduced below), Aizawa explicitly depicts a sensor that includes eight detectors.

FIG. 4 (a)



APPLE-1006, FIG. 4(a) (annotated)

202. Aizawa discloses that while one embodiment includes "four photodetectors which are disposed symmetrically," the "arrangement of the light emitting diode 21 and the photodetectors 22 is not limited to" such an arrangement. APPLE-1006, ¶[0032]. The number of photodetectors can be increased to "further improve detection efficiency" *Id*.

203. Accordingly, [2] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

D. Claim 3

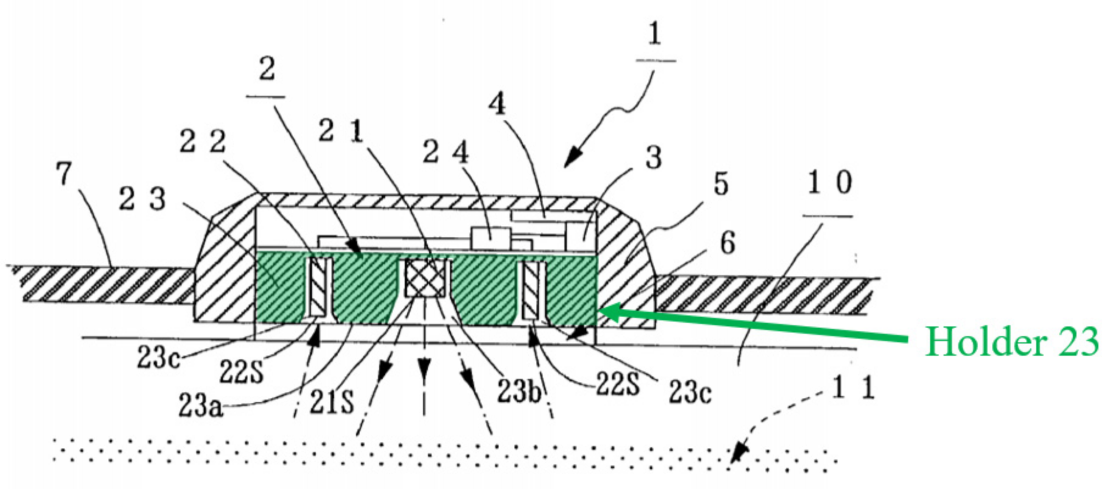
[3] The physiological measurement system of claim 2, wherein at least part of the single protruding convex surface is light permeable to provide at least one optical path to at least one of the at least four detectors.

204. As explained above with respect to [1pre]-[1k], the sensor resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have stored each of the photodetectors 22 in cavities included within the holder 23, an opaque structure extending from the substrate on which the photodetectors 22 are arranged to a translucent convex cover situated between the sensor and the user's tissue. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

205. As shown in FIG. 1(b) of Aizawa, reproduced below, Aizawa's holder 23 blocks light other than at cavities 23b and 23c for the light emitting diode 21 and the photodetectors 22, with each opening 23c allowing light to pass through to the corresponding detectors. APPLE-1006, ¶[0024]. The optical path taken by light exiting cavity 23b and entering cavities 23c are indicated by arrows. This "sectional view" of the sensor illustrates only two of the at least four photodetectors, and depicts two optical paths, one for each of the two illustrated

photodetectors. Thus, Aizawa discloses at least one optical path to at least one of the at least four detectors. *Id*.

FIG. 1 (b)

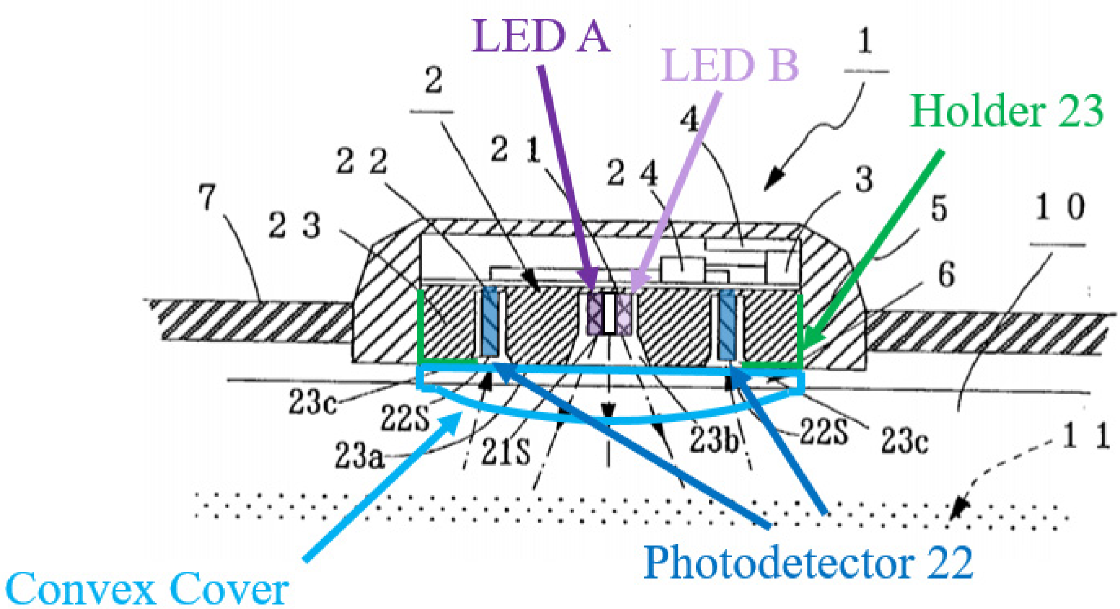


APPLE-1006, FIG. 1(b) (annotated)

206. As explained above with respect to [1pre]-[1k], and shown in FIG. 1(b) of Aizawa (reproduced below) the sensor resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 includes a transparent (or translucent), convex cover configured to be located between tissue of the user and the photodetectors when the sensor is worn by the user. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0029], [0030] ("the acrylic **transparent** plate is provided on the detection face 23a of the holder 23"), [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶¶[0015], [0017], [0025] ("The detecting element 2 is arranged on the user's wrist 4 so that the convex surface of the **translucent** board 8 is in intimate contact with the surface of the

user's skin"), FIGS. 1, 2, 4A, 4B; APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19.

FIG. 1 (b)



APPLE-1006, FIG. 1(b) (annotated)

207. A transparent or translucent material is, by definition, at least partially light permeable.

208. Accordingly, [3] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

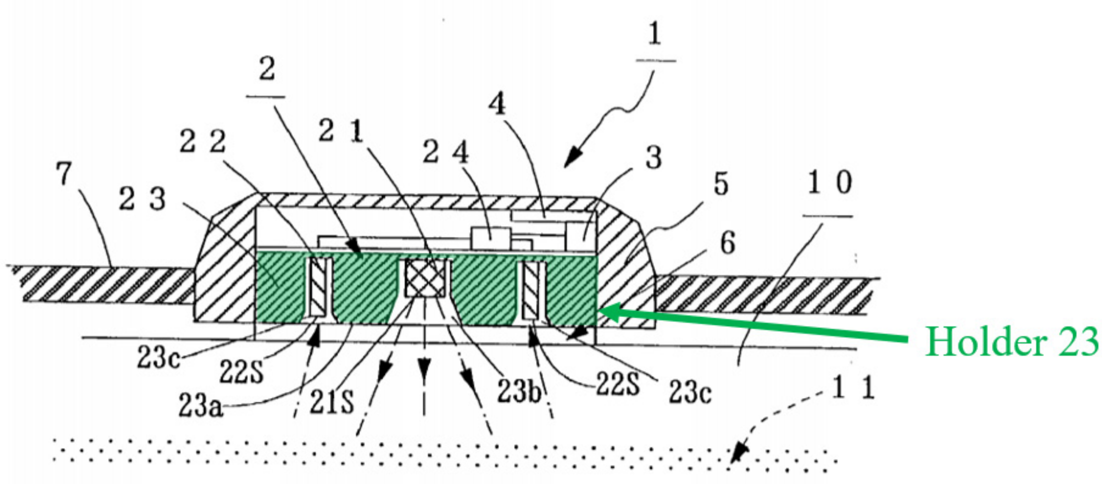
E. Claim 4

[4] The physiological measurement system of claim 3, wherein the physiological sensor device further comprises: an at least partially opaque layer blocking one or more optical paths to at least one of 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.

209. As explained above with respect to [1pre]-[1d] and [3], the sensor resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have stored each of the photodetectors 22 in cavities included within the holder 23, an opaque structure extending from the substrate on which the photodetectors 22 are arranged to a translucent convex cover situated between the sensor and the user's tissue. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

210. As shown in FIG. 1(b) of Aizawa, reproduced below, Aizawa's holder 23 blocks light other than at cavities 23b and 23c for the light emitting diode 21 and the photodetectors 22, with each opening 23c allowing light to pass through to the corresponding detectors. APPLE-1006, ¶[0024]. The optical path taken by light exiting cavity 23b and entering cavities 23c are indicated by arrows.

FIG. 1 (b)



APPLE-1006, FIG. 1(b) (annotated)

211. One of ordinary skill would have readily understood that Aizawa's holder 23, the wall circumscribing the photodetectors, itself is opaque, and any surface of the wall, including the detection face 23a of the holder 23 would be an opaque layer. One of ordinary skill would have thus found it obvious that Aizawa's holder 23 discloses, or at least suggests, an opaque layer.

212. The '554 patent itself describes such an opaque layer can be integral to the contact area of the sensor. APPLE-1001, 19:28-38 (describing that the "contact area 370 of the protrusion 305 can include openings or windows 320, 321, 322, and 323" and "the windows 320, 321, 322, and 323 mirror specific detector placements layouts such that light can impinge through the protrusion 305 onto the photodetectors.") One of ordinary skill would have understood that Aizawa's cavities 23b and 23c are openings or windows that mirror specific detector placement layouts "such that light can impinge…onto the photodetectors" that are formed in the contact face of holder 23.

213. Indeed, by the '554 patent's 2008 Critical Date, optical sensors commonly employed opaque layers with windows corresponding to detectors. APPLE-1013, ¶[0073], FIGS. 19A-19C; APPLE-1006, ¶¶[0012], [0013], [0023], [0024], [0030], FIGS. 1(a), 1(b). Schulz, for example, describes a pulse oximetry sensor featuring "a thin sheet of opaque material" placed inside the sensor's housing, with "a

window in the opaque material provid[ing] an aperture for transmission of optical energy to or from the tissue site." APPLE-1013, ¶[0073]. The opaque material blocks light, "and the window in the opaque material can be sized as needed to block the proper amount of light from entering the aperture to, for example, avoid saturation of the light detector." *Id.*, FIGS. 19A-19C.

214. Form this and related description, one of ordinary skill would have understood the holder to comprise an opaque surface and that the cavities within holder 23 teach windows in the opaque material of holder 23 that allow light through while avoiding saturation of each of the sensor's detectors. APPLE-1013, ¶[0073], FIGS. 19A-19C; *see also* APPLE-1019, 79, 86, 94 ("Ambient light from sources such as sunlight, surgical lamps etc may cause errors in SaO2 readings. In order to prevent this, the simple solution is to cover the sensor site with opaque material which can prevent ambient light from reaching the photodiode"); APPLE-1006, ¶¶[0012], [0023], [0024], FIGS. 1(a), 1(b) (illustrating an opaque holder with cavities for storing each of a plurality of photodetectors, the cavities being sized as appropriate to enable a proper amount of light to reach each detector).

