

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MASIMO CORPORATION

Petitioner,

v.

APPLE INC.

Patent Owner.

Case IPR2023-00635
U.S. Patent No. 10,987,054

**DECLARATION OF ALAN L. OSLAN IN SUPPORT OF PETITION FOR
INTER PARTES REVIEW OF U.S. PATENT NO. 10,987,054**

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I. INTRODUCTION

1. I, Alan L. Oslan, MSBE, MBA, have been retained by Knobbe, Martens, Olson & Bear, LLP, counsel for Masimo Corporation (“Masimo”). I understand that Masimo is petitioning for inter partes review of U.S. Patent No. 10,987,054 (“the ‘054 patent,” EX1001) and requests that the United States Patent and Trademark Office cancel Claims 1-20 of the ‘054 patent as unpatentable. The following discussion and analysis provides my opinion as to why Claims 1-20 would have been anticipated and/or obvious to a person of ordinary skill in the art (“POSITA”) in September of 2017. This declaration is provided after my review and analysis of the ‘054 patent, the prior art, relevant background technology, and is also based on my education and experience, as well as additional materials identified herein.

II. QUALIFICATIONS AND BACKGROUND

2. I am currently president of ElectroSurge LLC. I founded ElectroSurge in 2010 to consult for other companies based on my extensive experience in medical device development projects. As president of ElectroSurge, I have consulted for several medical device companies on device design and testing, NIH grant support, expert witness for medical device patent litigation including wearable monitoring devices, understanding electrical properties of body tissues, and surface electrodes for stimulation. Over the course of my career, I have worked at a variety of medical

device companies ranging from small start-ups, to large mature companies, and have been involved with numerous technologies relating to a multitude of anatomical regions (1977 to present).

3. I received a B.S. in the Electrical Engineering program from the University of Connecticut (1975) where I specialized in biomedical engineering principles. As an undergraduate, I worked in a metallurgy research lab on campus as a lab technician, in a United States Army research facility in Washington, D.C., on high-current pulsing of semiconductor devices, and in an on campus biobehavioral sciences research lab testing and repairing capacitive-based respiration monitors. Additionally, I did an independent study lab on using miniature electrodes to measure nerve signals of insects.

4. I received my M.S. in Biomedical Engineering from Boston University in Boston, MA on a part-time basis (1980). I took courses including biomaterials, human anatomy, and electrical signal analysis. My thesis topic was measurement and analysis of electromyography signals (EMGs). EMGs are physiological signals produced by the body to cause muscles to contract. EMG signals are similar to ECG signals, except that ECG signals are produced specifically by the heart muscle. The electrodes for this EMG medical device were dry (pasteless) surface electrodes and they interfaced with a biometric device that I designed.

5. I studied towards my Ph.D. in Electrical Engineering at the University of Connecticut with an anticipated thesis topic in medical ultrasound imaging (1980-81). I took courses in digital image processing and taught classes to junior-level electrical engineering undergraduate students in electrical signals and systems analysis. At the end of my first year, my academic advisor started a two-year sabbatical to obtain his M.D. degree, and I therefore decided not to continue my Ph.D. degree studies.

6. I earned an M.B.A. degree, specializing in management of technology enterprises, from Babson College in Wellesley, MA (2013). While doing so, I took a course entitled “Patents and Licensing in the Life Sciences” and learned about analysis and management of manufacturing costs and other issues facing technology companies.

7. I was a Biomedical Equipment Technician at New England Medical Center, a teaching hospital of Tufts University School of Medicine in Boston, MA (1977-78). Some of my responsibilities included performing scheduled maintenance and calibration of medical equipment including electrocardiogram (ECG) and respiratory monitoring equipment. I also responded to and resolved problems with equipment, including issues with ECG surface electrodes and respiration impedance electrodes, in use on patients in wards, ICUs, and surgery.

8. I was a Research Engineer in a research lab at Children's Hospital Medical Center, a teaching hospital of Harvard Medical School in Boston, MA (1978-80). My manager was an adjunct professor at Boston University and my lab project overlapped considerably with my M.S. thesis project discussed above, involving measurement and analysis of EMG signals using dry (pasteless) surface electrodes and designing a biomedical measuring device. At this time, I was also an advisor to a group of Boston University undergraduate students working towards their B.S. degrees in Biomedical Engineering.

9. I was an Electrical Engineer for Corning Medical & Scientific in Medfield, MA (1981-83) where I worked on systems for spectrophotometric-based blood analysis of hemoglobin. I helped designed an ultrasonic driver and power supply used within the system that could accommodate varying worldwide voltages and frequencies.

10. I was a Design Engineer for Zoll Medical Instrument Corp. in Cambridge, MA (1987) where I designed and tested a single package application-specific integrated circuit (ASIC) for a portable ECG/external pacemaker instrument. Additionally, I designed analog drive circuitry for magnetic deflection of a CRT display.

11. I was a Project Engineer developing various medical devices based on microwave energy and sensing techniques at Microwave Medical Systems, a start-

up company in Acton, MA (1988-92, 1996-97). As part of my responsibilities, I selected several connectors, with some containing alignment keys, for use with those medical devices. Additionally, I worked with a vacuum mold forming company to fabricate the plastic housing of a medical device.

12. I worked at Boston Scientific, a large and successful medical device company in Natick, MA, as a Sr. Biomedical/Electrical Engineer and Program Manager (1992-96, 2005-06). In this role (1992-96), I led a multidisciplinary team to develop a catheter for diagnosing and treating cardiac arrhythmias that was eventually released to the market. This catheter contained electrodes for measuring the ECG from within the heart. I explored printing conductive ink on an insulating substrate to reduce manufacturing costs.

13. I was a technical Program Manager at Aurora Imaging Corp. (no longer in business), a start-up company (1997-98, 2000-03). In this role, I was the technical and clinical lead for a breast biopsy system for use on an Aurora MRI machine dedicated to breast imaging that was eventually released to the market. I was also a co-inventor on a patent (US Pat. No. 7,171,256) relating to this device.

14. I was a technical Project Manager at Smith + Nephew (Endoscopy Division) in Andover, MA (1998-2000). In this role, I was the technical lead for an arthroscopic surgery device (used in joints such as shoulders and knees), which was eventually released to the market. The device included ceramic materials.

15. I am a co-inventor of two U.S. patents and one pending U.S. patent application: (a) U.S. Patent No. 7,171,256, directed toward breast magnetic imaging systems; (b) U.S. Patent No. 5,833,688, directed toward sensing temperature with a plurality of catheter sensors; and (c) U.S. Patent Appl. No. 20040030330, directed toward electrosurgery systems.

16. I am a member of Eta Kappa Nu (“HKN”) Electrical Engineering honor society, and the Institute of Electrical and Electronic Engineers (“IEEE”) subgroup Biomedical Engineering. I have been a member of the Medical Development Group (“MDG”) and actively advise medical device start-up companies in Massachusetts Medical Device Development (“M2D2”) center accelerator programs.

17. I am qualified to render an opinion regarding the design and development of electronic devices for monitoring or sensing biological parameters. Based on my expertise and qualifications, I am qualified to provide an opinion as to what a person of ordinary skill in the art would have understood, known, or concluded as of September 2017.

18. A copy of my curriculum vitae, attached as Exhibit 1004, contains further details concerning my education, experience, publications, patents, and other qualifications to render an expert opinion in this matter.

III. INFORMATION AND MATERIALS CONSIDERED

19. I have considered the following list of materials in formulating my opinions in this matter:

Exhibit No.	Description
1001	U.S. Patent No. 10,987,054 (“the ’054 patent”)
1002	File history of the ’054 patent
1005	US 2016/0058375 (“Rothkopf”)
1006	US20160228064 (“Jung”)
1007	WO2017/165532 (“Paulke”)
1008	US10231629 (“Pei”)
1009	ECG Monitoring Leads and Special Leads (“Francis”)
1010	US2016/0073914 (“Lapetina”)
1011	US6265789 (“Honda”)
1012	Principles of ECG (“Berbari”)
1013	Dry Electrodes for ECG (“Meziane”)
1014	Drying and Curing Inks and Coatings on Glass (“Canfield”)
1016	US9277880 (“Poeze”)

20. In addition to references specifically cited by Petitioner in the Petition, I have also reviewed the following materials that I personally located or purchased, including:

- Edward J. Berbari, *Principles of Electrocardiography*, in BIOMEDICAL ENGINEERING FUNDAMENTALS, (Joseph D. Bronzino et al. eds., 4th ed. 2015). (“Berbari”)
- N. Meziane et al., *Dry electrodes for electrocardiography*, *Physiol. Meas.* 34 (2013). (“Meziane”)
- Douglas Canfield, *Drying and Curing Inks and Coatings on Glass*, GLASS MAGAZINE (Mar. 26, 2013), www.glassmagazine.com/article/drying-and-curing-inks-and-coatings-glass. (“Canfield”)
- US9277880 entitled “Multi-Stream Data Collection System for Noninvasive Measurement of Blood Constituents” to Poeze et. al. published March 8, 2016. (“Poeze”).
- All other documents and exhibits cited in my declaration, to the extent they are not listed above.

21. EX1012 is a true and correct copy of the Berbari reference, a chapter in BIOMEDICAL ENGINEERING FUNDAMENTALS. I am familiar with engineering textbooks like BIOMEDICAL ENGINEERING FUNDAMENTALS in my over four decades of experience in the engineering of medical devices. BIOMEDICAL ENGINEERING FUNDAMENTALS indicates a copyright date of 2015. I understand that it is the regular practice of textbook publishers to affix a copyright data at the time of publication and BIOMEDICAL ENGINEERING FUNDAMENTALS appears to be consistent with that

practice. Further, the information included in the Berbari chapter is consistent with my own understanding of what was known to a person of skill at least as early as 2017. Accordingly, I relied on Berbari to inform my understanding of what was known to a person of ordinary skill in the art at the relevant time.

22. EX1013 is a true and correct copy of Meziene which I downloaded on February 16, 2023 from the research website www.deepdyve.com. I am familiar with engineering periodicals like Meziene in my experience in engineering medical devices. Meziene is a publication in the periodical *Physiological Measurement* by IOP Publishing. Meziene indicates a publication date of August 23, 2013. I understand that it is the regular practice of industry periodicals to include the publication date in each article and Meziene is consistent with this practice. Further, the information included in Meziene is consistent with my own understanding of what was known to a person of skill at least as early as 2017. Accordingly, I relied on Meziene to inform my understanding of what was known to a person of ordinary skill in the art at the relevant time.

23. EX1014 is a true and correct copy of Canfield which I downloaded on January 26, 2023 from GLASS MAGAZINE which is published by the National Glass Association at the website: <https://www.glassmagazine.com/article/drying-and-curing-inks-and-coatings-glass>. I am familiar with industry trade periodicals like GLASS MAGAZINE in my experience engineering medical devices. Canfield indicates

a publication date of March 26, 2013. I understand that it is the regular practice of industry trade periodicals to include the publication date in each article and Canfield is consistent with this practice. Further, the information included in Canfield is consistent with my own understanding of what was known to a person of skill at least as early as 2017. Accordingly, I relied on Canfield to inform my understanding of what was known to a person of ordinary skill in the art at the relevant time.

IV. RELEVANT LEGAL STANDARDS

24. I am not a lawyer. Therefore, in formulating my opinions and conclusions in this proceeding, I have been provided with an understanding of the relevant aspects of U.S. patent law that govern the issues of patent validity.

A. Prior Art

25. I understand that, in this IPR proceeding, the prior art to the '054 patent includes patents and printed publications in the relevant field(s) that predate the '054 patent's priority date.

B. Anticipation

26. I have been informed that a person cannot obtain a patent on an invention if someone else had already made the same invention. I understand that 35 U.S.C. § 102 is the statute that governs the determination of anticipation. I understand that under 35 U.S.C. § 102, a prior art reference anticipates a claim if each and every element of a claim is found, either expressly or inherently, within the single prior art reference. I understand that a reference anticipates a claim if all

elements of the claim are disclosed within the four corners of the reference in the same arrangement as in the claim.

C. Obviousness

27. I understand that a claim of a patent may be obvious to a person of ordinary skill in the art if the differences between the subject matter set forth in the patent claim and the prior art are such that the claimed subject matter as a whole would have been obvious at the time of the invention.

28. I understand that obviousness is a determination of law based on various underlying determinations of fact. In particular, these underlying factual determinations include (1) the scope and content of the prior art; (2) the level of ordinary skill in the art at the time the claimed invention was made; (3) the differences between the claimed invention and the prior art; and (4) the extent of any proffered objective “indicia” of non-obviousness. I understand that the objective indicia, also known as secondary considerations, which may be considered in such an analysis include, among other factors: the commercial success of the patented invention (including evidence of industry recognition or awards), the existence of a long-felt but unmet need in the field satisfied by the invention, the failure of others to arrive at the invention, industry acquiescence and recognition of the invention, initial skepticism of the invention by others in the field, the extent to which the

inventors proceeded in a direction contrary to the accepted wisdom of those of ordinary skill in the art, and licensing of the patent.

29. In determining the scope and content of the prior art, I understand a reference is considered prior art for the obviousness analysis if it falls within the inventors' field of endeavor. Additionally, a reference is prior art for the obviousness analysis, even if from a different field of endeavor, if it is reasonably pertinent to the particular problem for which the invention was made. A reference is reasonably pertinent if it is something a person of ordinary skill in the art would have looked to when attempting to solve the problem.

30. While multiple prior art references or elements may be combined to render a patent claim obvious, I understand that a patent claim composed of several elements is not proven obvious merely by demonstrating that each of its elements was, independently, known in the prior art. I understand that I should consider whether there is an "apparent reason" or motivation to combine the prior art references or elements in the way the patent claims. It is my further understanding that the law recognizes several rationales for combining references or modifying a reference to show obviousness of claimed subject matter. Some of these rationales include: combining prior art elements according to known methods to yield predictable results; simple substitution of one known element for another to obtain predictable results; a predictable use of prior art elements according to their

established functions; applying a known technique to a known method or product ready for improvement; and choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success.

V. LEVEL OF ORDINARY SKILL IN THE ART

31. I understand that my opinion must be taken from the perspective of what would have been known or understood by a person of ordinary skill in the art at the time of the invention. I have been informed by counsel and it is my understanding that the '054 Patent claims priority to a provisional application filed on September 5, 2017. I understand that date to be the time of the invention for my analysis. I have been informed that the level of ordinary skill in the art may be determined by various factors including: (a) the type of problems encountered in the art, (b) prior art solutions to those problems, (c) the rapidity with which innovations are made, (d) the sophistication of the technology, and (e) the educational level of active workers in the field.

32. A person of ordinary skill in the art related to the '054 patent would have had a B.S. degree in electrical or biomedical engineering or a related field, with at least two years of experience designing patient monitoring or similar systems. Alternatively, such a person may have had additional graduate education as a substitute for professional experience, or significant work experience as a substitute for formal education. My opinions concerning the unpatentability of the '054 patent

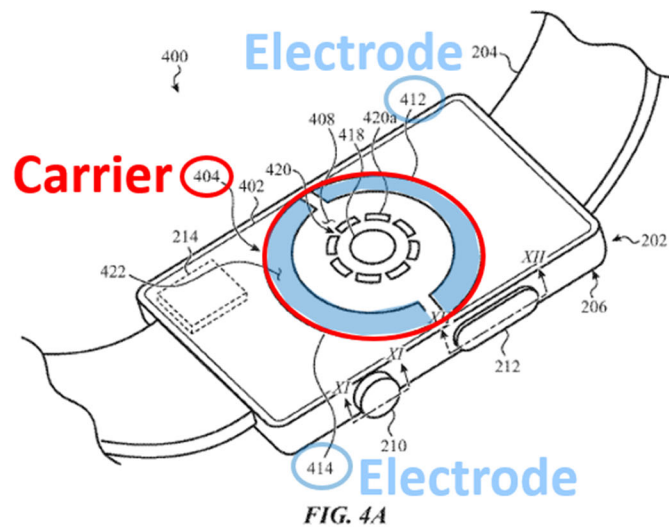
claims, as set forth herein, are from the perspective of a person of ordinary skill in the art, as set forth above.

VI. THE '054 PATENT

A. Specification of the '054 Patent

33. The '054 patent states that it is “directed to an electronic watch or other wearable electronic device having a set of electrodes that may be used to sense or determine biological parameters of a user that wears the wearable electronic device.” EX1001, 1:49-55. Relevant to the claims of the '054 patent, the '054 patent describes a “carrier” that is a “structure that supports the electrodes.” *Id.*, 6:12-14. Fig. 4A (reproduced below¹) of the '054 patent illustrates the disclosed watch with carrier 404 and electrodes 412, 414.

¹ All figures fully or partially reproduced herein are annotated unless otherwise noted.



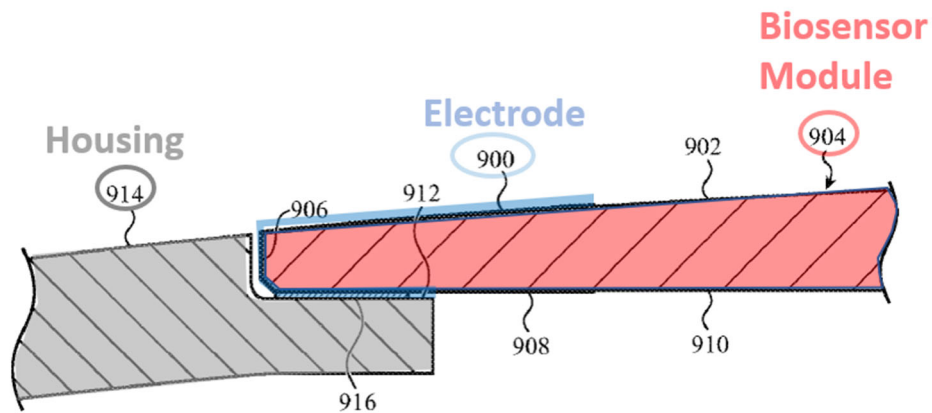
The Specification explains a “carrier may be any appropriate structure that supports the electrodes, on which the electrodes are formed, or to which the electrodes are attached.” EX1001, 6:11-13. The carrier is taught to be an optically transparent material or opaque material that has a domed, flat, stepped, or parallelepiped shape. EX1001, 6:12-20.