215. Accordingly, [4] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

F. Claim 5

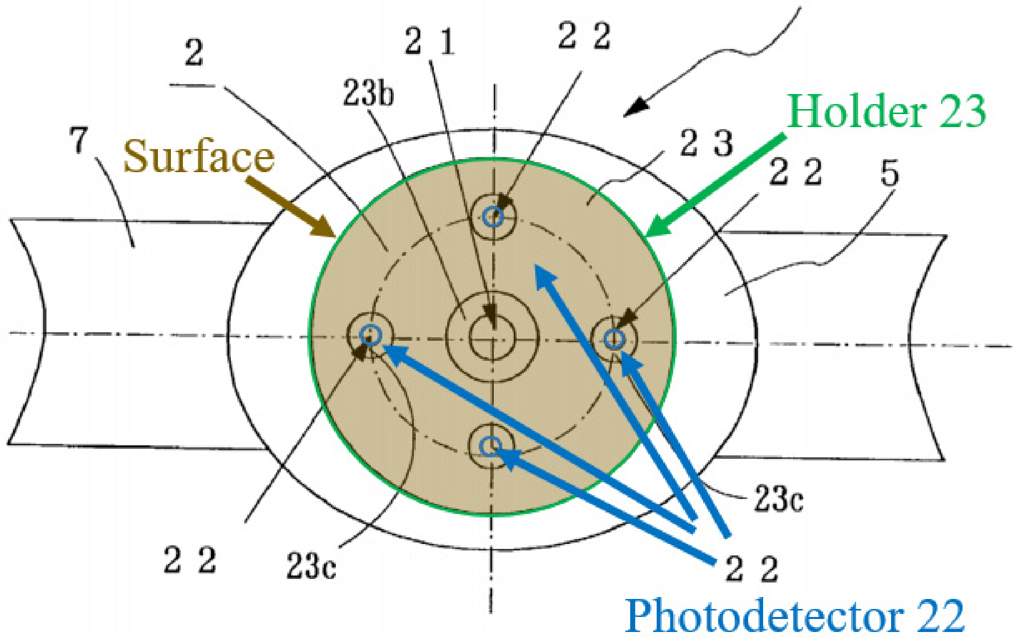
[5] The physiological measurement system of claim 4, wherein the physiological sensor device further comprises: a substrate having a first surface, wherein the at least four detectors are arranged on the first surface.

216. As explained above with respect to [1pre]-[1a], Aizawa in view of Inokawa teaches a wrist-worn "pulse wave sensor" that includes a plurality of light emitting diodes and "**four photodetectors disposed around the light emitting diode symmetrically on a circle** concentric to the light emitting diode." APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1006, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19.

217. To the extent that Aizawa does not explicitly describe photodetectors 22 as being arranged on a substrate or that the substrate itself is not explicitly labelled or described, one of ordinary skill would have found it obvious that Aizawa's photodetectors are arranged on a substrate. For example, one of ordinary skill would have understood that Aizawa's photodetectors are secured to the assembly, provided with power by a power source (also not shown), and can transmit signals to other portions of the sensors through such a structure. One of ordinary skill would have understood that the substrate provides physical support and electrical connectivity and is operably connected to the holder 23. For example, one of ordinary skill would have found it obvious that the substrate is attached to the holder 23. Indeed, one of ordinary skill would have found it obvious to use such a substrate because it provides a simpler manufacturing process and more compact

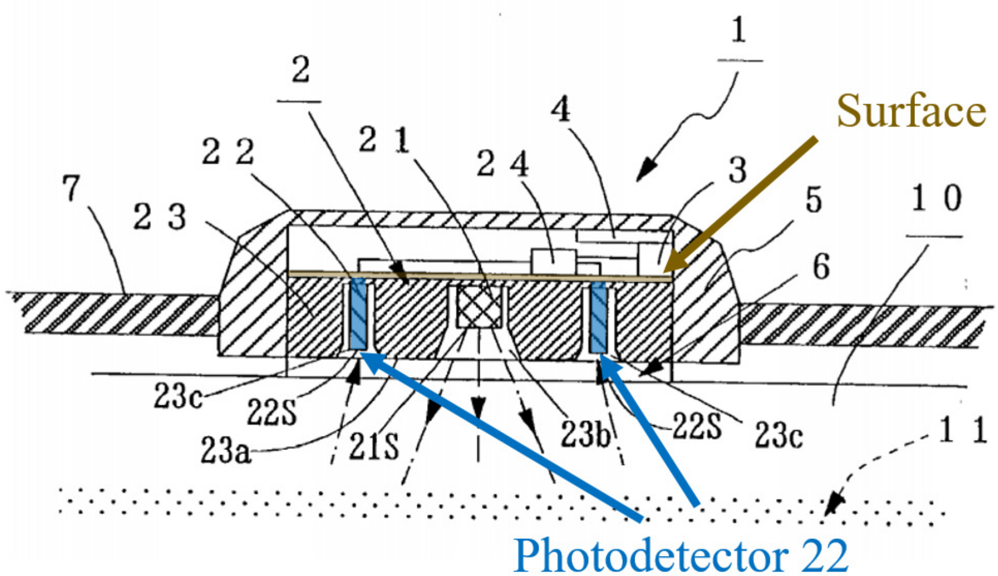
design than using and routing wires would allow. As shown in FIG. 1(b) of Aizawa (reproduced below), Aizawa illustrates a substrate, but does not label or describe such a structure. Such a substrate would have had at least one surface, and one of ordinary skill would have understood that the photodetectors would have been arranged on a surface of the substrate.

FIG. 1 (a)



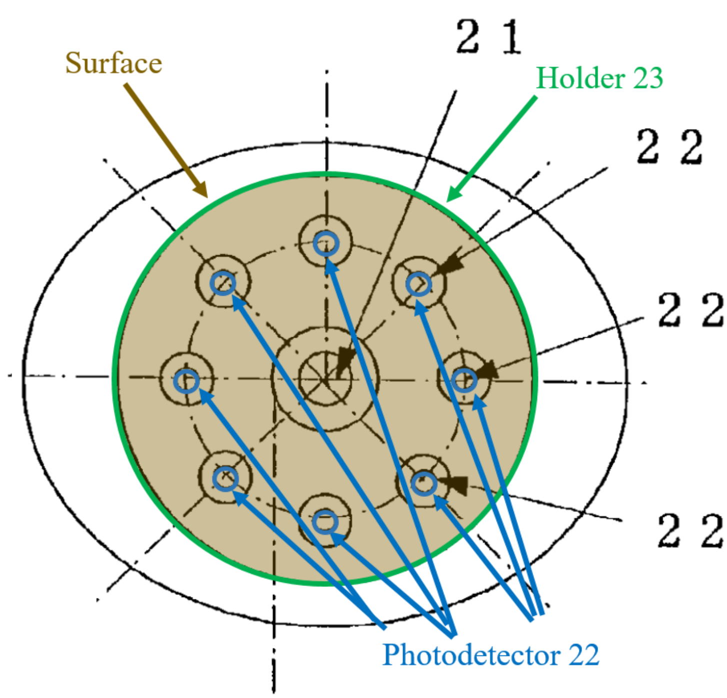
APPLE-1006, FIG. 1(a) (annotated)

F I G. 1 (b)



APPLE-1006, FIG. 1(b) (annotated)

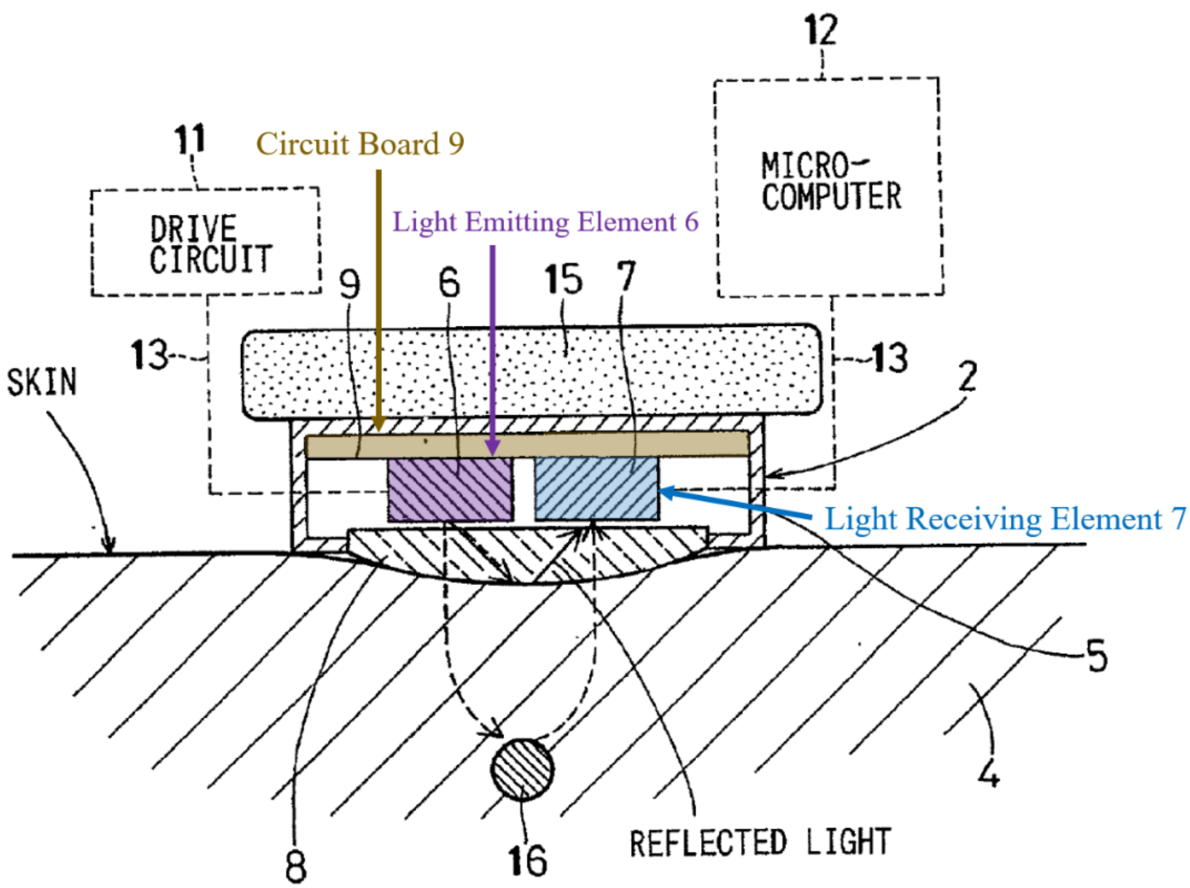
F I G. 4 (a)



APPLE-1006, FIG. 4(a) (annotated)

218. In addition or alternatively, it would have been obvious to modify Aizawa to incorporate a substrate on which photodetectors 22 are arranged. For example, Ohsaki discloses a substrate (circuit board 9). APPLE-1009, ¶[0017], FIG. 2. One of ordinary skill would have been motivated to modify Aizawa to incorporate circuit board 9 to enable photodetectors 22 to send signals to other portions of the sensor.

FIG. 2



APPLE-1009, FIG. 2 (annotated)

219. From this and related description, one of ordinary skill would have understood that Aizawa in view of Ohsaki renders obvious at least four detectors that are arranged evenly spaced from one another on a substrate, and that are configured to detect light that has been attenuated by the user's tissue. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027]-[0029], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶[0017], FIG. 2.

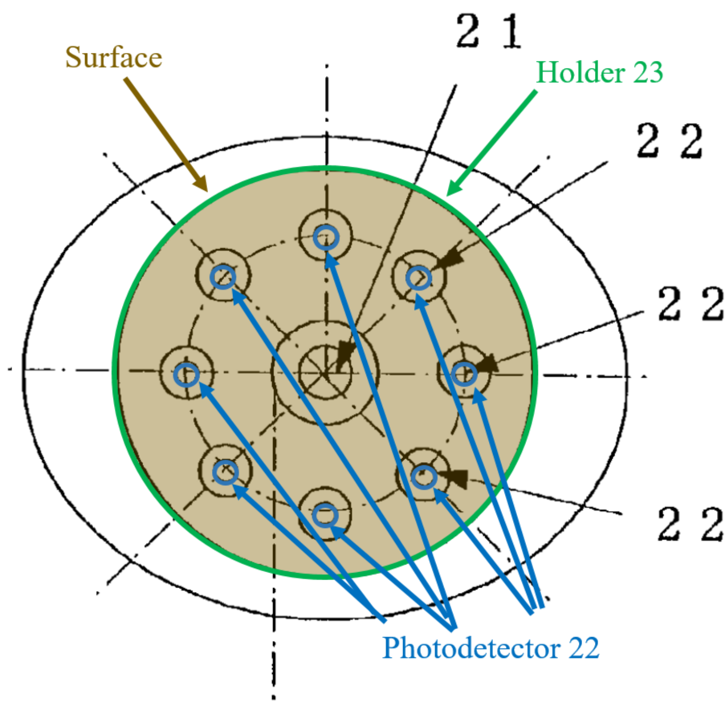
220. Accordingly, [5] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

G. Claim 6

[6] The physiological measurement system of claim 5, 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.