B. Prosecution History of the ‘054 Patent

34. I have reviewed the prosecution history of the application that led to the ‘054 patent. I restate here the arguments I understand to have resulted in allowance of the application that became the ‘054 patent. During prosecution of the ‘054 patent, the Application was rejected over US2016/0338598 (“Kegasawa”). The claims were amended in response to this rejection to add new limitations of a “carrier assembly” comprising a “carrier member” positioning first and second electrodes.

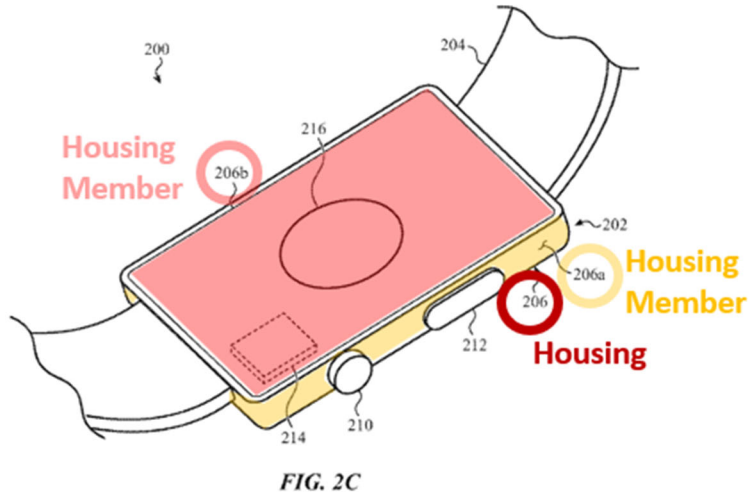
EX1002, 90-99 (OAR of Nov. 23, 2020, pp. 2-6). In the Amendment and Response, the patent owner cited Fig. 9A of the '054 patent (reproduced below with annotations), and argued the carrier member (904) has electrode (900) and is a “different structural component than the housing member 914 to which it is coupled.” *Id.* at 97.

'054 Fig. 9A



Patent owner then argued the cited prior art, Kegasawa, did not disclose these limitations because as shown in Fig. 16, below, its ECG leads 542 were positioned on a main housing 212, not a separate carrier 53. *Id.* at 97-98.

Kegasawa Fig. 16 (Cited Prior Art)



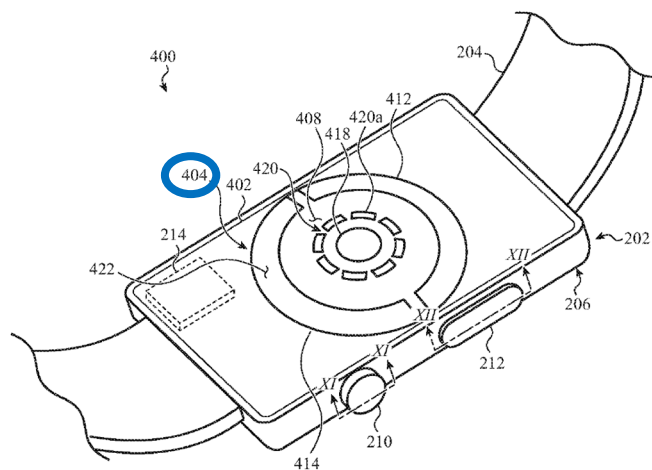


FIG. 4A

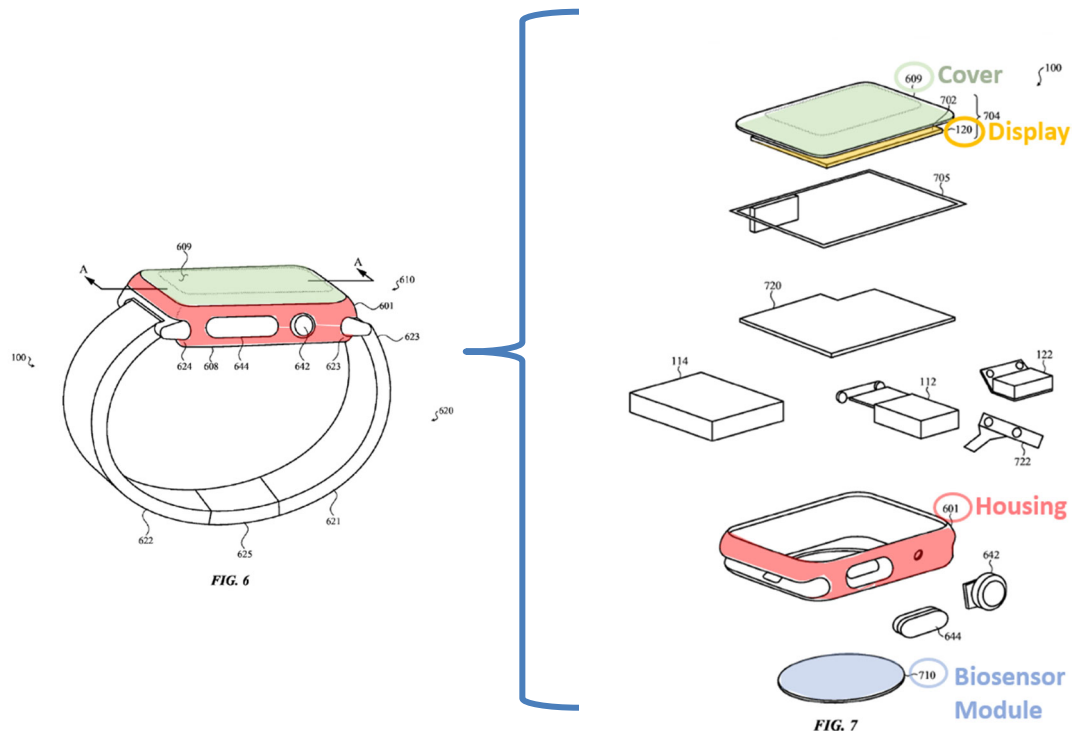
The carrier is taught to be an optically transparent material or opaque material that has a domed, flat, stepped, or parallelepiped shape. EX1001, 6:12-20. Additionally, the “components attached to the carrier 404 may include ... the optical subsystem 416.” Ex. 1001, 14:41-43. For purposes of this Declaration, I interpret the claim term “carrier assembly” consistent with the ’054 Specification to mean any appropriate structure that supports the electrodes and, optionally, optical components. Also, consistent with the usage of “housing member” discussed above, and for purposes of this Declaration, I therefore interpret the claim term “carrier member” to mean “a component of a carrier assembly.”

VIII. OVERVIEW OF PRIOR ART

40. Wearable electronic devices with electrodes for sensing biological parameters, such as described in the '054 patent were well known in the art at the time of filing.

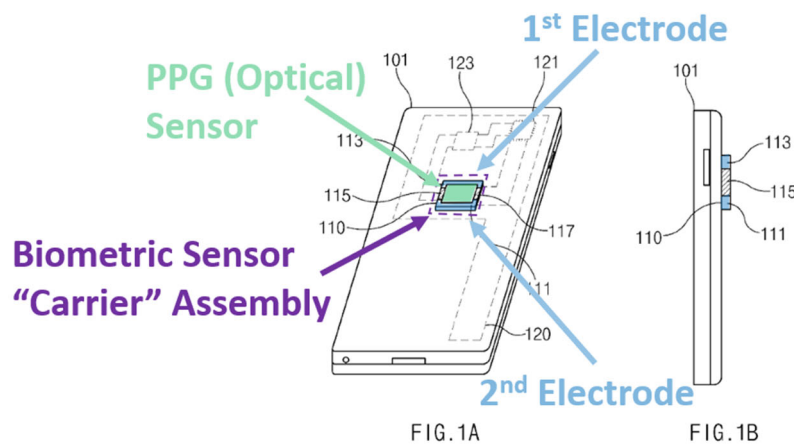
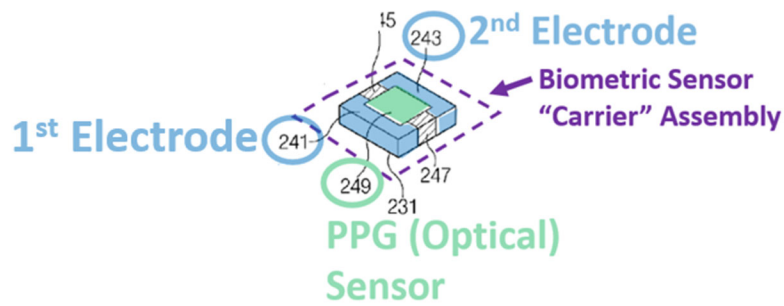
A. Rothkopf

41. Rothkopf teaches a watch with a housing 601 that has an opening on the top and bottom. EX1005, [0148]. A display 120 with an optically transparent cover 609 covers a top opening of the housing 601. EX1005, [0121], Fig. 6. A biosensor module 710 that holds optical sensors and electrodes and includes a separate cover to which the electrodes can be attached covers a bottom opening of the housing 601. EX1005, Figs. 6 and 7 (below), [0148].



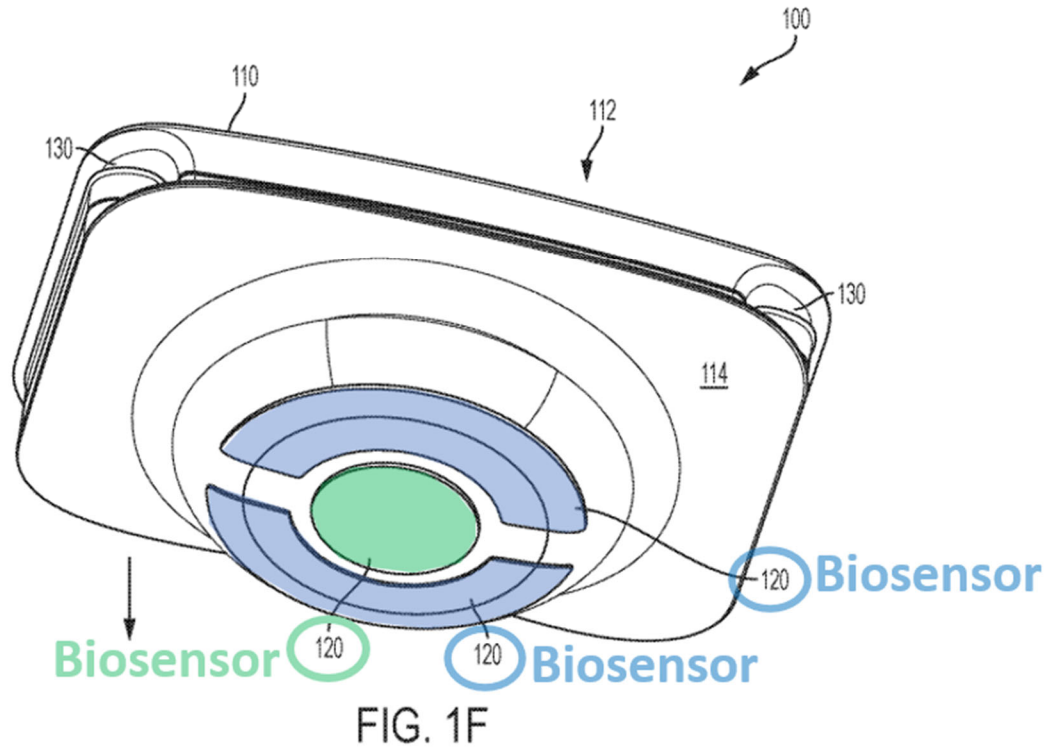
B. Jung

42. Jung teaches a mobile device with a carrier member, which Jung refers to as a biometric sensor (231). Biometric sensor (231) includes: first and second electrodes (241, 243, respectively); and a light emitter and receiver (249). As shown graphically in the illustration below, the first and second electrodes (241, 243) may be disposed on and around the edges of the biometric sensor 231. The biometric sensor (231) is placed into an opening (271) on the back of a housing cover (270) and connects directly to a circuit board (230) and processor inside the housing. EX1006, [0045]-[0046], [0050], Figs. 1A-B and 2 (reproduced below in part with annotations).



C. Paulke

43. Paulke teaches a watch with a biosensor module including biosensors (120) that can perform electrocardiography (ECG), pulse rate and/or blood oxygen saturation measurements. EX1007, Abstract, 6:16-17, 12:1-16, Fig. 1F (reproduced below with annotations).



D. Pei

44. Pei teaches a mobile phone or watch that can include electrodes in various forms and locations, including: as part of “a mechanical button 138 (e.g., home button, volume button or power button 132),” side trim 134, antenna 136, or screen 140; or on a frame 144, a band 154, a back plate 146, a watch face 152, a bezel 150, or a watch crown 148. EX1008, 7:64-8:32, Figs. 1C-1F (reproduced below with annotations).

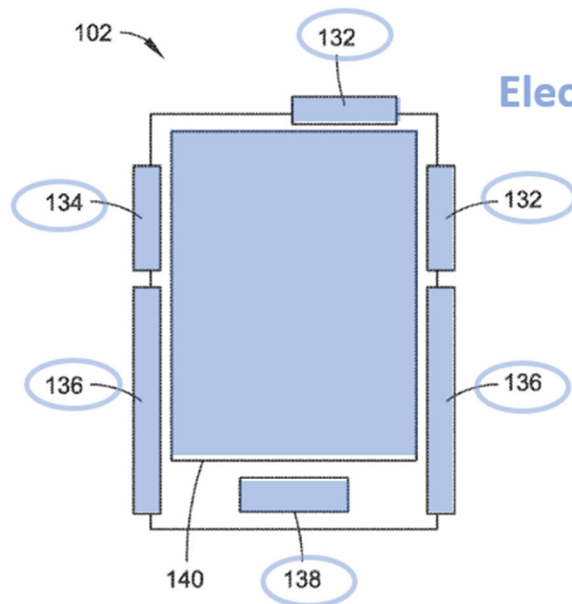


FIG. 1C

Electrodes

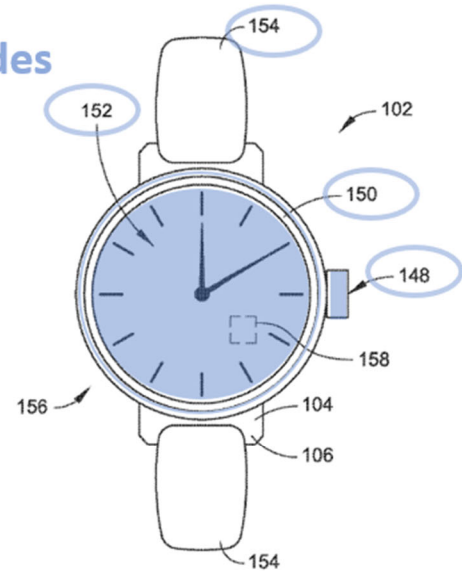


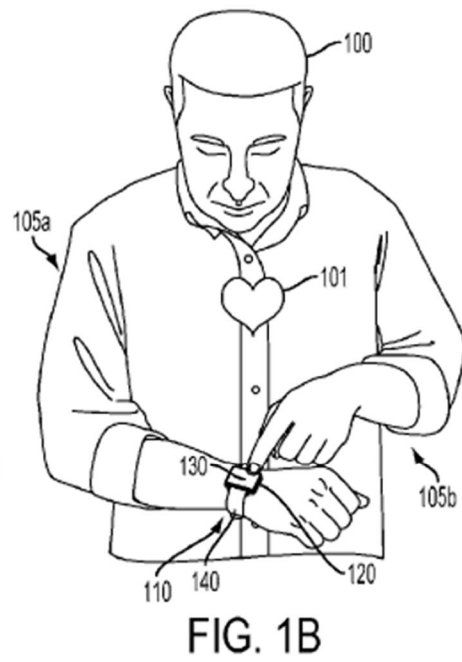
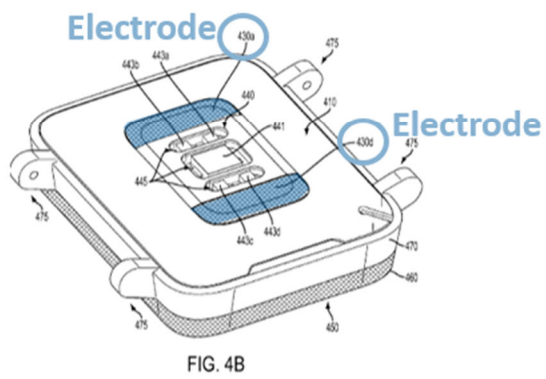
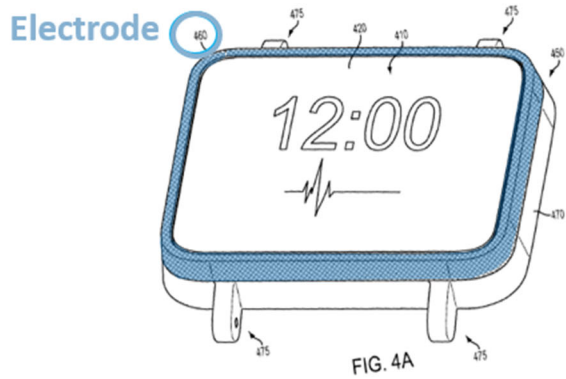
FIG. 1F

E. Lapetina

45. Lapetina explains how a watch positions a well-known three lead ECG system on the wrist. Lapetina explains:

an ECG waveform could be extracted from voltage fluctuations between the outer portion 460 of the frame and one or more electrical contacts 430a, 430b [misabeled as 430d in Fig. 4B] when the central housing 410 is mounted to a first external body surface (e.g., skin of a wrist of a first arm of a wearer) and a second body surface (e.g., skin of a finger of an arm of the wearer opposite the arm to which the wearable device is mounted).