221. As explained above with respect to [1pre]-[1k], [4], and [5] the sensor resulting from the combination of the teachings of Aizawa and Ohsaki would have included a wall that surrounds the at least four detectors, and that the at least four detectors are arranged on a substrate wherein the wall operably connects to the substrate and the cover. APPLE-1006, ¶¶[0012], [0013], [0023], [0024], [0030], FIGS. 1(a), 1(b); APPLE-1009, Abstract, [0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

F I G. 4 (a)

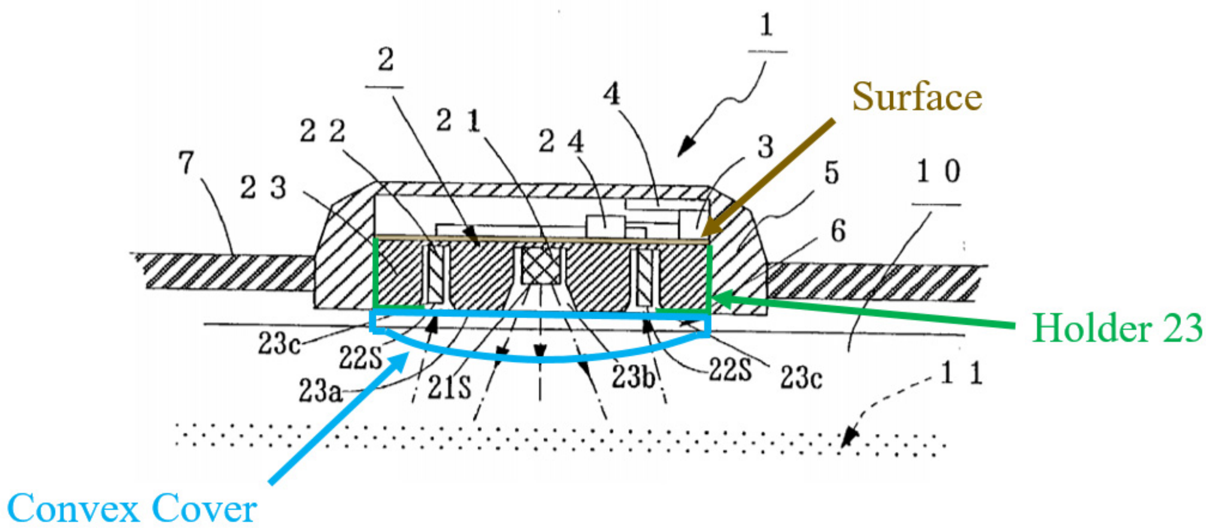


APPLE-1006, FIG. 4(a) (annotated)

222. As shown in FIG. 4(a) (reproduced above) Aizawa's holder 23 surrounds the at least four photodetectors 22. As explained above with respect to [1pre]-[1k] and [5], one of ordinary skill would have found it obvious that Aizawa's photodetectors 22 are arranged on a first surface of a substrate such as a circuit board.

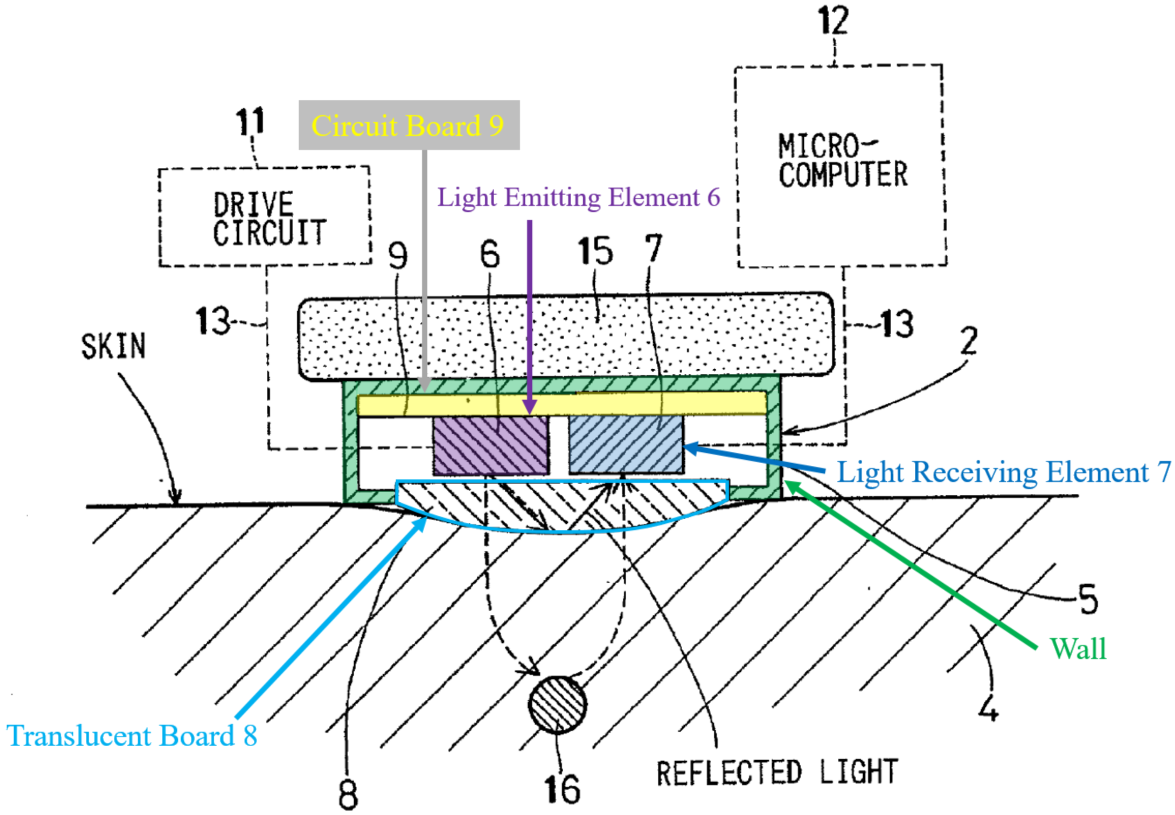
223. Additionally, as shown in FIG. 1(b), "an acrylic transparent plate [is] mounted to the detection face 23a of the holder 23" on the opposite side from where the substrate on which the photodetectors 22 are arranged. *Id.*, ¶[0023].

FIG. 1 (b)



APPLE-1006, FIG. 1(b) (annotated)

224. Additionally, as shown in Ohsaki's FIG. 2 (reproduced below), Ohsaki discloses that its "detecting element 2 comprises a package 5" which "has an opening and includes a circuit board 9 therein" as well as "a light emitting element 6 (e.g., LED), a light receiving element 7 (e.g., PD)" that are "arranged on the circuit board 9" and "a translucent board 8" that is a convex, "glass board which is transparent to light, and attached to the opening of the package 5." APPLE-1009, ¶[0017].



APPLE-1009, FIG. 2 (annotated)

225. Ohsaki's package 5 includes a wall that surrounds, or circumscribes, its light emitting element 6 and light receiving element 7. On one end, Ohsaki's wall is operably connected to circuit board 9 on which light emitting element 6 and light receiving element 7 are mounted. On the opposite end, Ohsaki's wall is operably connected to a convex, translucent board 8. Although Ohsaki does not display a plan view of the package 5, one of ordinary skill would have found it obvious that Ohsaki's package 5 includes a wall that circumscribes its light receiving element.

226. For at least these reasons, one of ordinary skill would have understood that Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006 discloses a wall configured to circumscribe at least the at least four detectors that operably connects to the substrate on one side and operably connects to the cover on an opposing side. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0029], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶[0017], FIG. 2.

227. Accordingly, [6] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

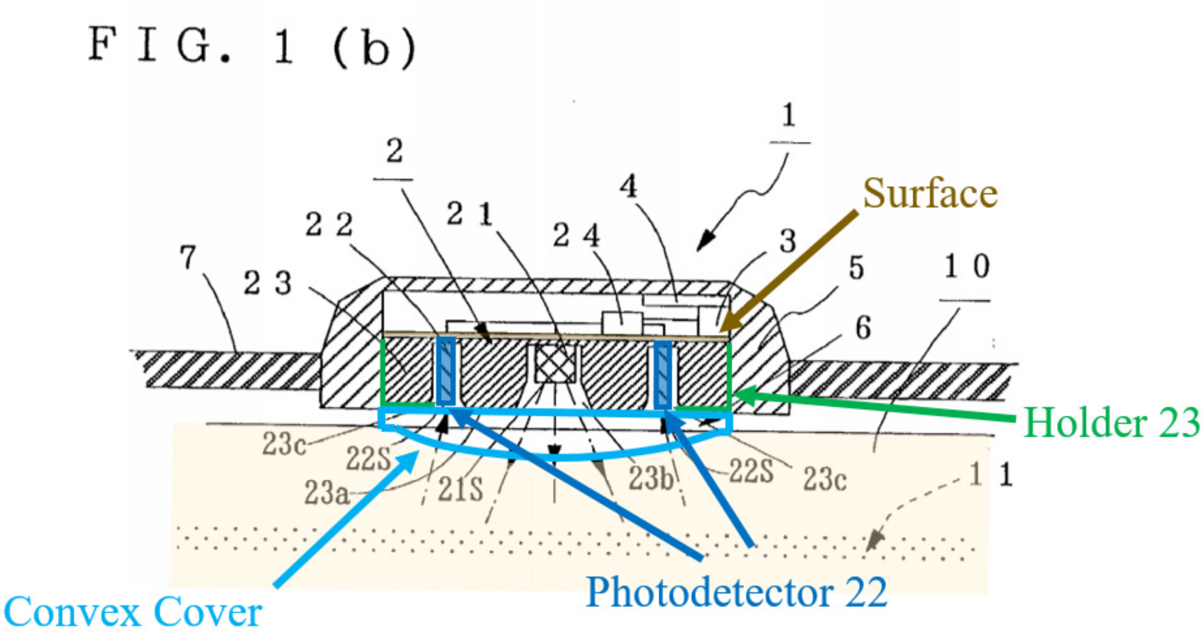
H. Claim 7

[7] The physiological measurement system of claim 6, 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.

228. As explained above with respect to [1pre]-[1e] and [2]-[6], one of ordinary skill would have understood Aizawa to include a substrate on which the photodetectors 22 are arranged, and that this substrate is operably connected to holder 23, which both circumscribes and retain the photodetectors. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0029], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶[0017], FIG. 2. Additionally, as shown in FIG. 1(b), "an acrylic transparent plate [is] mounted to the detection face 23a of

the holder 23" on the opposite side from where the substrate on which the photodetectors 22 are arranged. APPLE-1006, ¶[0023].

229. As shown in FIG. 1(b) of Aizawa (reproduced below), Aizawa illustrates that its wall, holder 23, creates one or more gaps between the surface of the substrate on which the photodetectors 22 are mounted and a surface of the convex cover that is interior to Aizawa's sensor 1. In further detail, Aizawa's FIG. 1(b) illustrates that the photodetectors 22 are positioned on the surface of the substrate within the one or more gaps created by holder 23 between the substrate and the cover.



APPLE-1006, FIG. 1(b) (annotated)

230. Accordingly, [7] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

I. Claim 20

[20pre] A physiological measurement system comprising:

231. As explained above with respect to [1pre]-[1k], Aizawa discloses a physiological measurement system. APPLE-1006, Abstract ("a pulse wave sensor for detecting a pulse wave by detecting light output from a light emitting diode and reflected from the artery of a wrist of a subject"), ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a).

232. Accordingly, [20pre] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[20a] a plurality of emitters configured to emit light into tissue of a user;

233. As explained above with respect to [1pre]-[1k], Aizawa discloses a physiological sensor device. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a).