EX1010, [0070]; *see also* [0041] (describing lead I ECG recording); Figs. 1B and 4A-B (reproduced below with annotations).



IX. OPINION ON GROUNDS OF UNPATENTABILITY:

A. Ground 1: Claims 9 and 13-15

46. As discussed in this section, Rothkopf teaches each and every element of claims 9 and 13-15 of the '054 patent.

1. Claim 9

a) Limitation 9a (preamble) “A wearable electronic device comprising”

47. The preamble of claim 9, recites a “wearable electronic device.” Rothkopf discloses a verbatim “wearable electronic device” and explains that the device can be a “wearable watch.” EX1005 Title, [0056]; *see also* Fig. 6 (reproduced below).

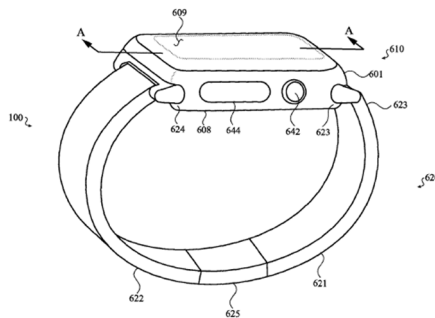


FIG. 6

b) Limitation 9b “a rectangular housing member defining a rectangular front opening and a circular rear opening”

48. Rothkopf teaches a generally rectangular housing member 601 including a generally rectangular front opening and a circular rear opening as shown in its Fig. 8. EX1005, [0119], Fig. 8 (below). Although Rothkopf’s housing member

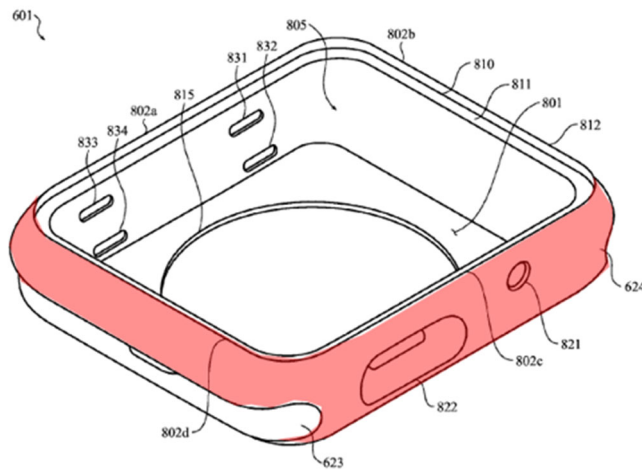
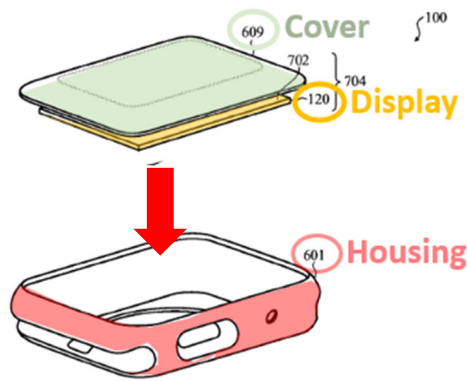


FIG. 8

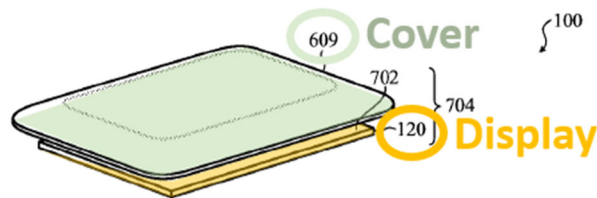
c) Limitation 9c “a cover having a rectangular cover profile and positioned over the rectangular front opening”

49. Rothkopf teaches “cover 609 is disposed above the display and encloses a cavity or opening formed in the top portion of the housing 601.” EX1005, [0122], Fig. 7. As shown below in an excerpt from Fig. 7 of Rothkopf, the cover has a rectangular profile and is positioned over the rectangular front opening of housing 601.



d) Limitation 9d “a display positioned below the cover”

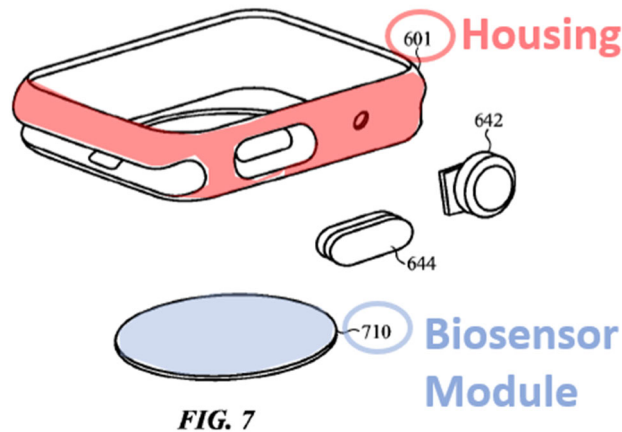
50. Rothkopf teaches “cover 609 is disposed above the display [120].” EX1005, [0122], Fig. 7. Thus, the display 120 of Rothkopf is positioned below the cover 609, as shown in Fig. 7 partially reproduced below with annotations.



e) Limitation 9e “a carrier assembly coupled to the rectangular housing member and comprising”

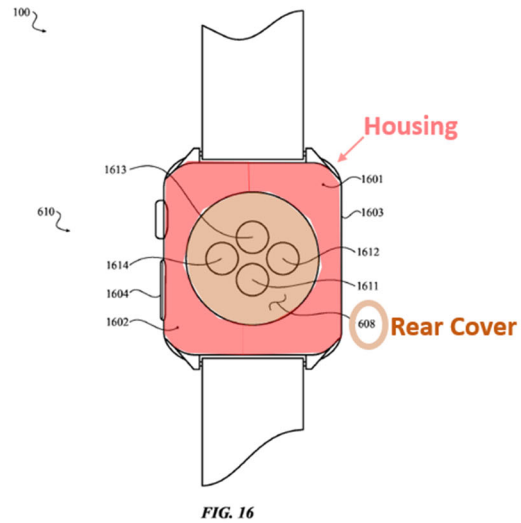
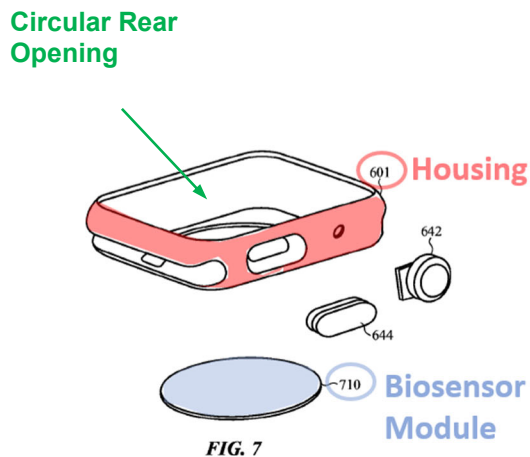
51. Rothkopf teaches a biosensor module 710. The biosensor module 710 is a carrier assembly which is coupled to the rectangular housing 601. The “biosensor module 710 includes the rear cover 608.” EX1005, [0148]. “The biosensor module 710 is disposed in an opening formed in the rear surface of housing 601, a chassis or plate facilitates attachment of the biosensor module 710 to the housing.” EX1005, [0148], Fig. 7 (below). The rear cover 608 also facilitates

attachment of the biosensor module 710 to the housing 601. *Id.* “[B]iosensors are disposed relative to or attached to a rear cover 608 that is formed from an optically transparent material” Ex. *Id.*, [0201] (emphasis added).



f) Limitation 9f “a carrier member having a circular carrier profile and positioned over the circular rear opening”

52. The biosensor module 710 “includes the rear cover 608.” EX1005, [0148]. The rear cover 608 is therefore a component of the carrier assembly and forms a carrier member. As shown in Figs. 7 and 16 below, the housing 601 has a circular opening in its rear into which the biosensor module 710 is inserted. *Id.*, [0148].



53. The “rear cover 608 may include a shelf or flange that may be used to form a seal between the biosensor module 710 and the housing 601.” EX1005, [0148]. In Fig. 16 (reproduced above with annotations) the rear cover 608 (brown) is shown having a circular profile. EX1005, Fig. 16. From the above disclosure, a POSITA would have understood that the cover 608 has a circular profile matching the circular profile of the opening and is positioned over the circular rear opening in order to form a seal.

g) Limitation 9g “a rear electrode positioned on the carrier member and configured to receive a first voltage signal from a wrist of a user”

54. Rothkopf teaches its “biosensor module 710 may include ... one or more electrodes or conductive elements that are configured to detect and measure a physiological condition or property of the user.” EX1005, [0148]. As noted previously, “biosensor module 710 includes the rear cover 608.” EX1005, [0148].

Rothkopf further teaches that its “biosensors are disposed relative to *or attached to* a rear cover 608” EX1005, [0201] (emphasis added). Rothkopf explains its “biosensors” can be an electrode configured to perform an ECG measurement. *Id.*, [0084]. Rothkopf explains its “device may also include at least one pair of electrodes disposed on an exterior surface of the wearable electronic device.” *Id.*, [0024]. Rothkopf teaches the electrodes “make contact with the skin of the user’s wrist when the device is being worn.” *Id.*, [0196].

55. Rothkopf further teaches the electrodes are coupled to a processor which detects “electrical activity” produced by the heart of the user, which a POSITA would understand can include a first voltage from the measurement site where the electrodes are worn, including the wrist. *Id.*, [0198].

56. Based on the above, a POSITA would understand Rothkopf teaches a rear electrode positioned on the carrier member (rear cover 608) and configured to receive a first voltage signal from a wrist of a user.

h) Limitation 9h-j “an optical sensor system comprising: an optical emitter positioned below a first region of the carrier member; and an optical receiver positioned below a second region of the carrier member”

57. Rothkopf teaches its biosensor can include optical biometric sensors including a light source and a photodetector that form a photoplethysmography (PPG) sensor. EX1005, [0084], Fig. 16 (below). Rothkopf’s “biosensor module 710 may include one or more light sources [and] one or more photodetectors” which a

POSITA would understand to be optical emitters and optical receivers, respectively. *Id.* [0148]. Rothkopf's rear cover 608 includes separate emitter and detector windows for each of emitters and detector 1614, 1612, 1613 and 1611. *Id.*, [0201]. Further, Rothkopf teaches the "biosensor module may also include an optically transparent rear cover disposed over the array of windows and operative to pass light emitted from the array of light sources into the user." *Id.* Because the emitters and detector are under (covered by) the rear cover 608, a POSITA would understand Rothkopf teaches an optical emitter positioned below a first region of the carrier, windows 1611-1612, and an optical receiver positioned below a second region of the carrier member, window 1614.

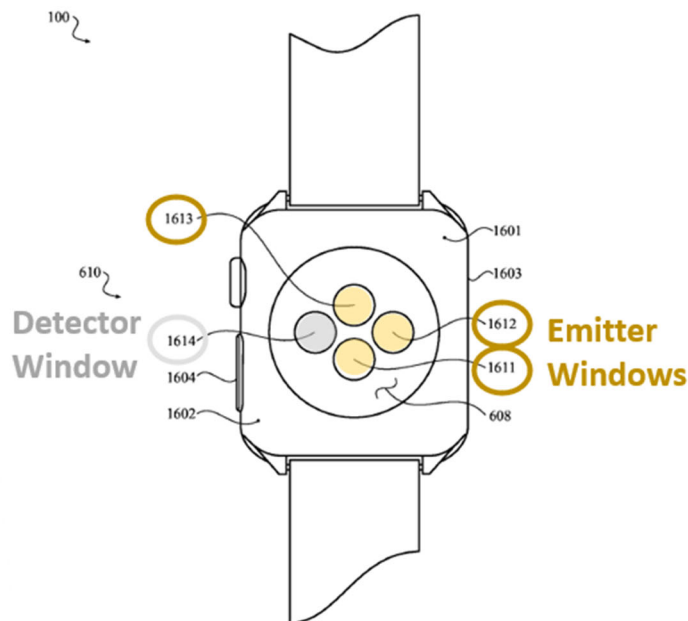
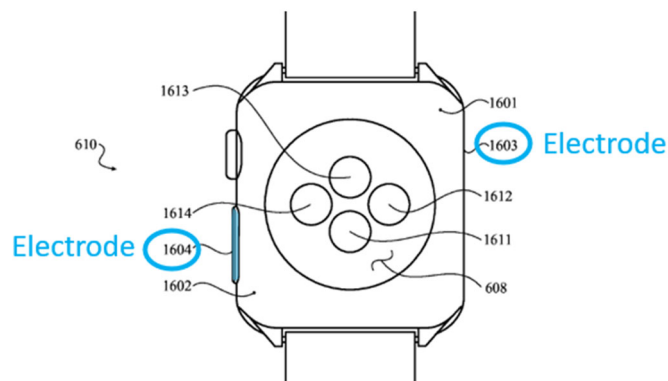


FIG. 16

i) **Limitation 9k “a side electrode positioned along an exterior of the rectangular housing member and configured to receive a second voltage signal from a finger of the user”**

58. Rothkopf teaches “a third electrode 1603 and fourth electrode 1604 may be disposed along a periphery of the device body 610.” EX1005, [0196], Fig. 16. Fig. 16 (partially reproduced below with annotations) illustrates these electrodes. The “third 1603 and fourth 1604 electrodes are configured to come into contact with the skin of the user’s other hand...(e.g., a forefinger and thumb).” *Id.* Further, Rothkopf teaches the electrodes are configured to detect “electrical activity” produced by the heart to produce an ECG. *Id.*, [0198]. A POSITA would understand the “electrical activity” described by Rothkopf is a voltage level. For example, Berbari states that the “voltage difference from any two [limb] sites will record an ECG.” EX1012, 45-2. Based on the above, a POSITA would understand Rothkopf teaches this limitation of a side electrode positioned along an exterior of the rectangular housing member and configured to receive a second voltage signal from a finger of the user.



j) Limitation 91 “a processor positioned within the wearable electronic device and configured to determine a biological parameter using the first and second voltage signals”

59. Rothkopf teaches that “processing units 102 may receive signals from the optical sensor(s) and/or electrodes and process the signals to correlate the signal values with a physiological parameter of the user.” EX1005, [0198], Fig. 2 (below showing processing units 102 as part of device 100). A POSITA would understand the “signals” described by Rothkopf are voltage signals. Based on the above, a POSITA would understand Rothkopf teaches a processor inside its wearable electronic device that determines a biological parameter using first and second voltage signals.

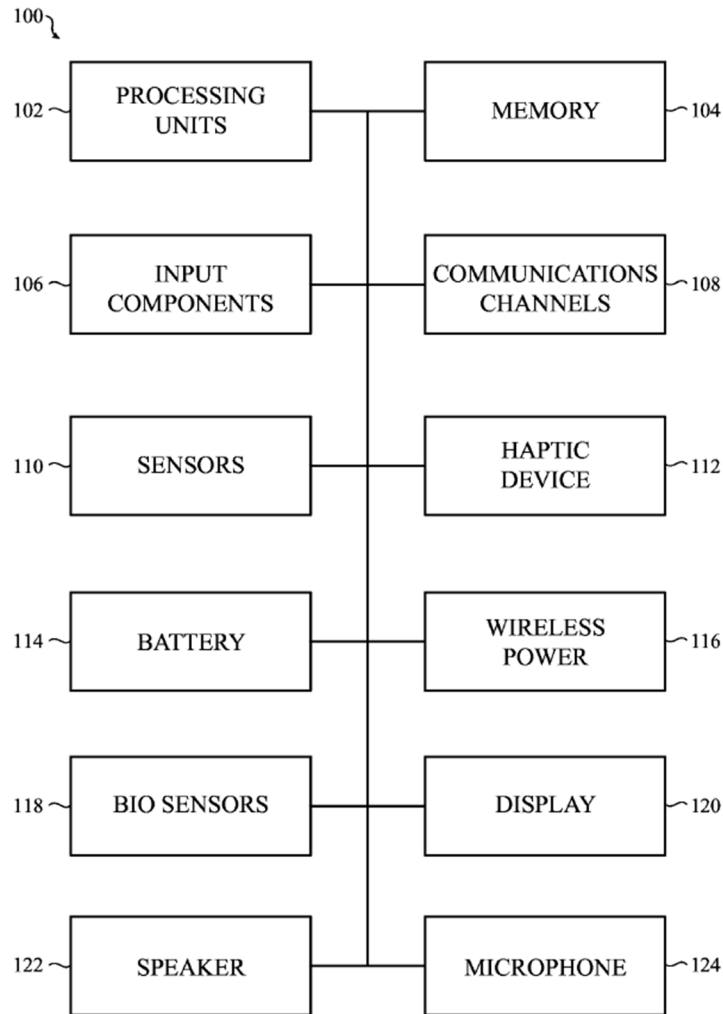


FIG. 2

2. **Claim 13 “The wearable electronic device of claim 9, wherein the optical sensor system is an optical heart rate sensor that is configured to measure a heart rate of the user”**

60. Rothkopf teaches that “optical (*e.g.*, PPG) sensor or sensors may be used to compute various health metrics, including, without limitation, a heart rate.” EX1005, [0193]. Based on the above, a POSITA would understand, Rothkopf

teaches a wearable electronic device with an optical sensor system which is an optical heart rate sensor that is configured to measure a heart rate of the user.

3. Claim 14 “The wearable electronic device of claim 9, wherein: the optical sensor system is configured to measure a heart rate of the user; and the biological parameter is an electrocardiogram (ECG) of the user”

61. Rothkopf teaches that “optical (*e.g.*, PPG) sensor or sensors may be used to compute various health metrics, including, without limitation, a heart rate.” EX1005, [0193]. Rothkopf also teaches that one or more biosensors may be configured to measure an ECG, which is a physiological (*i.e.*, biological) parameter. *Id.*, [0084], [0199]. Based on the above, a POSITA would understand, Rothkopf teaches a wearable electronic device including an optical sensor system configured to measure a heart rate of the user and the biological parameter is an electrocardiogram (ECG) of the user.

4. Claim 15

a) Limitation 15a (preamble) “A watch comprising”

62. Rothkopf teaches a “wearable watch.” EX1005, [0056], see also Fig. 6 (reproduced below).

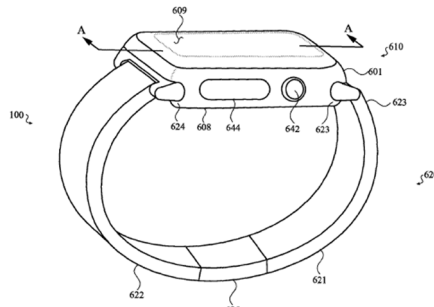


FIG. 6

b) Limitation 15b “a housing member”

63. Rothkopf teaches a housing member 601. EX1005, [0119], [0130], Fig.

8.

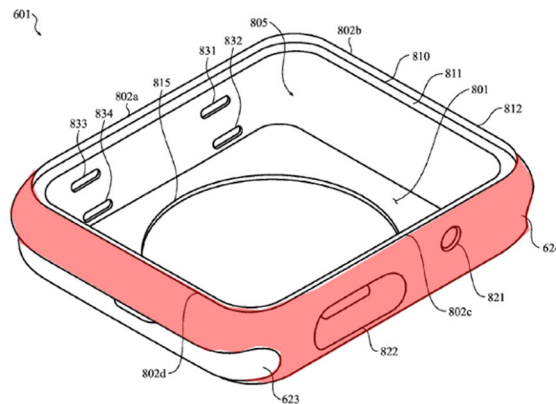
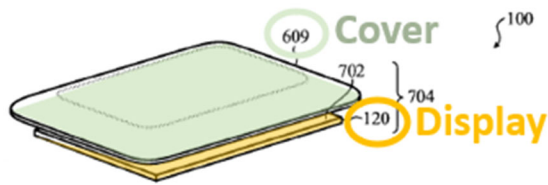


FIG. 8

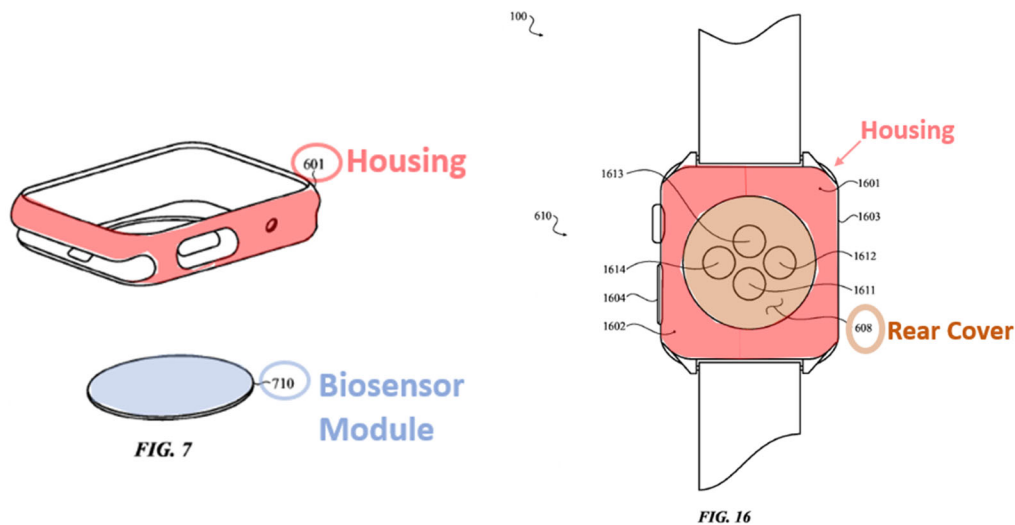
c) Limitation 15c “a display configured to display a graphical output”

64. Rothkopf teaches a display 120 “configured to present visual information or data that is based on the output of one or more sensors.” EX1005, [0120], Fig. 7 (reproduced below with annotations). Based on this, a POSITA would understand Rothkopf discloses a display configured to display a graphical output.



d) Limitation 15d “a carrier assembly coupled to the housing member and comprising: a carrier member protruding outward from an external surface of the housing member”

65. Rothkopf teaches a biosensor module 710 that forms a carrier assembly. Rothkopf teaches “biosensor module 710 is disposed in an opening formed in the rear surface of the housing 601 . . . biosensor module 710 includes the rear cover 608 and may also include a chassis or plate that facilitates attachment of the biosensor module 710 to the housing.” EX1005, [0148], Fig. 7 and 16 (below). Rothkopf further teaches the rear cover 608 can have a convex outer contour that protrudes outward from the back external surface of the housing member 601. EX1005, [0201]. Based on the above, a POSITA would understand Rothkopf discloses a carrier assembly coupled to the housing member and comprising a carrier member protruding outward from an external surface of the housing member.



e) **Limitation 15e “a rear electrode positioned on the carrier member, the rear electrode operably coupled to a processor and configured to detect a first voltage”**

66. Rothkopf teaches its “biosensor module 710 may include ... one or more electrodes or conductive elements that are configured to detect and measure a physiological condition or property of the user.” EX1005, [0148]. As previously noted above, “biosensor module 710 includes the rear cover 608.” EX1005, [0148]. Rothkopf further teaches that its “biosensors are disposed relative to *or attached to* a rear cover 608” EX1005, [0201] (emphasis added). Rothkopf explains its “biosensors” can be an electrode configured to perform an ECG measurement. *Id.*, [0084]. Rothkopf also states its “device may also include at least one pair of electrodes disposed on an exterior surface of the wearable electronic device.” *Id.*, [0024]. Based on the above, a POSITA would understand, Rothkopf teaches a rear

electrode positioned on the carrier member (rear cover 608), the rear electrode operably coupled to a processor and configured to detect a first voltage.

67. Rothkopf further teaches the electrodes are coupled to a processor and configured to detect electrical activity produced by the heart of the user, which a POSITA would understand can include a first voltage. *Id.*, [0198]; EX1012, 47-2.

f) Limitation 15f “an optical sensor positioned below the carrier member and configured to transmit optical signals through the carrier member”

68. Rothkopf teaches its biosensor can include optical biometric sensors including a light source and a photodetector that form a photoplethysmography (PPG) sensor. EX1005, [0084]. Rothkopf’s “biosensor module 710 may include one or more light sources [and] one or more photodetectors” which a POSITA would understand to be a PPG sensor. *Id.* [0148]. Rothkopf’s rear cover 608 includes emitter and detector windows for each of emitters and detector 1614, 1612, 1613 and 1611. *Id.*, [0201], Fig. 16 (below). Further, Rothkopf teaches the “biosensor module may also include an optically transparent rear cover disposed over the array of windows and operative to pass light emitted from the array of light sources into the user.” *Id.* Because the emitters are below the cover 608, a POSITA would understand Rothkopf teaches an optical emitter positioned below the carrier, windows 1611-1612.

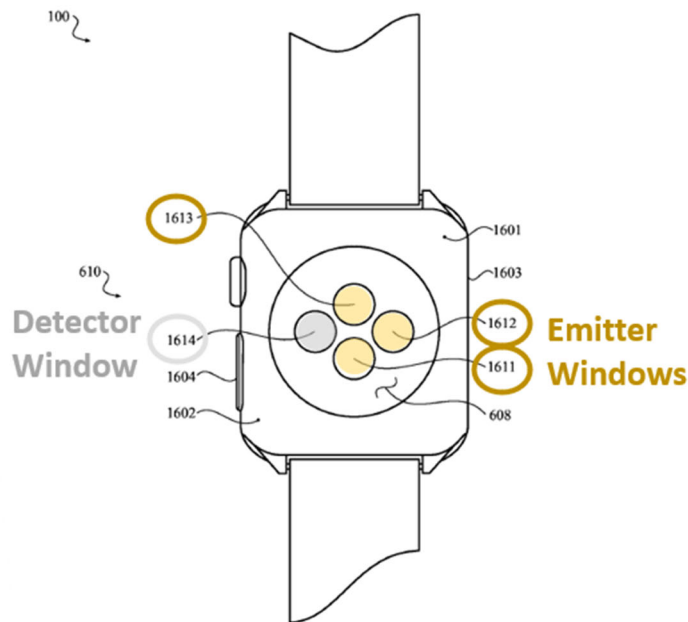
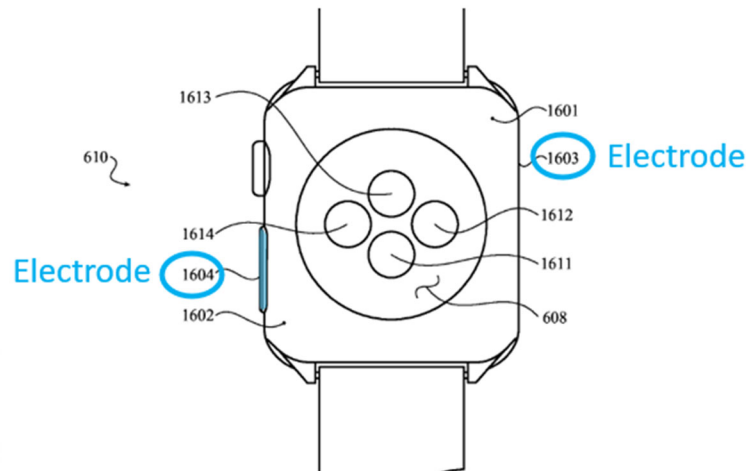


FIG. 16

g) Limitation 15g “a side electrode positioned along an exterior of the watch, the side electrode operably coupled to the processor and configured to detect a second voltage”

69. Rothkopf teaches “a third electrode 1603 and fourth electrode 1604 may be disposed along a periphery of the device body 610.” EX1005, [0196], Fig. 16 (below). The “third 1603 and fourth 1604 electrodes are configured to come into contact with the skin of the user’s other hand...(e.g., a forefinger and thumb).” *Id.* Further, Rothkopf teaches the electrodes are configured to detect electrical activity produced by the heart to produce an ECG. *Id.* [0198]. A POSITA would understand the “electrical activity” described by Rothkopf is a voltage level. EX1012, 47-2. Based on the above, a POSITA would understand Rothkopf teaches a side electrode

positioned along an exterior of the watch, the side electrode operably coupled to the processor and configured to detect a second voltage.



h) Limitation 15h “the processor positioned within the watch and configured to: determine a biological parameter”

70. As explained above, Rothkopf teaches that “processing units 102 may receive signals from the optical sensor(s) and/or electrodes and process the signals to correlate the signal values with a physiological parameter of the user.” *Id.* [0198], Fig. 2 (showing processing units 102 as part of device 100). Based on the above, a POSITA would understand Rothkopf teaches a processor inside its wearable electronic device that determines a biological parameter.

i) Limitation 15i “cause a change to the graphical output in response to determining the biological parameter”

71. Rothkopf teaches a display disposed within the housing and configured to display the health metric computed by its processor. EX1005, [0014], [0021], [0093]. Based on the above, a POSITA would understand Rothkopf teaches a change to the graphical output in response to determining the biological parameter.

B. Ground 1A: Claim 10

72. As discussed in this section, Rothkopf in combination with Francis and Lapetina teach each and every element of claim 10 of the ‘054 patent.

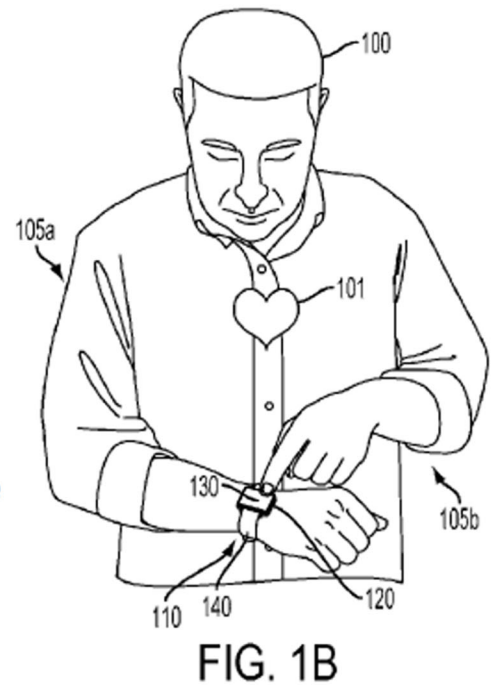
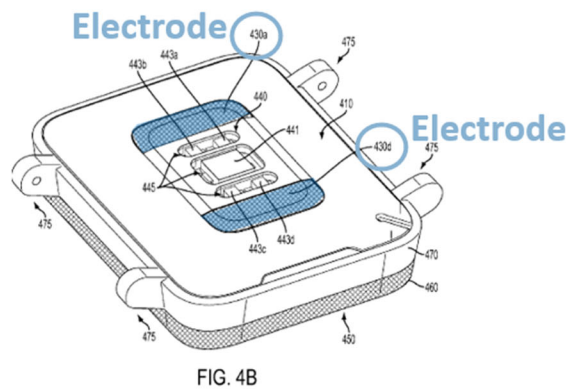
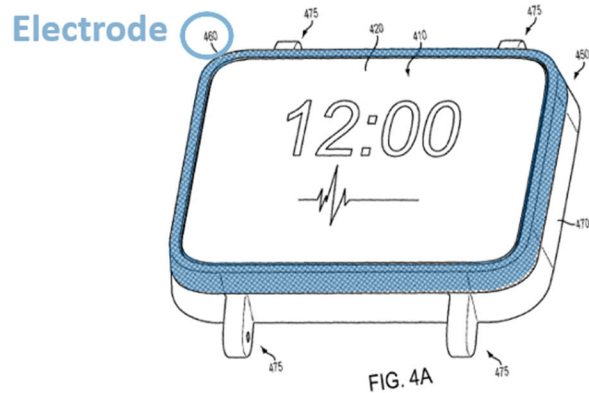
1. Claim 10 “The wearable electronic device of claim 9, wherein: the rear electrode is a first rear electrode; and the wearable electronic device further comprises a second rear electrode positioned on the carrier member and configured to ground the wearable electronic device to the user”

73. Rothkopf teaches its “biosensor module 710 may include ... one or more electrodes or conductive elements that are configured to detect and measure a physiological condition or property of the user.” EX1005, [0148]. As noted above, “biosensor module 710 includes the rear cover 608.” EX1005, [0148]. Rothkopf further teaches that its “biosensors are disposed relative to *or attached to* a rear cover 608 that is formed from an optically transparent material” EX1005, [0201] (emphasis added). Rothkopf explains its “biosensors” can be an electrode configured to perform an ECG measurement. *Id.*, [0084]. Rothkopf further confirms that its “device may also include at least one pair of electrodes disposed on an

exterior surface of the wearable electronic device.” *Id.*, [0024]. Based on the above, a POSITA would understand Rothkopf teaches a first and second electrode positioned on the carrier member (rear cover 608). Rothkopf does not explicitly describe an electrode configured to ground the device.

74. Using a ground electrode is common basic knowledge of ECG operation and is well within the knowledge of a person of ordinary skill. For example, Francis explains well known “three electrode monitoring uses two electrodes at a time for active monitoring and third one as ground electrode.” EX1009, 93.

75. Further, Lapetina explains how this well-known three lead ECG system can be applied using a watch on the wrist. Lapetina explains “an ECG waveform could be extracted from voltage fluctuations between the outer portion 460 of the frame and one or more electrical contacts 430a, 430b [misabeled as 430d in Fig. 4B] when the central housing 410 is mounted to a first external body surface (e.g., skin of a wrist of a first arm of a wearer) and a second body surface (e.g., skin of a finger of an arm of the wearer opposite the arm to which the wearable device is mounted) is in contact with the outer portion 460 of the frame 450.” EX1010, [0070], Figs. 1B and 4A-B (below); see also [0041] (describing lead I ECG recording).



76. A POSITA would understand that the two active electrodes are one of the two on the back of Rothkopf and the electrode touched by the opposite hand is the other active electrode. A POSITA would also understand that the second electrode on the rear of the device may be used as a reference or ground to improve ECG fidelity as taught by Francis and Lapetina. A POSITA would use the teachings of a ground electrode in Francis and Lapetina in order to implement an ECG system as taught by Rothkopf and in order to improve ECG fidelity.

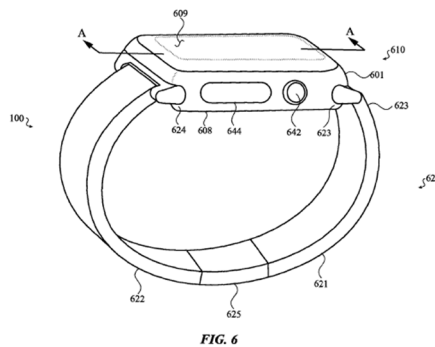
C. Ground 2: Claims 1-6, 9, 12-16, 17, 19

1. Claim 1

77. As discussed in this section, Rothkopf in combination with Jung teach each and every element of claims 1-6, 9, 12-16, 17, 19 of the ‘054 patent.

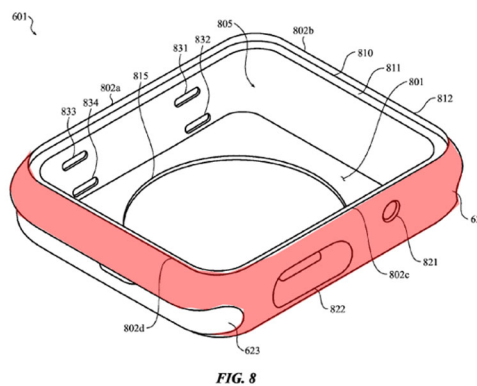
a) Limitation 1a (preamble) “An electronic watch comprising”

78. Rothkopf teaches a “wearable electronic device” and explains that the device can be a “wearable watch.” EX1005 Title, [0056], Fig. 6 (reproduced below).