234. Accordingly, [20a] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[20b] a plurality of emitters configured to emit light into tissue of a user;

235. As explained above with respect to [1pre]-[1k], the sensor resulting from the combination of the teachings of Aizawa and Inokawa would have included a

plurality of emitters configured to emit light into tissue of a user. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033] ("a **plurality of light emitting diodes** 21 are disposed around the photodetector 22"); APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19.

236. Accordingly, [20b] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[20c] 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;

237. As explained above with respect to [1pre]-[1k], the sensor resulting from the combination of the teachings of Aizawa and Inokawa would have included 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. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033] ("a plurality of light emitting diodes 21 are disposed around the photodetector 22"); APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19.

238. Accordingly, [20c] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[20d] a wall that surrounds at least the at least four detectors; and

239. As explained above with respect to [1pre]-[1k], the sensor resulting from the combination of the teachings of Aizawa and Inokawa would have included a wall that surrounds at least the at least four detectors. APPLE-1006, Abstract, ¶¶[0002],

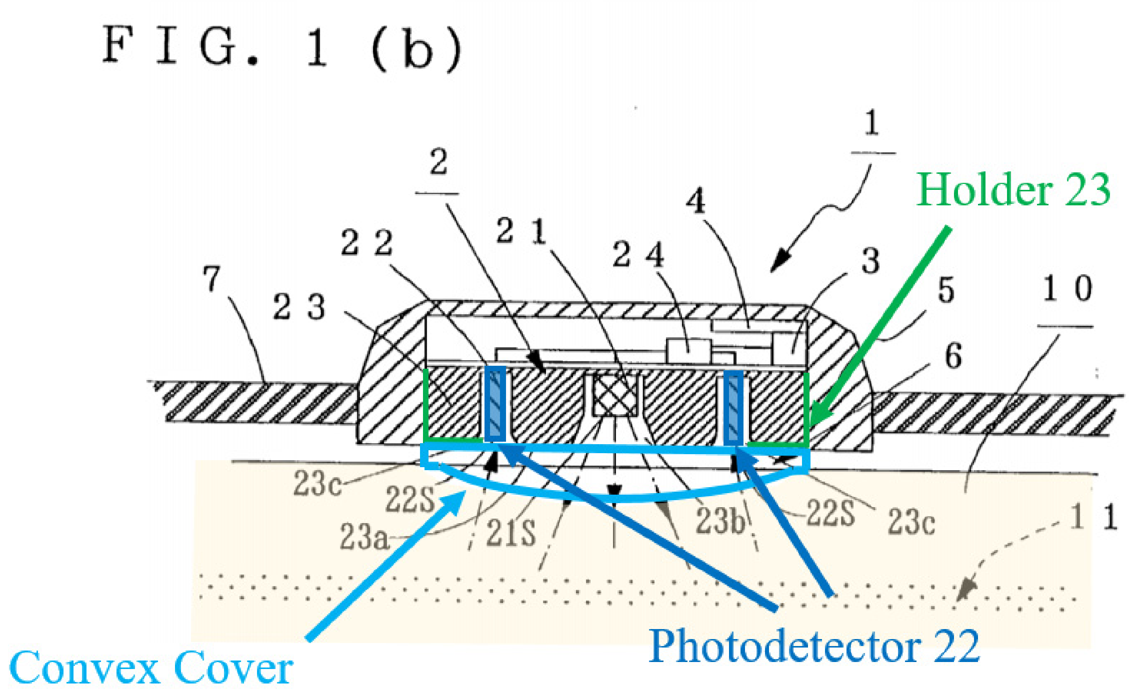
[0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19.

240. Accordingly, [20d] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[20e] a cover comprising a single protruding convex surface, wherein the single protruding convex surface 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 at least a portion of the single protruding convex surface 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 wherein the cover operably connects to the wall; and

241. As explained above with respect to [1pre]-[1k] and shown in FIG. 4(a) of Aizawa (reproduced below), the sensor resulting from the combination of the teachings of Aizawa, Inokawa, and Ohsaki would have included 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 . APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0026] (describing "an acrylic transparent plate 6" that "becomes close to the artery 11 of the wrist 10" of a subject wearing Aizawa's wrist-worn pulse sensor, improving "adhesion between the wrist 10 and the pulse rate detector 1"), [0027], [0033]; APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19. The cover would have comprised a single protruding convex surface, and would have been 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 device is worn by the user. APPLE-1009, ¶¶[0015], [0017], [0025] (the "convex surface of the translucent board 8 is in intimate contact with the surface of the user's skin"), FIGS. 1, 2, 4A, 4B.



APPLE-1006, FIG. 2 (annotated)

242. Accordingly, [20e] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[20f] a handheld computing device in wireless communication with the physiological sensor device.

243. As explained above with respect to [1pre]-[1k], the physiological measurement system resulting from the combination of the teachings of Aizawa,

Inokawa, Ohsaki, and Mendelson 2006 would have included a handheld computing device in wireless communication with the physiological sensor device. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0026], [0027], [0033]; APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19; APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; APPLE-1010, 1-4, FIG. 3; APPLE-1020, 1-4.

APPLE-1010, FIG. 3

244. Accordingly, [20f] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

J. Claim 21

[21a] The physiological measurement system of claim 20, 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;

245. As explained above with respect to [1pre]-[1k], the physiological measurement system resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included a handheld computing device that includes 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. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19; APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-4, 6-8.

246. Accordingly, [21a] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[21b] a touch-screen display configured to provide a user interface, wherein:

247. As explained above with respect to [1pre]-[1k], the physiological measurement system resulting from the combination of the teachings of Aizawa,

Inokawa, Ohsaki, and Mendelson 2006 would have included a handheld computing device that includes a touch-screen display configured to provide a user interface configured to display indicia responsive to measurements of the physiological parameter. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19; APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-4, 6-8; APPLE-1021, xvii-xviii, 10-12, 17, 63, 73-101, 176, 190-193, 363; APPLE-1022, 4-11, 30-31, 56-67, 72-92.

APPLE-1010, FIG. 3

248. Accordingly, [21b] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[21c] the user interface is configured to display indicia responsive to measurements of the physiological parameter, and

249. As explained above with respect to [1pre]-[1k], one of ordinary skill would have found it obvious to configure a touch-screen display of the PDA to provide a user interface, the user interface being configured to display indicia responsive to measurements of the physiological parameter. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1010, 1-4, FIG. 3; APPLE-1020, 1-4; *see also* APPLE-1009, ¶¶[0005] ("The information of pulse wave detected by the detecting element is displayed on the display of the sensor body fixed on the back side of the user's wrist"), [0020] ("The sensor body 3 is connected to the detecting element 2 by a signal line 13, and includes … a monitor display … the monitor display shows the calculated pulse rate and the like"); APPLE-1021, xvii-xviii, 10-12, 17, 63, 73-101, 176, 190-193, 363; APPLE-1022, 4-11, 30-31, 56-67, 72-92. In implementing this physiological measurement system, one of ordinary skill would have configured a touch-screen display of the PDA to provide a user interface, the user interface being configured to display indicia responsive to measurements of the physiological parameter.

250. Accordingly, [21c] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[21d] an orientation of the user interface is configurable responsive to a user input; and

251. As explained above with respect to [1pre]-[1k], one of ordinary skill would have found it obvious to configure a touch-screen display of the PDA to provide a user interface, the user interface being configured to display indicia responsive to measurements of the physiological parameter, and an orientation of the user interface being configurable responsive to a user input. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1010, 1-4, FIG. 3; APPLE-1020, 1-4; *see also* APPLE-1009, ¶¶[0005] ("The information of pulse wave detected by the detecting element is displayed on the display of the sensor body fixed on the back side of the user's wrist"), [0020] ("The sensor body 3 is connected to the detecting element 2 by a signal line 13, and includes … a monitor display … the monitor display shows the calculated pulse rate and the like"); APPLE-1021, xvii-xviii, 63; APPLE-1022, 8.

252. For example, Mendelson 2006 describes that a "dedicated National Instruments LabVIEW program" was developed to provide a graphical user interface (GUI) for a user to "control all interactions between the PDA and the wearable unit." APPLE-1010, 3; APPLE-1027, 186.

APPLE-1010, FIG. 3 (left) and APPLE-1020, 1 (right)

253. The LabVIEW program included features that allowed a user to perform tasks including setting the report orientation in either portrait or landscape. Thus, one of ordinary skill would have found it obvious that a system resulting from the combination of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have allowed an orientation of the user interface to be responsive to a user input.

254. Accordingly, [21d] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

[21e] a storage device configured to at least temporarily store at least the measurements of the physiological parameter.

255. As explained above with respect to [1pre]-[1k], the physiological measurement system resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included a handheld computing device that includes a storage device configured to at least temporarily store at least the measurements of the physiological parameter. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19; APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-4, 6-8; APPLE-1021, 31-36; APPLE-1022, 50-51.

256. Accordingly, [21e] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

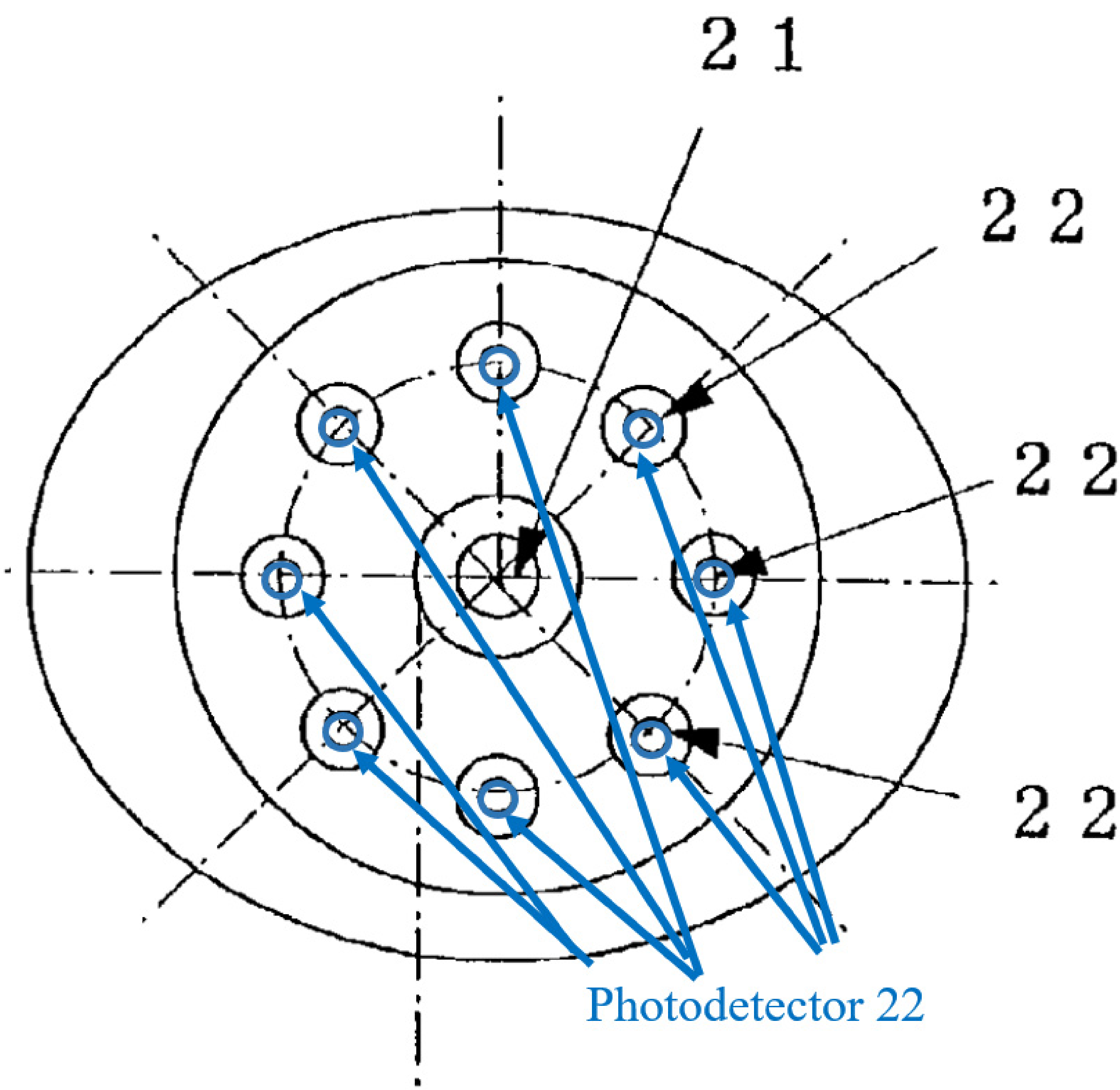
K. Claim 22

[22] The physiological measurement system of claim 21, wherein the at least four detectors comprise at least eight detectors.

257. As explained above with respect to [1pre]-[1k] and [2], the physiological measurement system resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included at least eight detectors. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19; APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-4, 6-8.

258. Indeed, as shown in FIG. 4(a) of Aizawa (reproduced below), Aizawa explicitly depicts a sensor that includes eight detectors.

FIG. 4 (a)



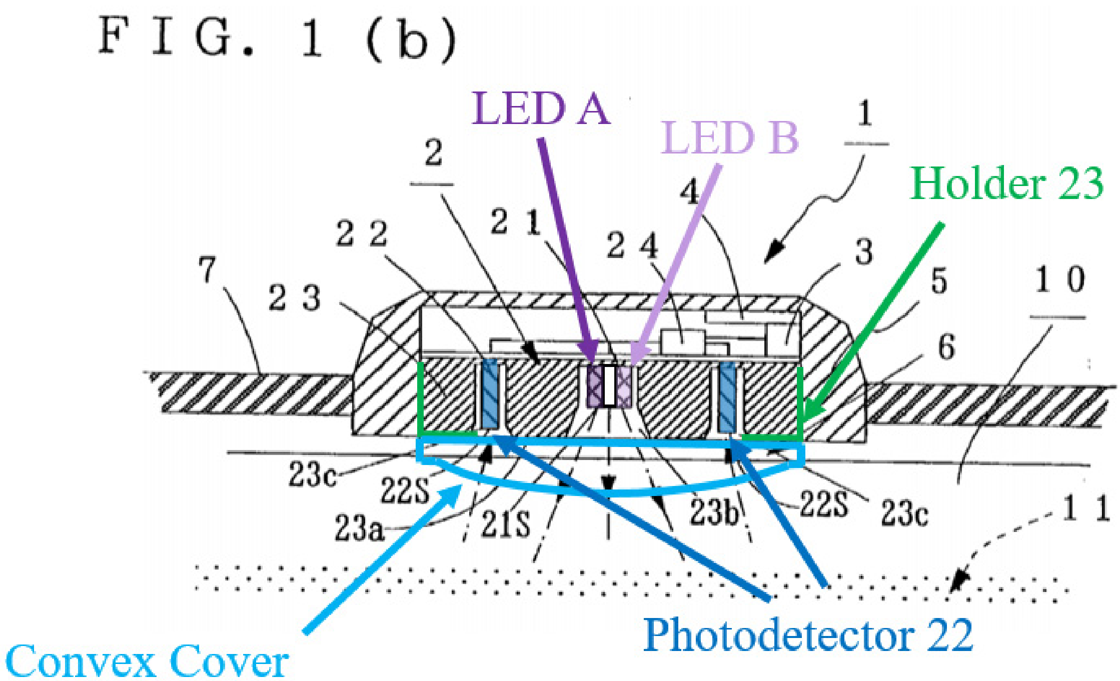
APPLE-1006, FIG. 4(a) (annotated)

259. Accordingly, [22] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

L. Claim 23

[23] The physiological measurement system of claim 22, wherein at least part of the single protruding convex surface is light permeable to allow light to reach at least one of the at least four detectors.

260. As explained above with respect to [1pre]-[1k] and [3], the physiological measurement system resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included a single protruding convex surface where at least part of the single protruding convex surface is light permeable to allow light to reach at least one of the at least four detectors. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19; APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-4, 6-8.



APPLE-1006, FIG. 1(b) (annotated)

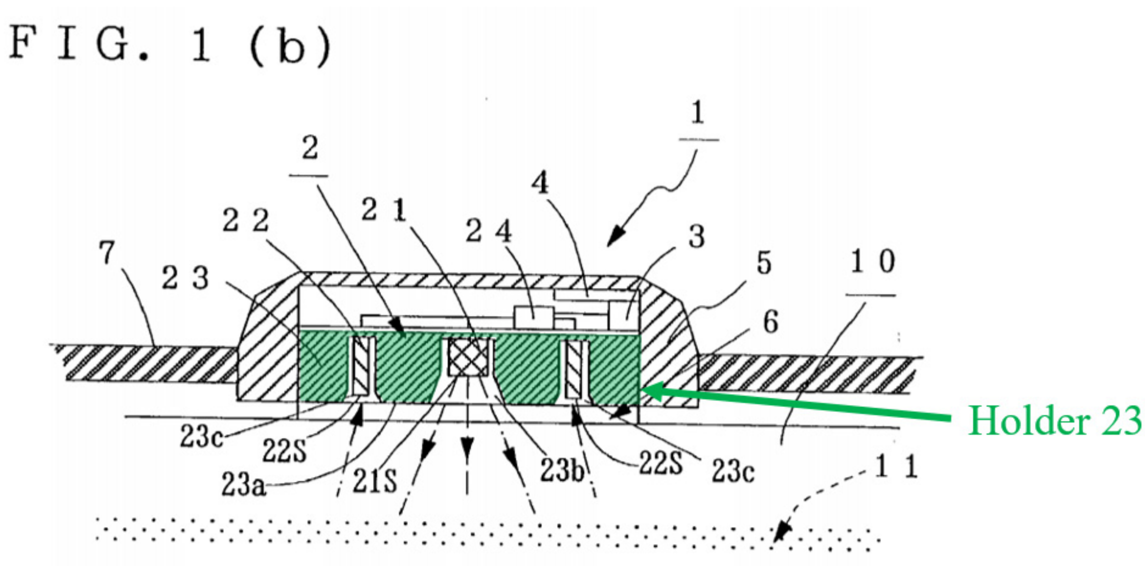
261. Accordingly, [23] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

M. Claim 24

[24] The physiological measurement system of claim 23, wherein the physiological sensor device further comprises: an at least partially opaque layer blocking one or more optical paths to at least one of 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.

262. As explained above with respect to [1pre]-[1k] and [4], the physiological measurement system resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included an at least partially opaque layer blocking one or more optical paths to at least one of 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. APPLE-1013, ¶[0073], FIGS. 19A-19C; APPLE-1019, 79, 86, 94 ("Ambient light from sources such as sunlight, surgical lamps etc may cause errors in SaO2 readings. In order to prevent this, the simple solution is to cover the sensor site with opaque material which can prevent ambient light from reaching the photodiode"); APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19; APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-4, 6-8.



APPLE-1006, FIG. 1(b) (annotated)

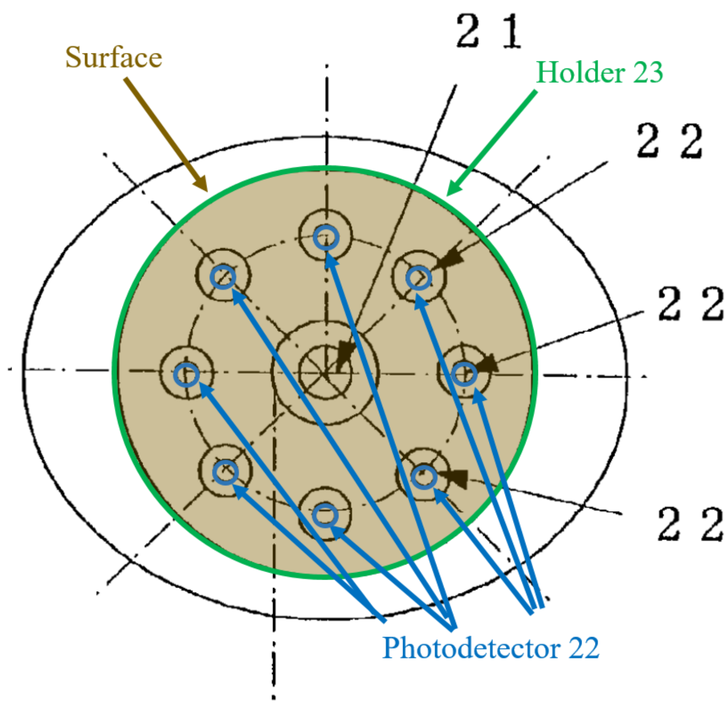
263. Accordingly, [24] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

N. Claim 25

[25] The physiological measurement system of claim 24, 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 cover on an opposing side of the wall.

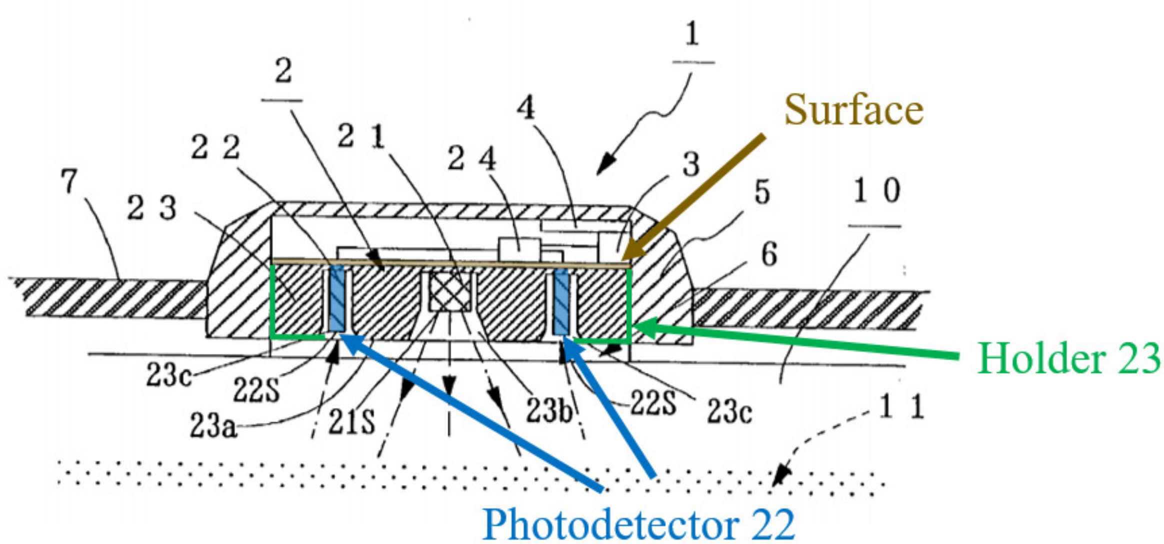
264. As explained above with respect to [1pre]-[1k], [5], and [6], the physiological measurement system resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included a substrate having a first surface, wherein the at least four detectors are arranged on the first surface, and wherein the wall surrounds at least the at least four detectors on the first surface and 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. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1008, ¶¶(0014), (0040), (0058)-(0059), FIGS. 2, 3, 19; APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; APPLE-1010, 1-4, FIGS. 1-3; APPLE-1020, 1-4, 6-8.

FIG. 4 (a)



APPLE-1006, FIG. 4(a) (annotated)

FIG. 1 (b)



APPLE-1006, FIG. 1(b) (annotated)

265. Accordingly, [25] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

O. Claim 26

[26] The physiological measurement system of claim 25, wherein a surface of the handheld computing device positions the touch-screen display.

266. As explained above with respect to [1pre]-[1k], [20pre]-[20f], and [21]-[25], the physiological measurement system resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included a handheld computing device featuring a touch-screen display.

267. In more detail, Mendelson 2006 describes the wireless transmission of "vital physiological information" acquired and processed by a "body-worn pulse oximeter" to the HP iPAQ h4150 PDA, which is utilized "as a local terminal" with a "low-cost touch screen interface" featuring a "simple GUI" "configured to present … input and output information to the user" and to allow "easy activation of various functions." APPLE-1010, 1-2, FIGS. 1-3; *see also* APPLE-1020, 3 (confirming that the HP iPAQ h4150 typically included a touch screen display); APPLE-1021, xvii-xviii, 10-12, 17, 63, 73-101, 176, 190-193, 363; APPLE-1022, 4-11, 30-31, 56-67, 72-92. As shown below, a surface of the HP iPAQ h4150 positions the touch-screen display. APPLE-1010, FIG. 3; APPLE-1020, 1.