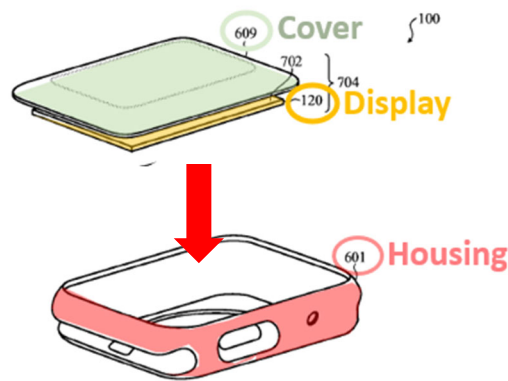
b) Limitation 1b “a housing member”

79. Rothkopf teaches a housing 601. EX1005, [0119], [0130], Fig. 8 (below). A POSITA would understand housing 601 is a “housing member.”



c) Limitation 1c “a display at least partially enclosed by the housing member”

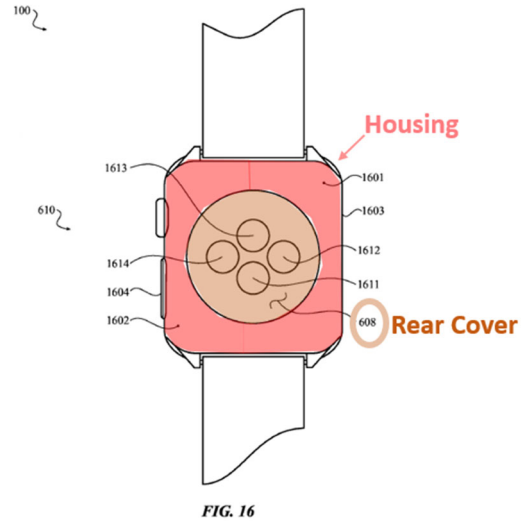
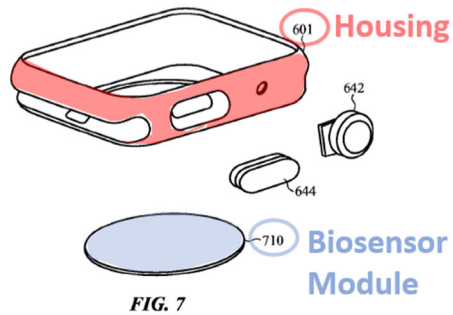
80. Rothkopf teaches “a main cavity of the housing 601” and a “display 120 within the cavity.” EX1005, [0141], [0120]. Based on the above, a POSITA would understand Rothkopf teaches that the display 120, by virtue of being in the cavity formed by housing 601, is *at least partially enclosed* within the housing 601. EX1005, [0141], Fig. 7 (below).



d) Limitation 1d “a carrier assembly coupled to the housing member”

81. Rothkopf teaches a biosensor module 710 which is coupled to the rectangular housing 601. Rothkopf teaches “biosensor module 710 is disposed in an opening formed in the rear surface of the housing 601 . . . biosensor module 710 includes the rear cover 608 and may also include a chassis or plate that facilitates attachment of the biosensor module 710 to the housing.” EX1005, [0148], Fig. 7 and 16 (below). Based on the above, a POSITA would understand Rothkopf teaches

a carrier assembly (biosensor module 710) coupled to the housing member (housing 601).

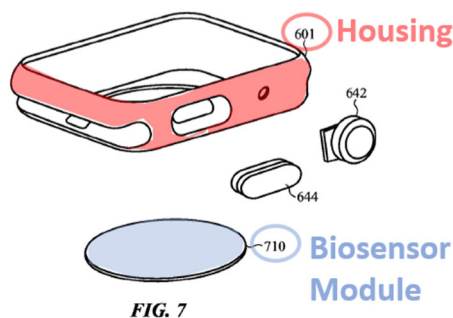


e) **Limitation 1e “a carrier member formed from a transparent material”**

82. Rothkopf teaches “biosensor module 710 includes the rear cover 608.” EX1005, [0148]. The rear cover 608 is a carrier member of the biosensor module 710. The “rear cover 608 is formed from an optically transparent material.” *Id.*, [0201]. “[B]iosensors are disposed relative to *or attached to* a rear cover 608” EX1005, [0201]. Based on the above, a POSITA would understand Rothkopf teaches a carrier member formed from a transparent material.

f) **Limitation 1f “a first electrode positioned on the carrier member, operably coupled to a processor and configured to detect a first voltage”**

83. Rothkopf teaches its “biosensor module 710 may include ... one or more electrodes or conductive elements that are configured to detect and measure a physiological condition or property of the user.” EX1005, [0148]. As previously noted above, “biosensor module 710 includes the rear cover 608.” EX1005, [0148], Fig. 7 (below). Rothkopf further teaches that its “biosensors are disposed relative to or *attached to* a rear cover 608 that is formed from an optically transparent material” EX1005, [0201]. Rothkopf explains its “biosensors” can be an electrode configured to perform an ECG measurement. *Id.*, [0084]. Rothkopf explains that its “device may also include at least one pair of electrodes disposed on an exterior surface of the wearable electronic device.” *Id.*, [0024]. Based on the above, a POSITA would understand Rothkopf teaches a first electrode positioned on the carrier member (rear cover 608).



84. Rothkopf also teaches its electrodes are coupled to a processor and configured to detect electrical activity produced by the heart of the user, which a POSITA would understand can include a first voltage. *Id.*, [0198].

g) Limitation 1g “a second electrode positioned on the carrier member, operably coupled to the processor and configured to detect a second voltage, the first and second electrodes at least partially surrounding a first region of the carrier member and a second region of the carrier member”

85. As explained above, Rothkopf teaches a second electrode (“pair of electrodes”) positioned on the carrier member (rear cover 608) and operably coupled to the processor to detect a second voltage.

86. Rothkopf, however, does not illustrate the exact configuration of the electrodes located on the biosensor module. Rothkopf does illustrate where emitters and detectors are located on the biosensor module in Fig. 16. Rear cover 608 includes emitter and detector windows 1614, 1612, 1613 and 1611. EX1005, [0190]. In the embodiment of Fig. 16, electrodes 1601 and 1602 are not located on the biosensor module. *Id.* But, as noted above, Rothkopf describes an embodiment where the electrodes are positioned on the cover 608. EX1005, [0201].

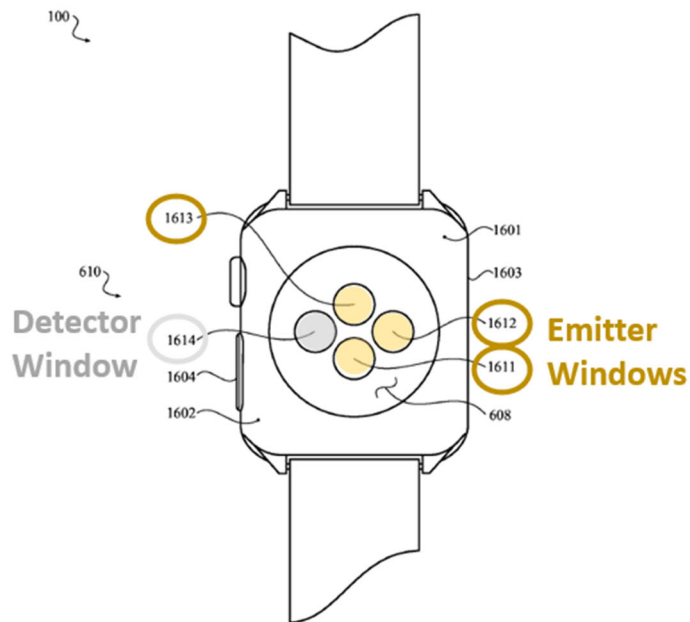
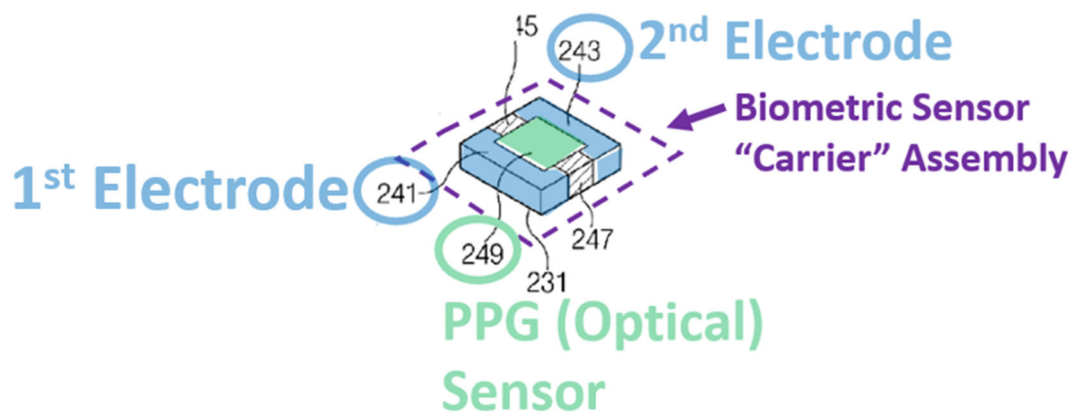


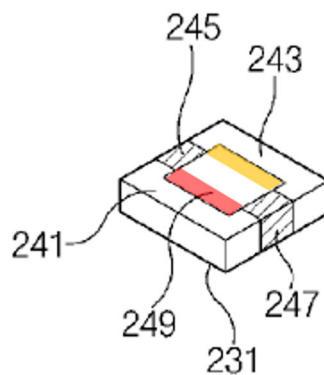
FIG. 16

A POSITA seeking to implement the teaching of Rothkopf to locate the electrodes (biosensors) on the biosensor module would look to other mobile electronic device references that teach the use of electrodes on a biosensor carrier assembly similar to that of Rothkopf.

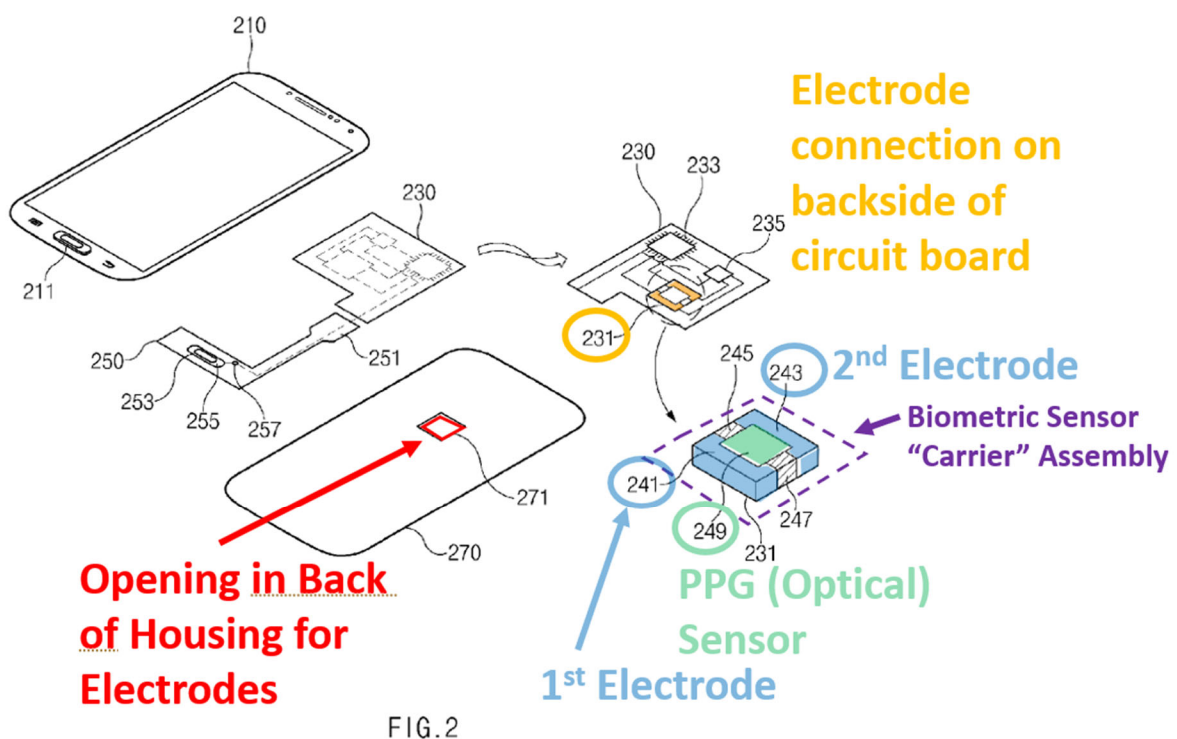
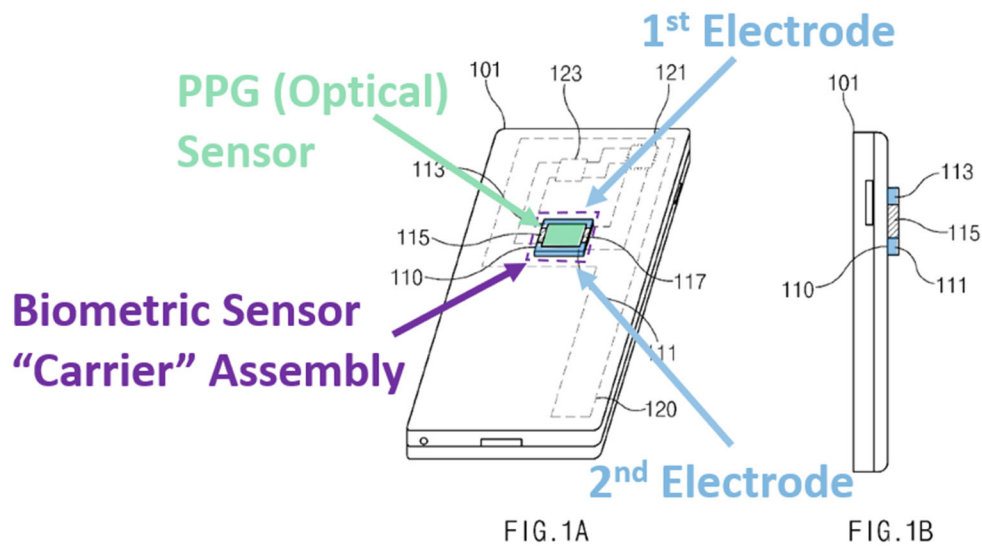
87. Jung teaches a biometric sensor carrier assembly with a biometric sensor carrier member (231) including a first electrode (241) (which detects a first voltage) and second electrode (243) (which detects a second voltage), the first and second electrodes are positioned on and wrapped around the edges of the carrier (231). EX1006, [0046]-[0047], Fig. 2 (below). The biometric sensor carrier assembly also includes a first insulator (245), a second insulator (247), and a photoplethysmogram (PPG) sensor (249).



The biometric sensor of Jung is coupled to a processor. EX1006, [0045] – [0047], [0050]. In Fig. 2 below, first electrode 241 partially surrounds a first region (annotated in red) and second electrode 243 partially surrounds a second region (annotated in orange).

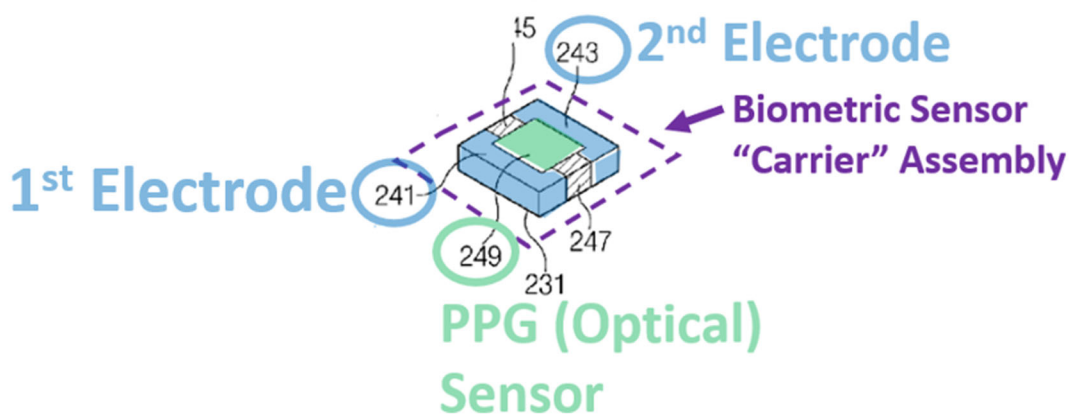


The biosensor carrier (231) is placed into an opening on the back of a housing (271) and connects directly to a circuit board (230) and processor inside the housing. *Id.*, [0047], [0050]; *see also* Figs. 1A-2 (reproduced below with annotations).

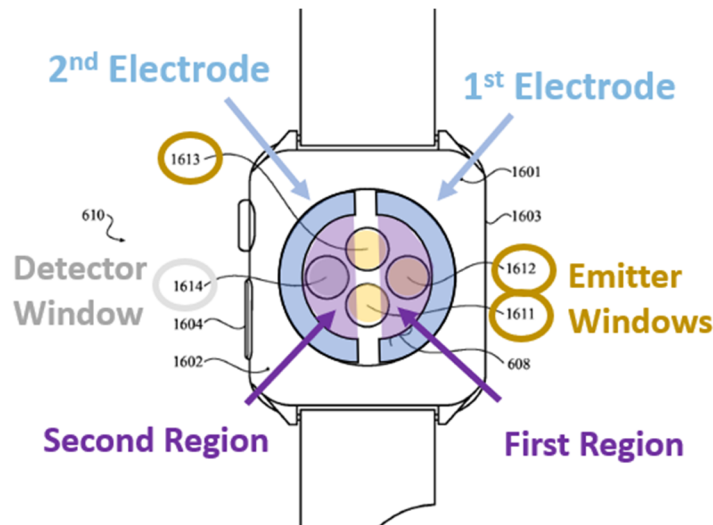


A POSITA seeking to implement the teachings of Rothkopf would understand based on Jung's disclosure, that the electrodes can wrap around the edges of a carrier member and connect internally to a processing board. Further, A POSITA would

understand that the electrodes can wrap around an optical PPG sensor in a central location of the carrier member.



88. A POSITA would be motivated to use the teachings of Jung to implement the carrier assembly taught by Rothkopf. A POSITA would position the electrodes on any available space of Rothkopf's carrier member and wrap the electrodes around the edges of Rothkopf's carrier member as taught by Jung in order to improve contact with the user's skin by covering as much of the carrier member as possible without obstructing the optical sensor. A POSITA would understand that it is advantageous to increase the contact area of the skin-to-electrode interface to maintain lower impedance and exhibit better behavior in reducing motion artifacts. EX1013, R56. A POSITA would combine these references with a sensor arrangement shown below using the teachings of Jung in the system of Rothkopf:

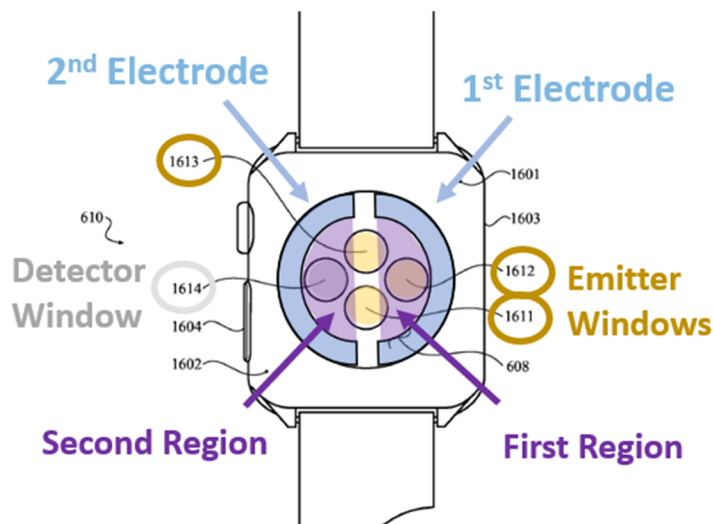


A POSITA would have expected success in making this combination as it is a simple rearrangement of known compatible components in a predictable way to obtain a predictable result. For example, Jung’s carrier structure is similar in size and purpose to the carrier structure of Rothkopf. Also, Jung teaches a POSITA how to incorporate electrodes on a carrier structure as expressly suggested by Rothkopf. This would be a simple rearrangement of known components in a known way to achieve known results.

h) Limitation 1h “a light emitter positioned below the first region of the carrier member”

89. Rothkopf teaches a light emitter positioned below the first region of the carrier member of Claims 1h. Rothkopf teaches its cover 608 includes windows that allow its light emitters to emit light through apertures or openings in the cover 608 indicating the light emitters are below its cover 608. EX1005 at [0201]. Thus, a POSITA would combine the teachings of Rothkopf and Jung such that the light

emitters are located below the emitter windows 1611, 1612 and 1613 as illustrated below:

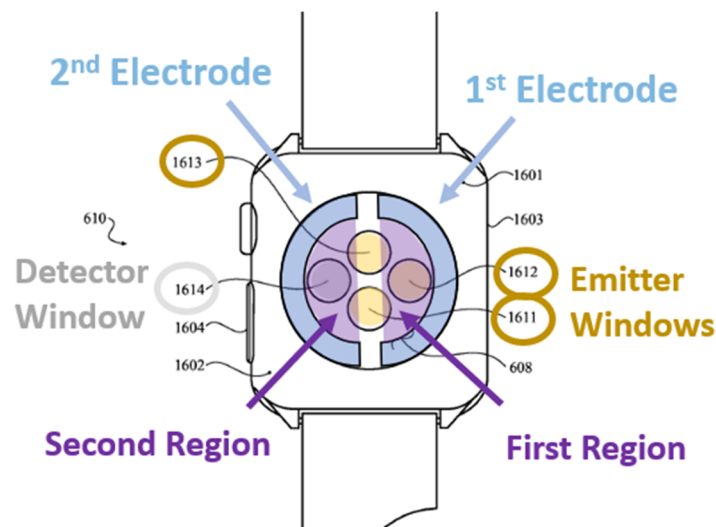


90. Jung also teaches a biometric sensor carrier that includes a PPG sensor. The PPG sensor includes a light emitter and receiver and “may be disposed in a specific area in the *interior* of the biometric sensor 231.” Based on the above, a POSITA would understand Jung teaches a light emitter that may be *below* the first region of the carrier. EX1010 at [0045 – 0046]. Accordingly, a POSITA would arrive at the above shown combination and would have a reasonable expectation of success as the combination is a basic rearrangement of components.

- i) **Limitation 1i “a light receiver positioned below the second region of the carrier member and configured to receive light reflected from a wrist”**

Rothkopf teaches a light receiver positioned below the second region of the carrier member of Claims 1i as illustrated below. Rothkopf teaches its cover 608

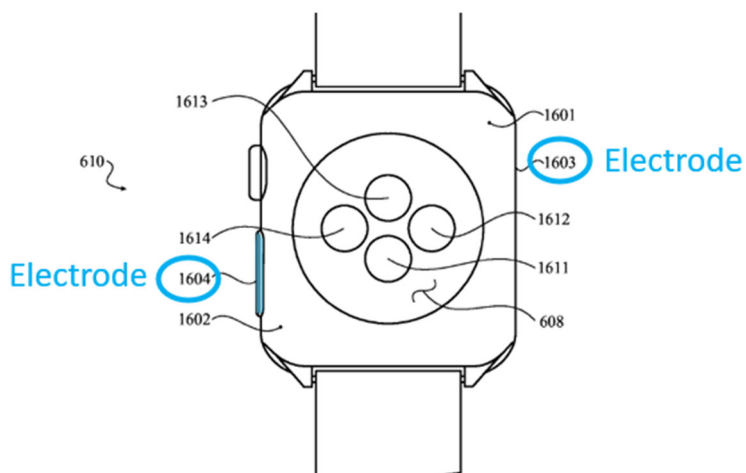
includes a window that allows its light detector to receive light through an aperture or an opening in the cover 608 indicating the light detector is below its cover 608. EX1005, [0201]. Thus, a POSITA would combine the teachings of Rothkopf and Jung such that the light emitters are located below the detector window 1614 as illustrated below:



91. Jung also teaches a biometric sensor carrier that includes a PPG sensor. The PPG sensor includes a light emitter and receiver and “may be disposed in a specific area in the *interior* of the biometric sensor 231.” Therefore, Jung teaches a light emitter that may be *below* the first region of the carrier. EX1006, [0045] – [0046]. Accordingly, a POSITA would arrive at the above shown combination and would have a reasonable expectation of success as the combination is a basic rearrangement of components.

j) Limitation 1j “a third electrode coupled to the housing member, operably coupled to the processor, and configured to detect a third voltage”

92. Rothkopf teaches “a third electrode 1603 and fourth electrode 1604 may be disposed along a periphery of the device body 610.” EX1005, [0196], Fig. 16 (below). The “third 1603 and fourth 1604 electrodes are configured to come into contact with the skin of the user’s other hand...(e.g., a forefinger and thumb).” *Id.* The electrodes detect a voltage and are operatively coupled to sensing circuits and processing units. EX1005, [0196], [0199]. Based on the above, a POSITA would understand Rothkopf teaches a third electrode coupled to the housing member, operably coupled to the processor, and configured to detect a third voltage and the third electrode could be added to the combination device of Rothkopf and Jung with a reasonable expectation of success.



k) Limitation 1k “the processor positioned within the electronic watch and configured to determine an electrocardiogram

using the first voltage, the second voltage, and the third voltage”

93. Rothkopf teaches a processor inside its watch configured to determine an electrocardiograph using voltages from its electrodes. EX1005, [0198]-[0199]. Additionally, Rothkopf teaches that the device “may measure an electrocardiogram or a body fat ratio of a user through the first and second electrodes 241 and 243 disposed on the biometric sensor 231 (e.g., the PPG sensor) and the third electrode 255 disposed on the physical button 211.” EX1005, [0051].

94. Jung also teaches that “biometric information may include biometric electric potential information obtained through electrodes associated with an electrocardiogram (ECG) sensor” and “the biometric information processing module 123 may be integrated into the processor 121.” EX1006, [0040]. The electrical potential (voltage) information is used to determine an ECG, which is a biological parameter. Based on the above, a POSITA would understand Rothkopf teaches the processor positioned within the electronic watch and configured to determine an electrocardiogram using the first voltage, the second voltage, and the third voltage.

2. Claim 2 “The electronic watch of claim 1, wherein the light receiver is a first light receiver; the electronic watch further comprises a second light receiver; and the first and second light receivers are configured to measure a heart rate using the light reflected from the wrist”

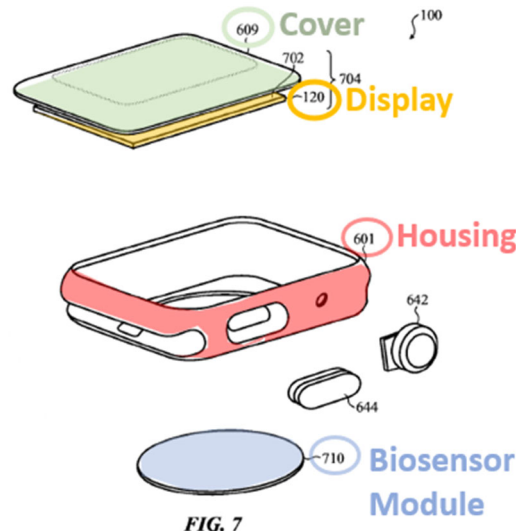
95. Rothkopf teaches “the biosensor module 710 may include one or more light sources, one *or more photodetectors* ... that are configured to detect and

measure a physiological condition or property of the user.” EX1005, [0148] (emphasis added). Rothkopf further teaches “optical (*e.g.*, PPG) sensor or sensors may be used to compute various health metrics, including, without limitation, a heart rate.” EX1005, [0193]. Based on the above, a POSITA would understand a Rothkopf/Jung combined watch could include a first and second light receiver where the first and second light receivers are configured to measure a heart rate using the light reflected from the wrist as explicitly taught by Rothkopf. Further, prior art references recognize that multiple detectors are desirable in order improve “noise cancellation and noise reduction” (1016, 4:8-9) and to “detect light piping” (1016, 21:56-58). A POSITA would have expected success as this is a simple mechanical addition that duplicates already included components as suggested by Rothkopf itself and for the beneficial reasons recognized in the prior art.

3. Claim 3 “The electronic watch of claim 1, wherein: the housing member defines a rectangular outer housing profile; the display is a rectangular display; and the carrier member defines a circular outer carrier profile”

96. Rothkopf teaches a generally rectangular housing member (housing 601) including a generally rectangular display (display 120) and a circular outer carrier (biosensor module 710) in Fig. 7 (reproduced below with annotations). EX1005, [0007], [0119], Fig. 7. Although Rothkopf’s housing member 601 and display 120 have rounded corners, a POSITA would understand the generally

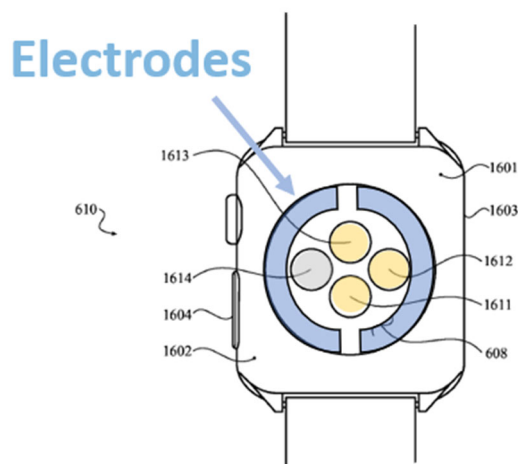
rectangular shape of Rothkopf's housing and front opening to satisfy the limitations of the '054 patent claims.



4. **Claim 4** “The electronic watch of claim 1, wherein: the first electrode includes a first conductive coating deposited on the carrier member; and the second electrode includes a second conductive coating deposited on the carrier member”

97. Rothkopf teaches “biosensor module 710 may include ... one or more electrodes or conductive elements that are configured to detect and measure a physiological condition or property of the user.” EX1005, [0130]. Rothkopf further teaches “the housing 601 may be formed from a variety of materials including ... glass, ceramics ... may include a surface treatment or coating, which may be formed from a variety of materials, including, without limitation aluminum, steel, gold, silver and other metals, metal alloys, ceramics, wood, plastic, glasses, and the like.” *Id.* A POSITA would understand that conductive coatings can be deposited on

various surfaces to form electrodes, such as a silver coating on ceramic. *See* EX1013, Table 1. Based on the above as taught by Rothkopf, a POSITA would have found it obvious to use conductive coatings, such as silver or ceramic surface coatings, on a glass or ceramic biosensor module housing to create the electrodes of Claim 4 as shown below.



5. **Claim 5 “The electronic watch of claim 4, wherein the first and second conductive coatings include one or more of an aluminum titanium nitride material, a chromium silicon carbon nitride material, or a diamond like carbon material”**

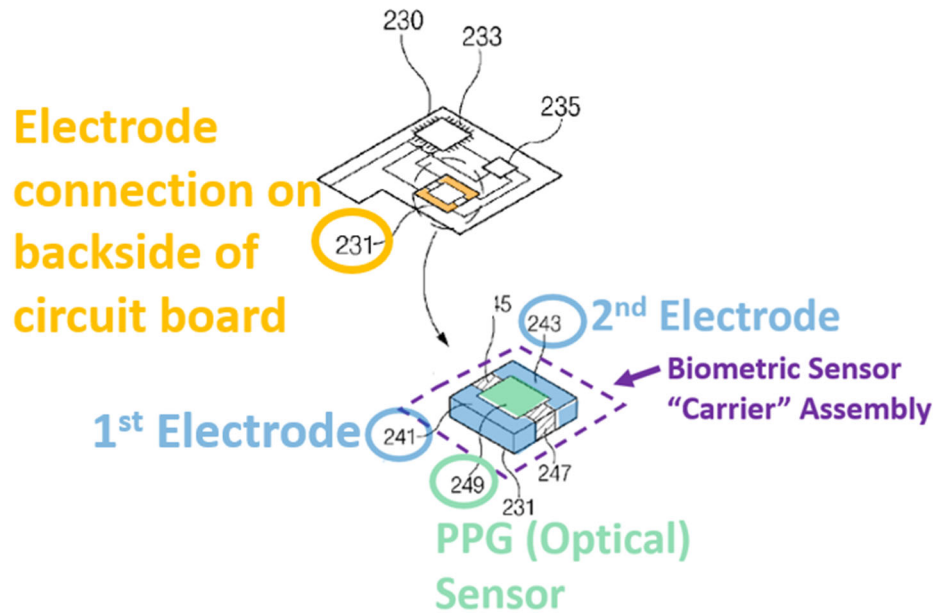
98. Rothkopf teaches using surface treatments or coatings of aluminum, steel, gold, silver and other metals, metal alloys, ceramics, wood, plastic, glasses, and the like. EX1005, [0130]. A POSITA would have found it obvious to use any conductive materials or alloys or ceramics for conductive coating materials to form the electrodes. For example, Lapetina teaches “electrical contacts could have a variety of surface compositions to allow ohmic (*i.e.*, related to conduction by ionic and/or redox reaction across the surface of the electrical contacts) and/or capacitive

(i.e., related to the accumulation of opposite charges on opposite sides of a surface of the electrical contacts) electrical coupling between the electrodes and skin locations of a wearer.” EX1010, [0043]. Such surface compositions could include stainless steel, gold, platinum, silver, silver/silver-chloride, polymers or rubbers containing conductive particles, or other conductive or partially conductive materials.” EX1010, [0053]. Accordingly, a POSITA would have looked to any conductive material for the conductive coatings of Claim 5 including one or more of an aluminum titanium nitride material, a chromium silicon carbon nitride material, or a diamond like carbon material.

- 6. Claim 6 “The electronic watch of claim 4, wherein: the first conductive coating is deposited along an exterior surface of the carrier member, an edge of the carrier member, and an interior surface of the carrier member; and the processor is operably coupled to the first electrode along a portion of the first conductive coating positioned along the interior surface of the carrier member”**

99. Jung teaches a biometric sensor (231) consisting of a first and second electrode (241, 243, respectively) that wrap around the edge of the carrier member (231); the carrier member (231) then passes through an opening on the back of a housing (271) and the electrodes connect directly to a circuit board (230) and processor inside the housing. EX1006, [0050]-[0050]. Jung teaches that “printed circuit board 230 may be connected to a biometric sensor 231” that “may include a

first electrode 241 [and] a second electrode.” EX1006, [0045]-[0046], Fig. 2 (below).



100. It would have been obvious to a POSITA to use the electrode structure of Jung to implement the teachings of Rothkopf because Jung teaches how to connect electrodes on the exterior of a bio-sensor carrier member to an internal circuit board having a processor and would expect to be successful based on the teachings of Jung.

7. Claim 9

a) Limitation 9a (preamble) “A wearable electronic device comprising”

101. Rothkopf teaches a “wearable electronic device” and explains that the device can be a “wearable watch.” EX1005 Title, 6:64, see also Fig. 6 (reproduced below).