APPLE-1010, FIG. 3 (left) and APPLE-1020, 1 (right)

268. Accordingly, [26] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

P. Claim 27

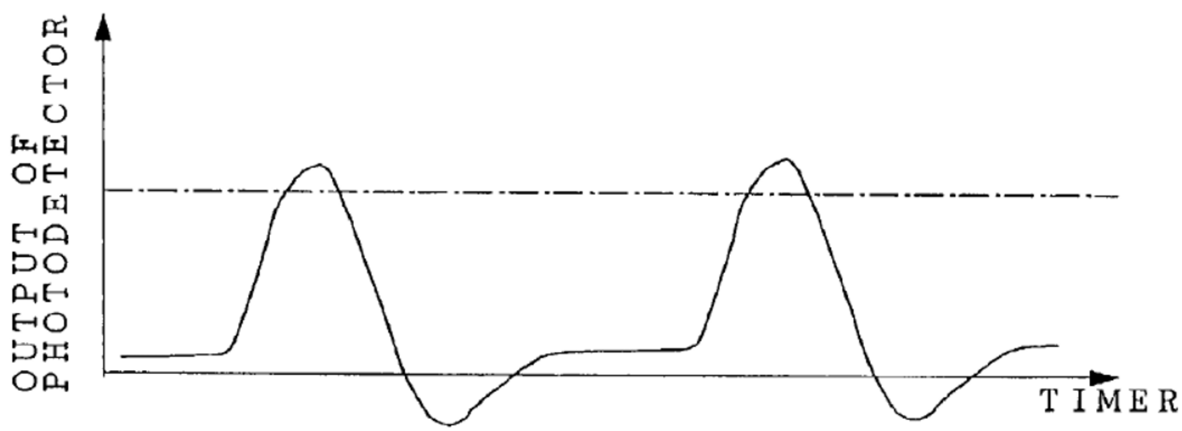
[27] The physiological measurement system of claim 26, wherein the physiological parameter comprises at least one of: pulse rate, glucose, oxygen, oxygen saturation, methemoglobin, total hemoglobin, carboxyhemoglobin, carbon monoxide, or a state or trend of wellness of the user.

269. As explained above with respect to [1pre]-[1k], [20pre]-[20f], and [21]-[26], the physiological measurement system resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, Mendelson 2006 would have included a processor

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. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027]-[0028], [0033]; APPLE-1010, 1-4, FIG. 3.

270. As shown below, Aizawa discloses displaying the "waveform of a pulse wave" as output by the photodetectors. APPLE-1006, ¶[0028].

FIG. 3



APPLE-1006, FIG. 3

271. Further, and as shown below, Mendelson 2006 discloses that the HP iPAQ h4150 PDA displays indicia responsive to measurements of physiological parameters that include SpO_2 and HR, the PDA having wirelessly received signals responsive to the user's SpO2 and HR from a body-worn pulse oximeter. APPLE-1010, 2-3, FIG. 3.

APPLE-1010, FIG. 3

272. Accordingly, [27] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

Q. Claim 28

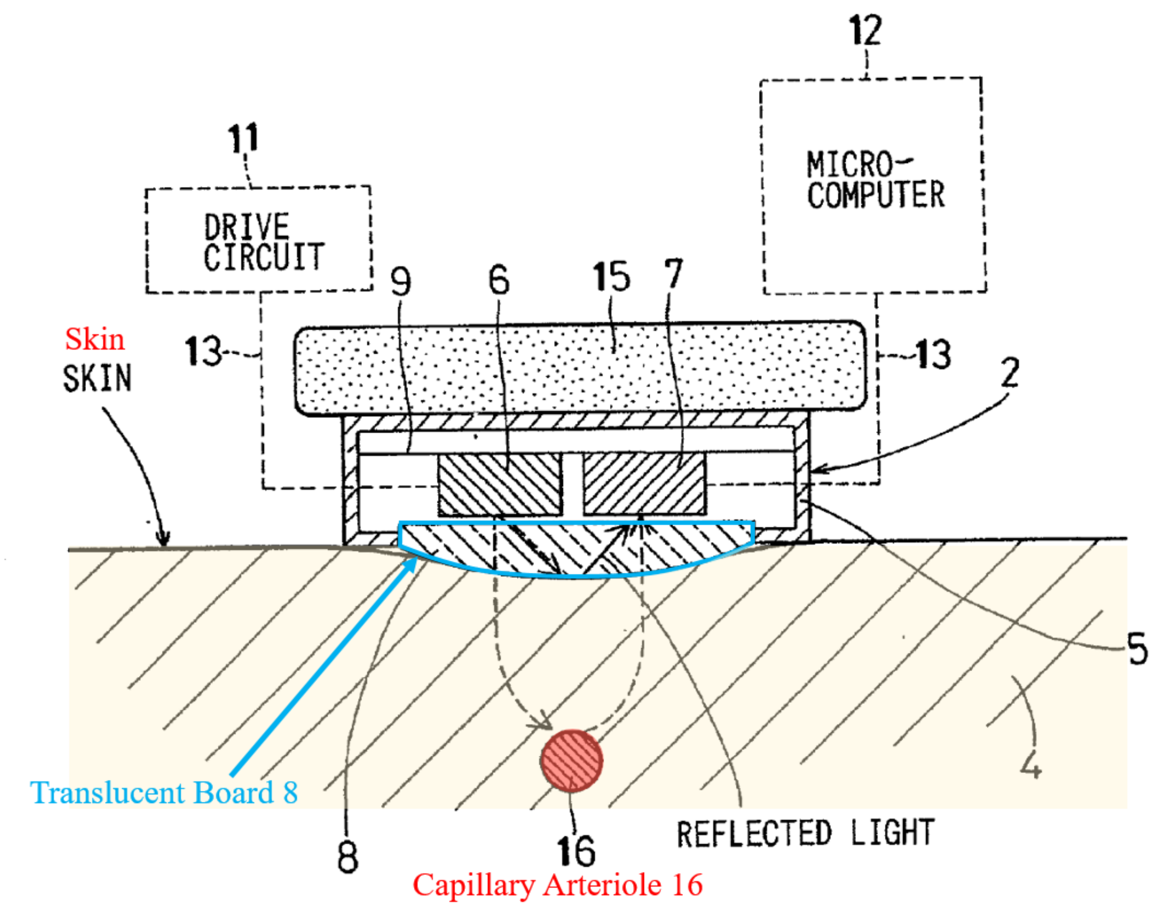
[28] The physiological measurement system of claim 27, wherein the single protruding convex surface protrudes a height greater than 2 millimeters and less than 3 millimeters.

273. As explained above with respect to [1pre]-[1k], [20pre]-[20f], and [21]-[27], the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 would have included a cover featuring a

single protruding convex surface. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027]-[0028], [0033]; APPLE-1009, Abstract, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

274. In more detail, and as shown below, the convex cover taught by Ohsaki is designed to be "in intimate contact with the surface of the user's skin," so as to prevent slippage of the detecting element from its position on the user's wrist. APPLE-1009, ¶¶[0009]-[0010], FIG. 2.

FIG. 2



APPLE-1009, FIG. 2 (annotated)

275. In incorporating Ohsaki's teachings, one of ordinary skill would have found it obvious that a device designed to fit on a user's wrist would be on the order of millimeters. Additionally, one of ordinary skill would have taken the user's comfort into consideration—Ohsaki's convex cover, for example, is said to solve the problem of "the user feel[ing] uncomfortable" due to pressure from the device and belt on the user's limbs. APPLE-1009, ¶[0006]; *see also* APPLE-1010, 2 (describing its "optical reflectance transducer" as "small (⌀ = 22mm)"); *see also* APPLE-1017, 2 (describing a "standard 24-pin (dimensions: 19 x 19 mm) microeletronic package" for its sensor).

276. One of ordinary skill would have found it obvious that in order to provide a comfortable cover featuring a protruding convex surface that prevents slippage, the surface should protrude a height greater than 2 millimeters and less than 3 millimeters. Indeed, there would have been a finite range of possible protruding heights, and it would have been obvious to select a protruding height that would have been comfortable to the user.

277. Accordingly, [28] would have been obvious over Aizawa in view of Inokawa, Ohsaki, and Mendelson 2006.

VIII. GROUND 2 – Claims 8-19 are Rendered Obvious by Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey

A. Combination of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey

278. The Aizawa-Inokawa-Ohsaki-Mendelson combination does not explicitly disclose that the substrate, the wall, and the cover together hermetically seal the at least four detectors.

279. However, by the '554 patent's 2008 earliest effective filing date, internal electronics within devices, such as wristwatches, worn on a person's wrist would have been "hermetically sealed in the watch case to be free of dust and moisture," and the "sealed components [would have been] resiliently mounted for improved shock resistance." APPLE-1016, Abstract.

280. One of ordinary skill would have been motivated to look to prior art such as Bergey, for example, to obtain the advantages described by Bergey (e.g., to hermetically seal the components to produce a waterproof, shockproof device) by modifying the Aizawa-Inokwawa-Ohsaki-Mendelson-2006 device such that the sensor hermetically seals components, such as its LEDs and photodetectors 22, between a cover and a substrate as taught by Bergey to protect the electronics and prevent "condensation of water vapor" inside of the case. APPLE-1016, Abstract, 2:56-67, 8:48-9:34.

281. This and related description would have motivated one of ordinary skill to hermetically seal the at least four photodetectors 22 using the substrate, the holder 23, and the cover. Indeed, one of ordinary skill would have understood that the benefits of hermetically sealing internal electronics of a wristwatch would have

applied directly to hermetically sealing internal electronics of a physiological sensing system that is similarly configured to be worn on a subject's wrist.

B. Claim 8

[8] The physiological measurement system of claim 6, wherein the substrate, the wall, and the cover together hermetically seal the at least four detectors.

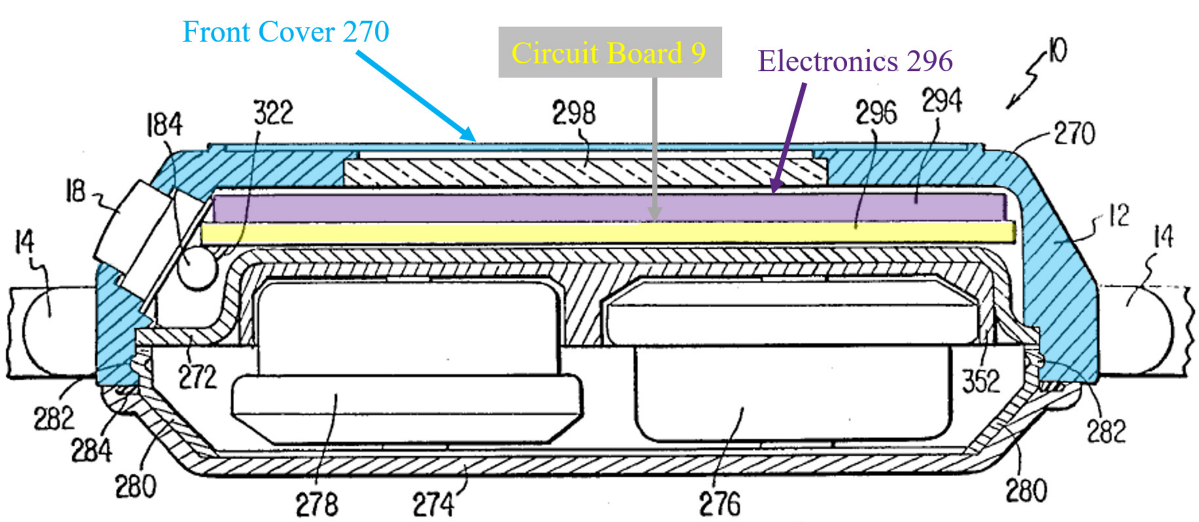
282. As explained above with respect to [1pre]-[1k], the physiological measurement system of Aizawa, Inokawa, Ohsaki, and Mendelson 2006 depicts and describes a wristworn "pulse wave sensor for detecting a pulse wave by detecting light output from a light emitting diode and reflected from the artery of a wrist of a subject." APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a). The Aizawa-Inokawa-Ohsaki-Mendelson combination does not explicitly disclose that the substrate, the wall, and the cover together hermetically seal the at least four detectors.