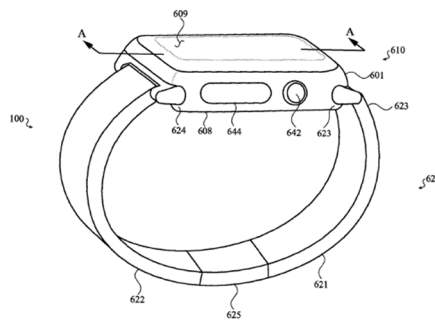
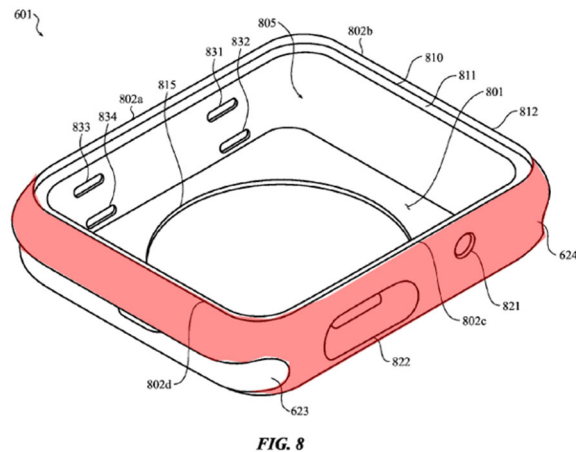


FIG. 6

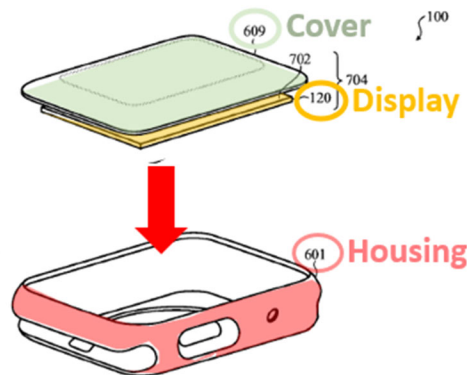
b) Limitation 9b “a rectangular housing member defining a rectangular front opening and a circular rear opening”

102. Rothkopf teaches a rectangular housing member 601 including a rectangular front opening and a circular rear opening as shown in its Fig. 8. EX1005, [0119], [0130], Fig. 8.



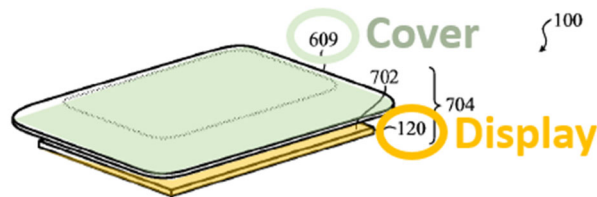
c) Limitation 9c “a cover having a rectangular cover profile and positioned over the rectangular front opening”

103. Rothkopf teaches “cover 609 is disposed above the display and encloses a cavity or opening formed in the top portion of the housing 601.” EX1005, [0122], Fig. 7. As shown below in Fig. 7 of Rothkopf, the cover has a rectangular profile and is positioned over the rectangular front opening of housing 601.



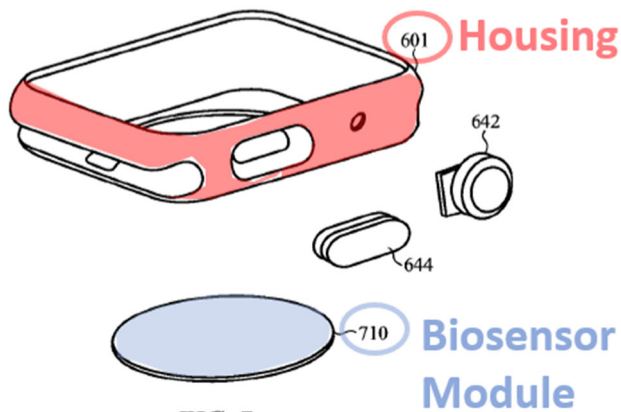
d) Limitation 9d “a display positioned below the cover”

104. As explained above, Rothkopf teaches “cover 609 is disposed above the display” 120. EX1005, [0122], Fig. 7. Thus, the display 120 of Rothkopf is positioned below the cover 609, as shown in Fig. 7 partially reproduced below with annotations.



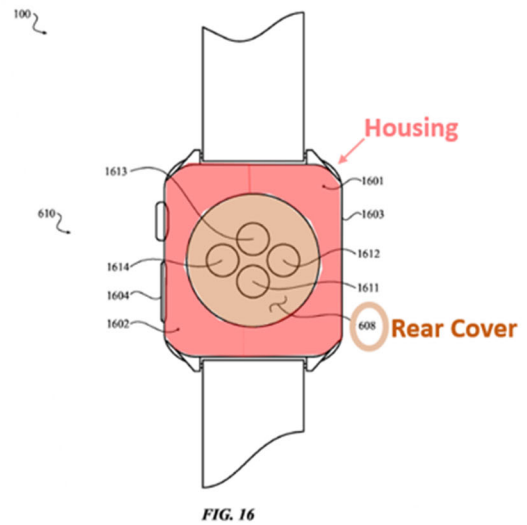
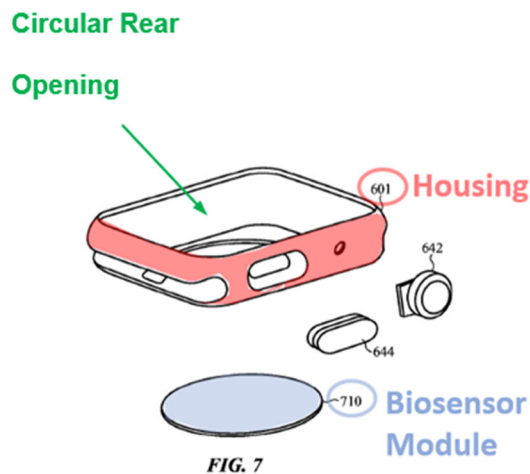
e) Limitation 9e “a carrier assembly coupled to the rectangular housing member and comprising”

105. Rothkopf teaches a biosensor module 710. The biosensor module 710 is a carrier assembly which is coupled to the rectangular housing 601. The “biosensor module 710 includes the rear cover 608.” EX1005, [0148]. “The biosensor module 710 is disposed in an opening formed in the rear surface of housing 601, a chassis or plate facilitates attachment of the biosensor module 710 to the housing.” EX1005, [0148]; Fig. 7 (below). The rear cover 608 also facilitates attachment of the biosensor module 710 to the housing 601. *Id.* “[B]iosensors are disposed relative to or **attached to** a rear cover 608 that is formed from an optically transparent material” EX1005, [0201] (emphasis added).



f) Limitation 9f “a carrier member having a circular carrier profile and positioned over the circular rear opening”

106. The biosensor module 710 “includes the rear cover 608.” EX1005, [0148]. The rear cover 608 is therefore a component of the carrier assembly and forms a carrier member. As shown in Figs. 7 and 16 below, the housing 601 has a circular opening in its rear into which the biosensor module 710 is inserted. *Id.*, [0148], Figs. 7 and 16.



The “rear cover 608 may include a shelf or flange that may be used to form a seal between the biosensor module 710 and the housing 601.” EX1005, [0148]. In Fig. 16 (reproduced above with annotations) the rear cover 608 (brown) is shown having a circular profile. EX1005, Fig. 16. From the above disclosure, a POSITA would have understood that the cover 608 has a circular profile matching the circular profile of the opening and is positioned over the circular rear opening in order to form a seal.

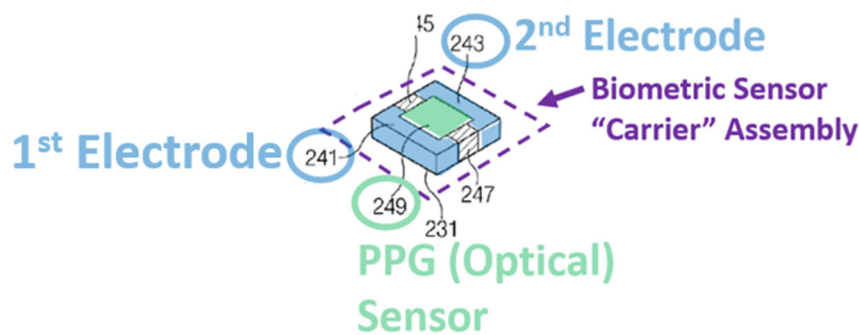
g) Limitation 9g “a rear electrode positioned on the carrier member and configured to receive a first voltage signal from a wrist of a user”

107. Rothkopf teaches its “biosensor module 710 may include ... one or more electrodes or conductive elements that are configured to detect and measure a physiological condition or property of the user.” EX1005, [0148]. As noted above, “biosensor module 710 includes the rear cover 608.” EX1005, [0148]. Rothkopf

further teaches that its “biosensors are disposed relative to or attached to a rear cover 608 that is formed from an optically transparent material.” EX1005, [0201]. Rothkopf explains its “biosensors” can be an electrode configured to perform an ECG measurement. *Id.*, [0084]. Rothkopf further confirms that its “device may also include at least one pair of electrodes disposed on an exterior surface of the wearable electronic device.” *Id.*, [0024]. Rothkopf also teaches the electrodes “make contact with the skin of the user’s wrist when the device is being worn.” *Id.*, [0196]. Accordingly, Rothkopf teaches a first electrode positioned on the carrier member (rear cover 608) and positioned against the wrist while worn.

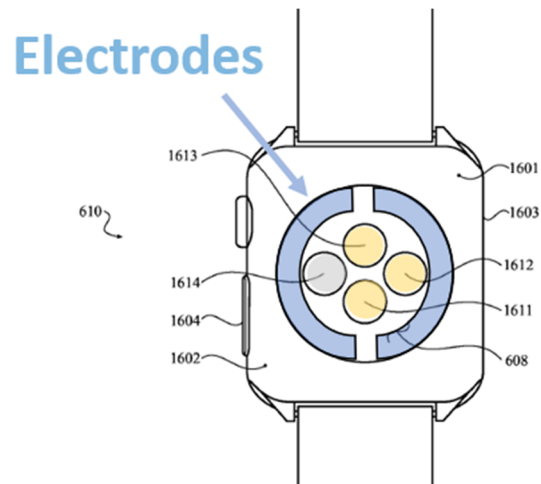
108. Rothkopf further teaches the electrodes are coupled to a processor and configured to detect electrical activity produced by the heart of the user, which a person of skill in the art would understand can include a first voltage from the measurement site where the electrodes are worn, including the wrist. *Id.*, [0198].

109. Jung also teaches a biometric sensor carrier assembly with a biometric sensor carrier member (231) including a first electrode (241) (which detects a first voltage) and second electrode (243) (which detects a second voltage), the first and second electrodes are positioned on and wrapped around the edges of the carrier (231). EX1006, [0046]-[0047], Fig. 2 (below). The biometric sensor carrier assembly also includes a first insulator (245), a second insulator (247), and a photoplethysmogram (PPG) sensor (249).



The biometric sensor is coupled to a processor. EX1006 at [0045] – [0047] [0050]. The biosensor carrier (231) is placed into an opening on the back of a housing (271) and connects directly to a circuit board (230) and processor inside the housing. *Id.*, [0047], [0050]. Accordingly, Jung provides further details on the suggested embodiments of Rothkopf.

110. A POSITA would be motivated to use the teachings of Jung to implement the carrier assembly taught by Rothkopf. A person of skill would position two electrodes and wrap the electrodes around the edges of Rothkopf's carrier member as taught by Jung in order to improve contact with the patient's skin by covering as much of the carrier member as possible without obstructing the optical sensor. A POSITA would understand that it is advantageous to "increase the contact area of the skin-to-electrode interface to maintain lower impedance and exhibit better behavior in reducing motion artifacts." EX1013, R56. A POSITA would combine the teachings of Jung and Rothkopf in a sensor arrangement shown below:

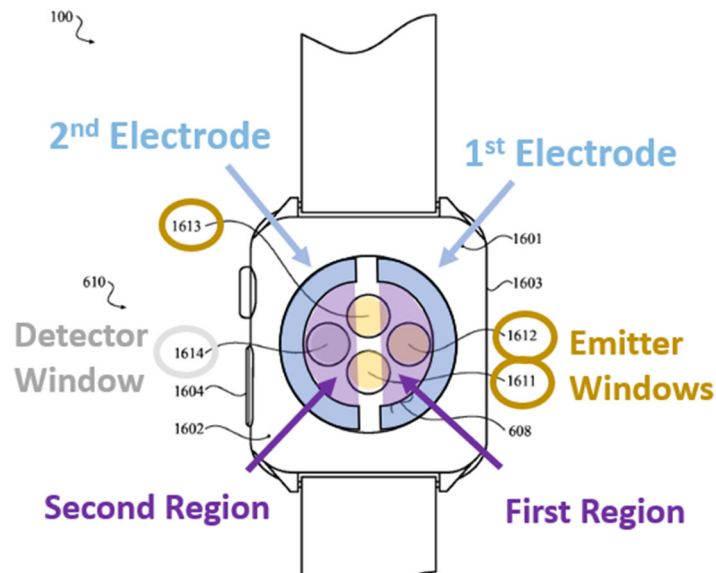


A POSITA would have expected success in making this combination as it is a simple rearrangement of known compatible components in a predictable way to obtain a predictable result. Jung’s carrier structure is similar in size and purpose to the carrier structure of Rothkopf and Jung teaches a POSITA how to incorporate electrodes on a carrier structure as expressly suggested by Rothkopf. Accordingly, success in making the combination would have been expected.

h) Limitation 9h-j “an optical sensor system comprising: an optical emitter positioned below a first region of the carrier member; and an optical receiver positioned below a second region of the carrier member”

111. Rothkopf teaches its biosensor can include optical biometric sensors including a light source and a photodetector that form a photoplethysmography (PPG) sensor. EX1005, [0084]. Rothkopf’s rear cover 608 includes emitter and detector windows for each of emitters and detector 1614, 1612, 1613 and 1611. *Id.*, [0201]. Further, Rothkopf teaches the “biosensor module may also include an optically transparent rear cover disposed over the array of windows and operative to

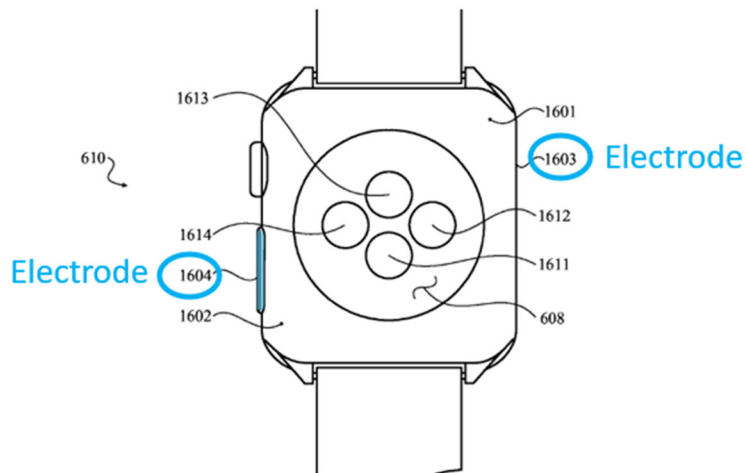
pass light emitted from the array of light sources into the user.” *Id.* Because the emitters and detector are under the rear cover 608, Rothkopf teaches an optical emitter positioned below a first region of the carrier, for example, window 1612, and an optical receiver positioned below a second region of the carrier member, window 1614.



112. Jung also teaches a biometric sensor carrier that includes a PPG sensor. The PPG sensor includes a light emitter and receiver and “may be disposed in a specific area in the *interior* of the biometric sensor 231.” Based on the above, a POSITA would understand Jung teaches a light emitter that may be *below* the first region of the carrier. EX1006 at [0045] – [0046].

i) Limitation 9k “a side electrode positioned along an exterior of the rectangular housing member and configured to receive a second voltage signal from a finger of the user”

113. Rothkopf teaches “a third electrode 1603 and fourth electrode 1604 may be disposed along a periphery of the device body 610.” EX1005, [0196]; Fig. 16 (below). The “third 1603 and fourth 1604 electrodes are configured to come into contact with the skin of the user’s other hand...(e.g., a forefinger and thumb).” *Id.* Further, Rothkopf teaches the electrodes are configured to detect electrical activity produced by the heart to produce an ECG. *Id.* [0198]. A POSITA would understand the “electrical activity” described by Rothkopf is a voltage level. For example, Berbari states that the “voltage difference from any two [limb] sites will record an ECG.” EX1012, 45-2. Based on the above, a POSITA would understand Rothkopf teaches this limitation as a side electrode positioned along an exterior of the rectangular housing member and configured to receive a second voltage signal from a finger of the user.



j) Limitation 91 “a processor positioned within the wearable electronic device and configured to determine a biological parameter using the first and second voltage signals”

114. As explained above, Rothkopf teaches that “processing units 102 may receive signals from the optical sensor(s) and/or electrodes and process the signals to correlate the signal values with a physiological parameter of the user.” *Id.* [0198]; Fig. 2 (showing processing units 102 as part of device 100). A POSITA would understand the “signals” described by Rothkopf are voltage signals. Based on the above, a POSITA would understand Rothkopf teaches a processor inside its wearable electronic device that determines a biological parameter using first and second voltage signals.

115. Jung also teaches that “biometric information may include biometric electric potential information obtained through electrodes associated with an

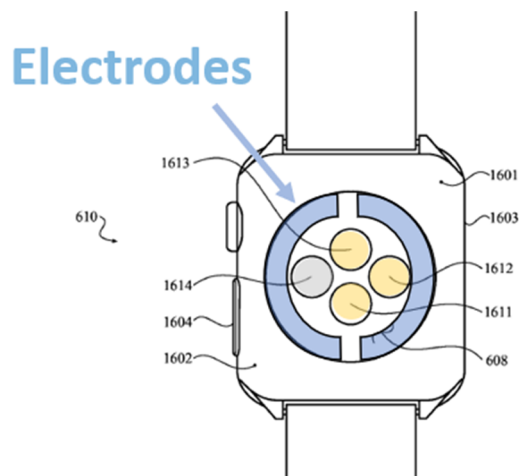
electrocardiogram (ECG) sensor” and “the biometric information processing module 123 may be integrated into the processor 121.” EX1006, [0040]. The electric potential (voltage) information is used to determine an ECG, which is a biological parameter.