283. By the '554 patent's 2008 Critical Date, however, internal electronics within devices, such as wristwatches, worn on a person's wrist would have been "hermetically sealed in the watch case to be free of dust and moisture," and the "sealed components [would have been] resiliently mounted for improved shock resistance." APPLE-1016, Abstract.

284. Bergey, for example, describes a digital wristwatch. *Id*. The components are "solid state electronic components," and "may be hermetically sealed to

produce a unit that is shockproof and waterproof, regardless of the environment in which it is placed. *Id.*, 2:56-67. Bergey discloses a method for sealing the electronics within the watch case in which the internal electronics are "mounted on [the] circuit substrate" and "hermetically sealed all the way around between [an] inner cover[] and [a] front plate." APPLE-1016, 8:48-9:34. The seal "acts as protection to the electronics and also prevents condensation of water" within the case of the watch. *Id.*

FIG. 7



APPLE-1016, FIG. 7 (annotated)

285. To obtain the advantages described by Bergey (e.g., to hermetically seal the components to produce a waterproof, shockproof device), one of ordinary skill would have been motivated to modify the Aizawa-Inokwawa-Ohsaki-Mendelson 2006 such that Aizawa's pulse wave sensor would be modified to seal its

components, such as its LEDs and photodetectors 22, between a cover and a substrate as taught by Bergey to protect the electronics and prevent "condensation of water vapor" inside of the case. APPLE-1016, Abstract, 2:56-67, 8:48-9:34.

286. This and related description would have motivated one of ordinary skill to hermetically seal the at least four photodetectors 22 using the substrate, the holder 23, and the cover. Indeed, one of ordinary skill would have understood that the benefits of hermetically sealing internal electronics of a wristwatch would have applied directly to hermetically sealing internal electronics of a physiological sensing system that is similarly configured to be worn on a subject's wrist.

287. Accordingly, [8] would have been obvious over Aizawa in view of Inokawa, Ohsaki, Mendelson 2006, and Bergey.

C. Claim 9

[9] The physiological measurement system of claim 8, wherein a surface of the handheld computing device positions the touch-screen display.

288. As explained above with respect to [1pre]-[1k], [8], and [26], the physiological sensing system resulting from the combination of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey would have included a handheld computing device that provides a "touch screen interface," where a surface of the handheld computing device positions the touch-screen display. APPLE-1010, 3; APPLE-1020, 1-4 (depicting and describing the HP iPAQ h4150 Pocket PC PDA utilized in Mendelson 2006's system).

289. Accordingly, [9] would have been obvious over Aizawa in view of Inokawa, Ohsaki, Mendelson 2006, and Bergey.

D. Claim 10

[10] The physiological measurement system of claim 9, wherein the physiological parameter comprises at least one of: pulse rate, glucose, oxygen, oxygen saturation, methemoglobin, total hemoglobin, carboxyhemoglobin, or carbon monoxide.

290. As explained above at [1pre]-[1k], [8]-[9], and [27], the sensor resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey describes a "pulse wave sensor" that is communicably connected to and transmits "pulse wave data to an unshown display." APPLE-1006, ¶[0023]. This display is "for displaying the…**pulse rate** data." *Id.*, ¶[0028].

291. Accordingly, [10] would have been obvious over Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey.

E. Claim 11

[11] The physiological measurement system of claim 10, wherein the single protruding convex surface protrudes a height between 1 millimeter and 3 millimeters.

292. As explained above with respect to [1pre]-[1k], [20pre]-[20f], and [21]-[28], the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey would have included a cover featuring a single protruding convex surface that protrudes a height greater than 2 millimeters and less than 3 millimeters. APPLE-1006, Abstract, ¶¶[0002], [0005],

[0008]-[0016], [0023], [0027]-[0028], [0033]; APPLE-1009, Abstract, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B. Thus, one of ordinary skill would have found it obvious that the surface should protrude a height greater than 1 millimeters and less than 3 millimeters. Indeed, there would have been a finite range of possible protruding heights, and it would have been obvious to select a protruding height that would have been comfortable to the user.

293. Accordingly, [11] would have been obvious over Aizawa in view of Inokawa, Ohsaki, Mendelson 2006, and Bergey.

F. Claim 12

[12] The physiological measurement system of claim 11, wherein at least one of the detectors is configured to detect light that has been attenuated by tissue of the user.

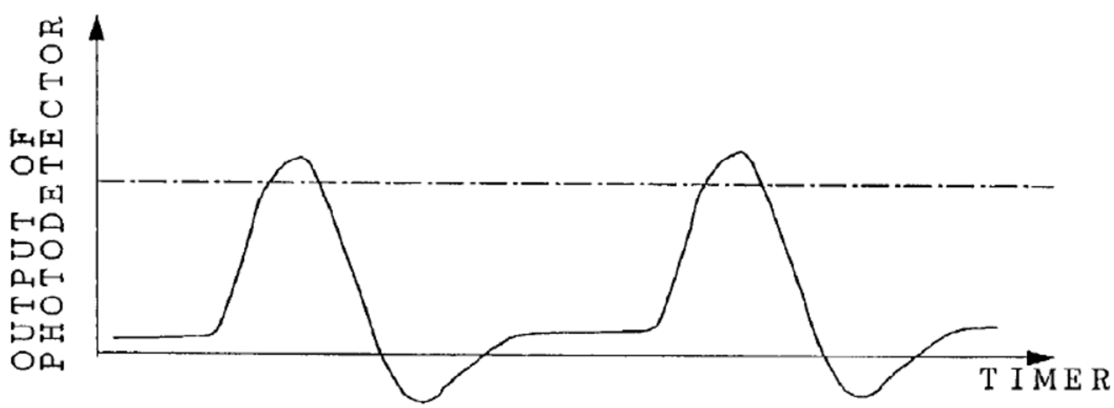
294. As explained above with respect to [1pre]-[1k], Aizawa in view of Inokawa, Ohsaki, Mendelson 2006, and Bergey teaches a wrist-worn "pulse wave sensor" that includes a plurality of light emitting diodes and "four photodetectors disposed around the light emitting diode symmetrically on a circle concentric to the light emitting diode." APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033].

295. The sensor "**detect[s] light** output from a light emitting diode and **reflected from the artery of a wrist** of a subject." APPLE-1006, ¶[0009]. In order to reach the arteries within the wrist of a subject and be reflect back, the light emitted by the

light emitting diode is necessarily attenuated by the tissue of the subject. In particular, "[n]ear infrared radiation output toward the wrist 10 from the light emitting diode 21 is reflected by a red corpuscle running through the **artery 11 of the wrist 10** and this reflected light is detected by the plurality of photodetectors 22 so as to detect a pulse wave." *Id.*, ¶[0027].

296. For example, "the waveform of a pulse wave" detected by Aizawa's photodetectors 22 can be displayed as represented by FIG. 3. *Id.*, ¶¶[0028]-[0029].

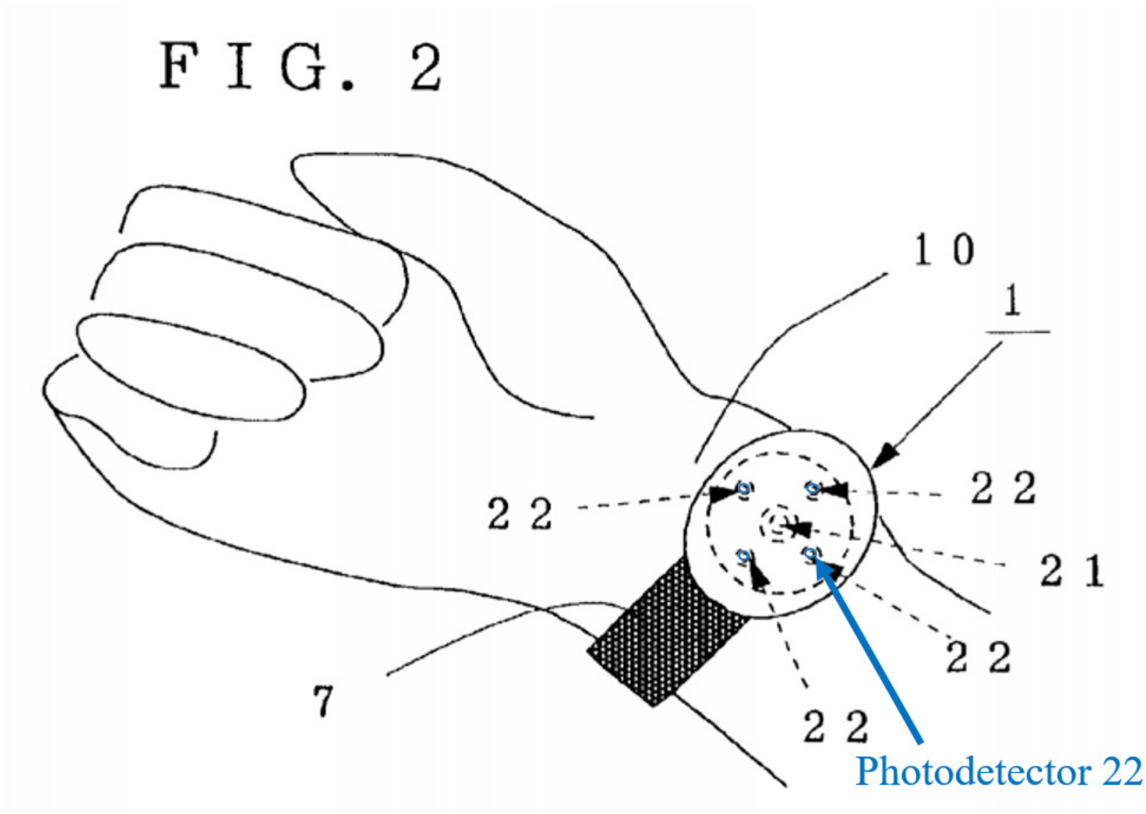
FIG. 3



APPLE-1006, FIG. 3

297. The photodetectors 22 are "disposed at an equal distance from the light emitting diode" (APPLE-1006, ¶[0011]) and arranged such that "even when the attachment position of the pulse rate detector 1 is dislocated, one of the photodetectors 22 is located **near the artery 11**, thereby making it possible to detect a pulse wave accurately." *Id.*, ¶[0027]. This arrangement allows for some

movement of the detector assembly as it is worn on the subject's wrist while still providing accurate readings. The photodetectors are "disposed symmetrically" and used "to detect the pulse wave of the wrist," although the "arrangement of the light emitting diode 21 and the photodetectors 22 is not limited to this." *Id.*, ¶[0032].



APPLE-1006, FIG. 2 (annotated)

298. Accordingly, [12] would have been obvious over Aizawa in view of Inokawa, Ohsaki, Mendelson 2006, and Bergey.

G. Claim 13

[13] The physiological measurement system of claim 12, wherein the displayed indicia are further responsive to temperature.

299. As explained above with respect to [1pre]-[1k], the physiological measurement system resulting from the combination of the disclosures of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey would have included a touch-screen display that provides a GUI including display indicia that are response to a user input. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1010, 1-4, FIG. 3; APPLE-1020, 1-4; *see also* APPLE-1009, ¶¶[0005] ("The information of pulse wave detected by the detecting element is displayed on the display of the sensor body fixed on the back side of the user's wrist"), [0020] ("The sensor body 3 is connected to the detecting element 2 by a signal line 13, and includes … a monitor display … the monitor display shows the calculated pulse rate and the like").

300. Consistent with Mendelson 2006's description of the PDA's "simple GUI" being configured to allow for "easy activation of various functions," one of ordinary skill would have found it obvious to make an orientation of the PDA's user interface configurable responsive to temperature, for the sake of user convenience. APPLE-1010, 3; APPLE-1020, 2, 6. For example, the LabVIEW program included features that indicated "when the temperature goes above a certain level." One of ordinary skill would have understood that a display indicia that changes when the temperature reaches a threshold value is responsive to temperature. Thus, one of ordinary skill would have found it obvious that a system

resulting from the combination of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey would have allowed an orientation of the user interface to be further responsive to temperature.

301. Accordingly, [13] would have been obvious over Aizawa in view of Inokawa, Ohsaki, Mendelson 2006, and Bergey.

H. Claim 14

[14] The physiological measurement system of claim 13, 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.

302. As explained above with respect to [1pre]-[1k], Aizawa in view of Inokawa, Ohsaki, Mendelson 2006, and Bergey teaches a wrist-worn “pulse wave sensor” that includes a plurality of light emitting diodes and at least four photodetectors. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027], [0033]; APPLE-1009, ¶[0017], FIG. 2.

303. One of ordinary skill would have found it obvious that a device designed to fit on a user’s wrist could be of different sizes to accommodate different sizes of users. The user’s comfort is an important consideration for a wristworn sensing device—Ohsaki’s convex cover solves the problem in which “the user feels uncomfortable” due to pressure from the device and belt on the user’s limbs. APPLE-1009, [0006].

304. Indeed, by the ’554 patent’s 2008 Critical Date, medical devices were commonly adjustable or provided in different sizes to accommodate the needs of different subjects. APPLE-1013, ¶¶[0034] (describing that a component of the sensor is “easily bent and shaped to comfortably fit various ear shapes and sizes”), [0057] (the component can be “formed to accommodate a variety of ear shapes and sizes.”); APPLE-1006, ¶¶[0012], [0013], [0023], [0024], [0030], FIGS. 1(a), 1(b). One of ordinary skill viewing the disclosure of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey and motivated to optimize subject comfort would have found it obvious to modify the physiological measurement system resulting from the combined disclosure of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey to provide different sizes of components for differently sized subjects.

305. Accordingly, [14] would have been obvious over Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey.

I. Claim 15

[15] The physiological measurement system of claim 14, 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.

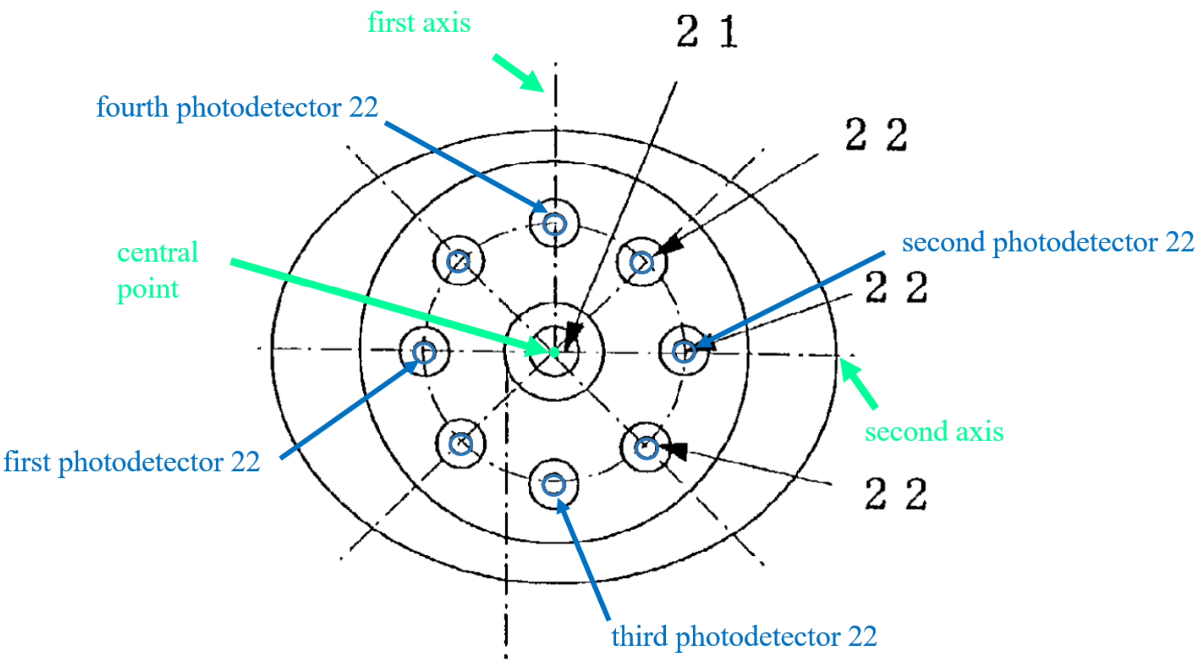
306. As explained above with respect to [1pre]-[1d], and shown in FIG. 4(a) of Aizawa, reproduced below, the sensor resulting from the combination of teachings

of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey would have included at least four detectors arranged evenly spaced from one another. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

307. Indeed, Aizawa explicitly discloses that at least four "photodetectors 22 [are] disposed around the light emitting diode 21 **symmetrically on a circle** concentric to the light emitting diode 21." APPLE-1006, ¶¶[0029], [0011], claim 3.

308. As shown in FIG. 4(a) of Aizawa (reproduced below), a first detector and a second detector 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 are arranged across from each other on opposite sides of the central point along a second axis which is different from the first axis.

FIG. 4 (a)



APPLE-1006, FIG. 4(a) (annotated).

309. Accordingly, [15] would have been obvious over Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey.

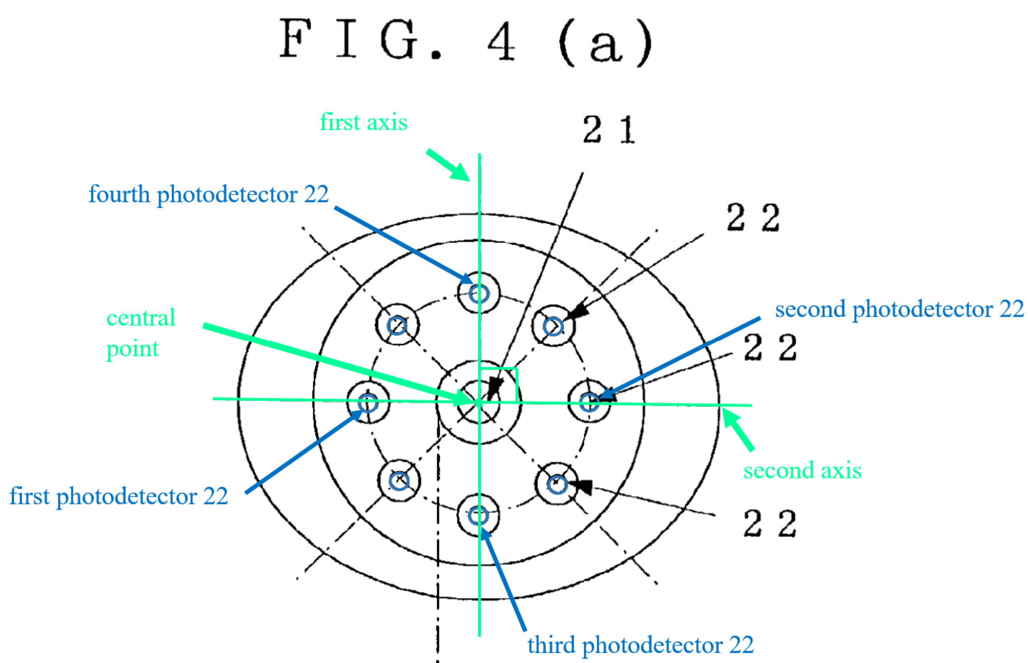
J. Claim 16

[16] The physiological measurement system of claim 15, 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.

310. As explained above with respect to [1pre]-[1d] and [15], and shown in FIG. 4(a) of Aizawa, reproduced below, the sensor resulting from the combination of teachings of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey would have included at least four detectors arranged evenly spaced from one another. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023]-[0024], [0027]-[0030],

[0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

311. As shown in FIG. 4(a) of Aizawa (reproduced below), the first axis is perpendicular to the second axis, and the first, second, third and fourth detectors form a cross pattern about the central point.



APPLE-1006, FIG. 4(a) (annotated)

312. Accordingly, [16] would have been obvious over Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey.

K. Claim 17

[17] The physiological measurement system of claim 16, wherein the single protruding convex surface protrudes a height greater than 2 millimeters and less than 3 millimeters.

313. As explained above with respect to [1pre]-[1k], [11], [20pre]-[20f], and [21]-[28], the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey would have included a cover featuring a single protruding convex surface that protrudes a height greater than 2 millimeters and less than 3 millimeters. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027]-[0028], [0033]; APPLE-1009, Abstract, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; *see also* APPLE-1010, 2 (describing its "optical reflectance transducer" as "small (⌀ = 22mm)"); *see also* APPLE-1017, 2 (describing a "standard 24-pin (dimensions: 19 x 19 mm) microeletronic package" for its sensor).

314. Accordingly, [17] would have been obvious over Aizawa in view of Inokawa, Ohsaki, Mendelson 2006, and Bergey.

L. Claim 18

[18] The physiological measurement system of claim 17, wherein the attenuated light is reflected by the tissue.

315. As explained above with respect to [1pre]-[1k] and [12], the physiological sensor device resulting from the combined teachings of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey would have had at least one detector configured to detect light that has been attenuated by tissue of the user. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027]-[0028], [0033]; APPLE-1009, Abstract, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

316. Accordingly, [18] would have been obvious over Aizawa in view of Inokawa, Ohsaki, Mendelson 2006, and Bergey.

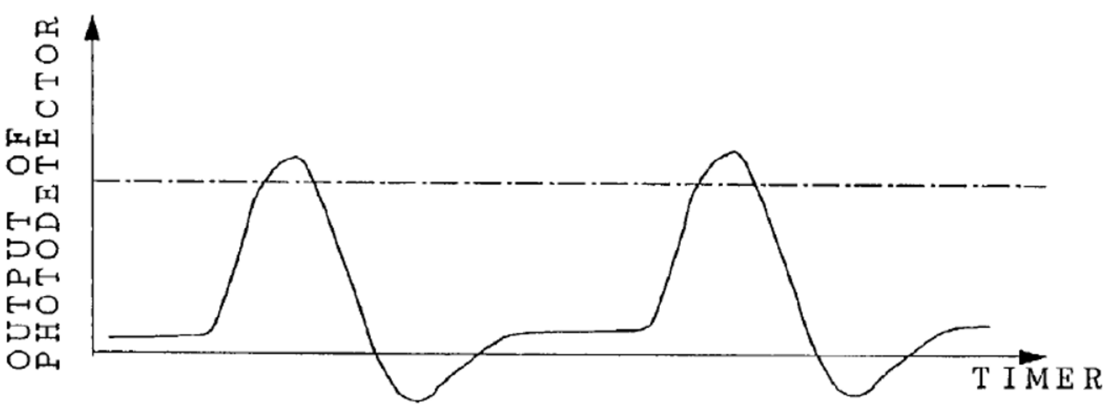
M. Claim 19

[19] The physiological measurement system of claim 9, wherein the physiological parameter comprises a state or trend of wellness of the user.

317. As explained above with respect to [1pre]-[1k], [8]-[9], and [27], the sensor resulting from the combination of the teachings of Aizawa, Inokawa, Ohsaki, Mendelson 2006, and Bergey describes a "pulse wave sensor" that is communicably connected to and transmits data to a display "for displaying the…**pulse rate** data." APPLE-1006, ¶[0028].

318. For example, "the waveform of a pulse wave" detected by Aizawa's photodetectors 22 can be displayed as represented by FIG. 3. *Id.*, ¶¶[0028]-[0029].

FIG. 3



APPLE-1006, FIG. 3

319. One of ordinary skill would have understood that a pulse rate represents a state of wellness of a subject. Indeed, a pulse wave signal provides information regarding a subject's pulse rate and a trend of the subject's pulse over time. Id. One of ordinary skill would have understood that a pulse rate represents a state of wellness of the subject. *Id*.

320. Accordingly, [19] would have been obvious over Aizawa in view of Inokawa, Ohsaki, Mendelson 2006, and Bergey.

IX. CONCLUSION

321. I reserve the right to supplement my opinions to address any information obtained, or positions taken, based on any new information introduced throughout this proceeding.

322. I declare under penalty of perjury that the foregoing is true and accurate to the best of my ability.