116. Based on the above, a POSITA would understand Rothkopf and Jung both teach a processor positioned within the wearable electronic device and configured to determine a biological parameter using the first and second voltage signals.

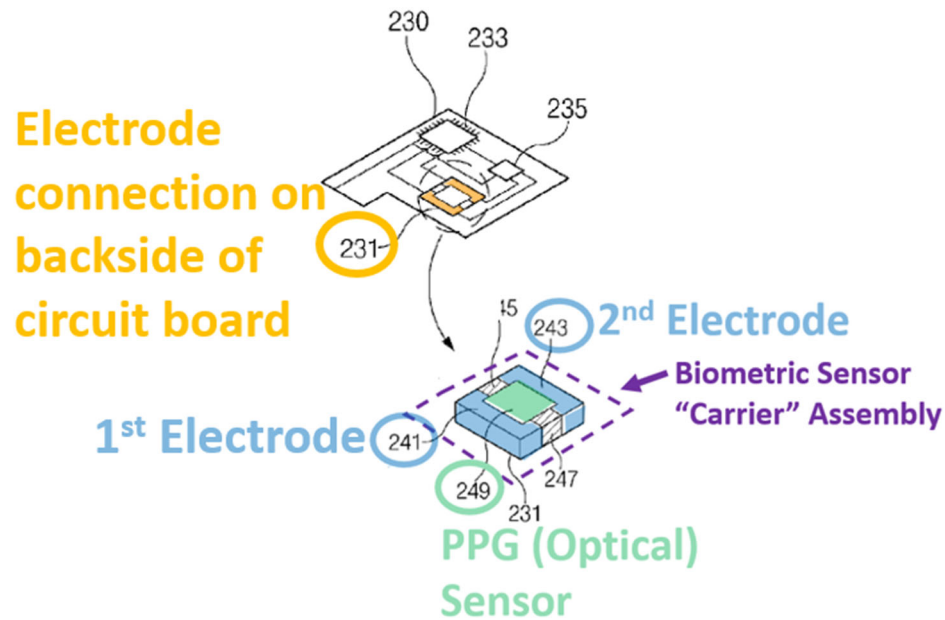
8. **Claim 12 “The wearable electronic device of claim 9, wherein: the rear electrode is formed from a conductive coating deposited along an exterior surface of the carrier member; and the conductive coating extends around an edge of the carrier member and along an inner portion of the carrier member that is internal to the wearable electronic device”**

117. Rothkopf teaches “biosensor module 710 may include ... one or more electrodes or conductive elements that are configured to detect and measure a physiological condition or property of the user.” EX1005, [0130]. Rothkopf further teaches “the housing 601 may be formed from a variety of materials including ... glass, ceramics ... may include a surface treatment or coating, which may be formed from a variety of materials, including, without limitation aluminum, steel, gold, silver and other metals, metal alloys, ceramics, wood, plastic, glasses, and the like” *Id.* Based on the above, a POSITA would understand, as taught by Rothkopf, it would have been obvious to use conductive coatings, such as silver or ceramic

surface coatings, on a biosensor module housing to create the electrodes of the combined Rothkopf/Jung device illustrated below.



118. In addition, Jung teaches a biometric sensor (231) (that is, in effect, a carrier member) consisting of a first and second electrode (241, 243, respectively) that may be wrapped around the edge of the carrier member (231), including an inside edge; the carrier member (231) then passes through an opening on the back of a housing (271) and the electrodes connect directly to a circuit board (230) and processor inside the housing through the interior wrapped portion of the electrode. EX1006, [0045]-[0050], Fig. 2 (below). Jung teaches that “printed circuit board 230 may be connected to a biometric sensor 231” that “may include a first electrode 241 [and] a second electrode.” EX1006, [0045]-[0046]. As discussed above, a POSITA seeking to implement the teachings of Rothkopf would be motivated to use the teachings of Jung.



119. Based on the above, a POSITA would combine Rothkopf's and Jung's disclosures in order to make a rear electrode formed from a conductive coating deposited along an exterior surface of the carrier member and the conductive coating would extend around an edge of the carrier member and along an inner portion of the carrier member that is internal to the wearable electronic device. A POSITA would have expected success in making this combination as it is a simple rearrangement of known compatible components in a predictable way to obtain a predictable result. Jung's carrier structure is similar in size and purpose to the carrier structure of Rothkopf. Jung teaches a POSITA how to incorporate electrodes on a carrier structure (as expressly suggested by Rothkopf) and connect the structure to an underlying circuit board (as explained by Jung). Rothkopf in combination with Jung obviates this claim.

9. Claim 13 “The wearable electronic device of claim 9, wherein the optical sensor system is an optical heart rate sensor that is configured to measure a heart rate of the user”

120. Rothkopf teaches that “optical (e.g., PPG) sensor or sensors may be used to compute various health metrics, including, without limitation, a heart rate.” EX1005, [0193]. Based on the above, a POSITA would understand the wearable electronic device of Rothkopf and Jung would include an optical sensor system that is an optical heart rate sensor configured to measure a heart rate of the user.

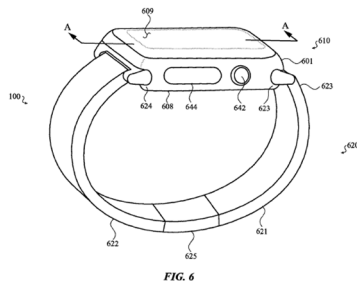
10. Claim 14 “The wearable electronic device of claim 9, wherein: the optical sensor system is configured to measure a heart rate of the user; and the biological parameter is an electrocardiogram (ECG) of the user”

121. Rothkopf teaches that “optical (e.g., PPG) sensor or sensors may be used to compute various health metrics, including, without limitation, a heart rate.” EX1005, [0193]. Rothkopf also teaches that its one or more biosensors may be configured to measure an ECG. *Id.*, [0084]. Based on the above, a POSITA would understand the wearable electronic device of Rothkopf and Jung would include an optical sensor system configured to measure a heart rate of the user and the biological parameter is an electrocardiogram (ECG) of the user.

11. Claim 15

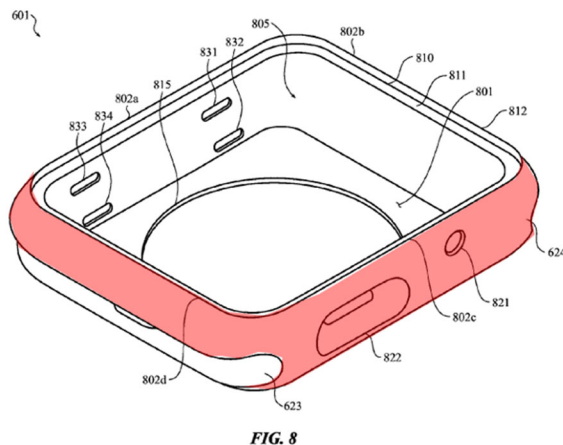
a) Limitation 15a (preamble) “A watch comprising”

122. Rothkopf teaches “wearable watch.” EX1005, [0056], see also Fig. 6 (reproduced below).



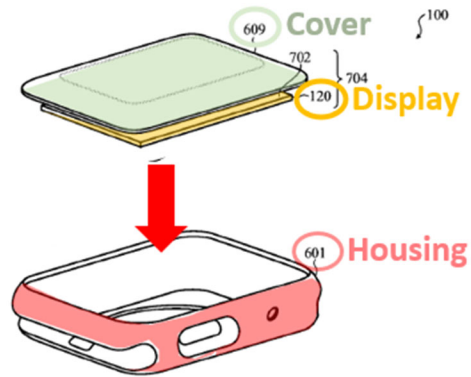
b) Limitation 15b “a housing member”

123. Rothkopf teaches a housing member 601. EX1005, [0119], [0130], Fig. 8 (below).



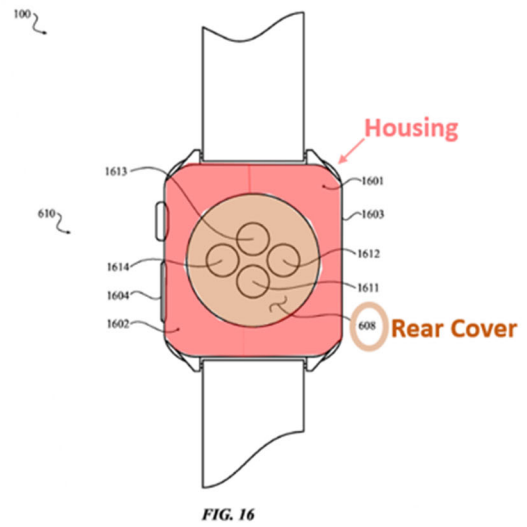
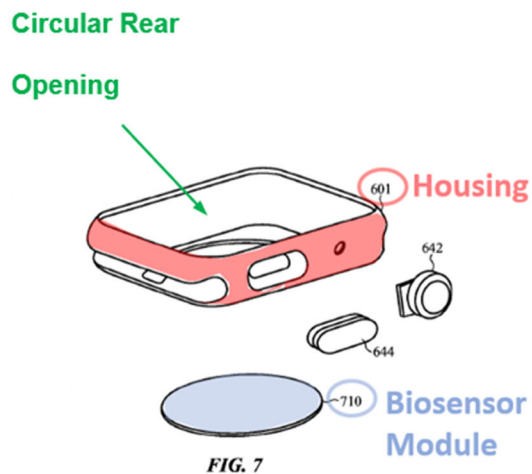
c) Limitation 15c “a display configured to display a graphical output”

124. Rothkopf teaches a display 120 which displays a graphical output. EX1005, [0120], Fig. 7 (reproduced below with annotations).

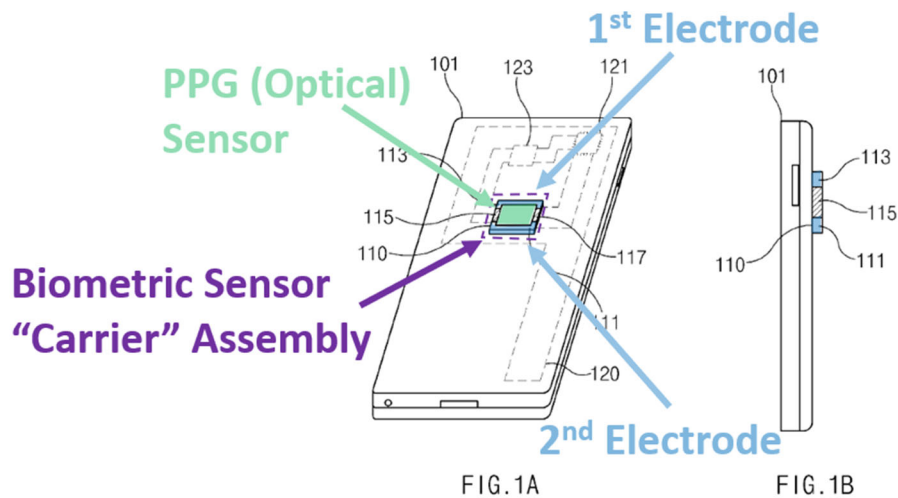


- d) **Limitation 15d “a carrier assembly coupled to the housing member and comprising: a carrier member protruding outward from an external surface of the housing member”**

125. Rothkopf teaches a biosensor module 710 that forms a carrier assembly. Rothkopf teaches “biosensor module 710 is disposed in an opening formed in the rear surface of the housing 601 . . . biosensor module 710 includes the rear cover 608 and may also include a chassis or plate that facilitates attachment of the biosensor module 710 to the housing.” EX1005, [0148], Fig. 7. Rothkopf further teaches the rear cover can have a convex outer contour that protrudes outward from the back external surface of the housing member 601. EX1005, [0123], [0201], Fig. 16 (below). This cover 608 is the carrier member of Claim 15.



126. Additionally, Jung discloses that a carrier assembly “may protrude outwardly from the surface of the housing.” EX1006, Figs. 1A-1B, [0035].



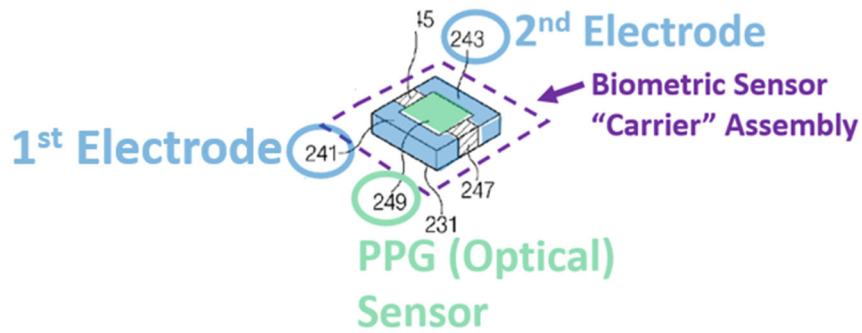
e) **Limitation 15e “a rear electrode positioned on the carrier member, the rear electrode operably coupled to a processor and configured to detect a first voltage”**

127. Rothkopf teaches its “biosensor module 710 may include ... one or more electrodes or conductive elements that are configured to detect and measure a physiological condition or property of the user.” EX1005, [0148]. As noted above, “biosensor module 710 includes the rear cover 608.” EX1005, [0148]. Rothkopf further teaches that its “biosensors are disposed relative to or attached to a rear cover 608 that is formed from an optically transparent material” EX1005, [0201]. Rothkopf explains its “biosensors” can be an electrode configured to perform an ECG measurement. *Id.*, [0084]. Rothkopf further confirms that its “device may also include at least one pair of electrodes disposed on an exterior surface of the wearable electronic device.” *Id.*, [0024]. Accordingly, Rothkopf teaches a first electrode positioned on the carrier member (rear cover 608).

128. Rothkopf further teaches the electrodes are coupled to a processor and configured to detect electrical activity produced by the heart of the user, which a person of skill in the art would understand can include a first voltage. *Id.*, [0198].

129. Jung also teaches a biometric sensor carrier assembly with a biometric sensor carrier member (231) including a first electrode (241) (which detects a first voltage) and second electrode (243) (which detects a second voltage), the first and second electrodes are positioned on and wrapped around the edges of the carrier

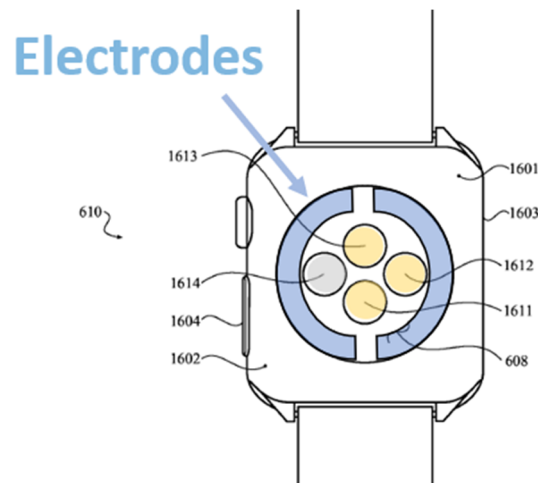
(231). EX1006, [0046]-[0047], Fig. 2 (below). The biometric sensor carrier assembly also includes a first insulator (245), a second insulator (247), and a photoplethysmogram (PPG) sensor (249).



The biometric sensor is coupled to a processor. EX1006 at [0045 – 0047]; [0050]. The biosensor carrier (231) is placed into an opening on the back of a housing (271) and connects directly to a circuit board (230) and processor inside the housing. *Id.*, [0047], [0050]. Accordingly, Jung provides further details on the suggested embodiments of Rothkopf.

130. A POSITA would be motivated to use the teachings of Jung to implement the carrier assembly taught by Rothkopf. A POSITA would position the electrodes and wrap the electrodes around the edges of Rothkopf's carrier member as taught by Jung in order to improve contact with the user's skin by covering as much of the carrier member as possible without obstructing the optical sensor. A POSITA would understand that it is advantageous to "increase the contact area of the skin-to-electrode interface to maintain lower impedance and exhibit better

behavior in reducing motion artifacts.” EX1013, R56. A POSITA would combine the teachings of Rothkopf and Jung and end up with a sensor arrangement shown below using the teachings of Jung in the system of Rothkopf:

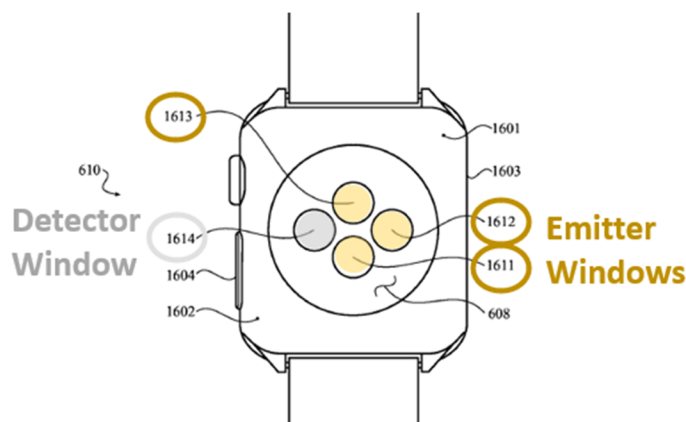


A POSITA would have expected success in making this combination as it is a simple rearrangement of known compatible components in a predictable way to obtain a predictable result. Jung’s carrier structure is similar in size and purpose to the carrier structure of Rothkopf and Jung teaches a POSITA how to incorporate electrodes on a carrier structure as expressly suggested by Rothkopf. Accordingly, success in making the combination would have been expected.

f) Limitation 15f “an optical sensor positioned below the carrier member and configured to transmit optical signals through the carrier member”

131. Rothkopf teaches its biosensor can include optical biometric sensors including a light source and a photodetector that form a photoplethysmography (PPG) sensor. EX1005, [0084]. Rothkopf’s “biosensor module 710 may include

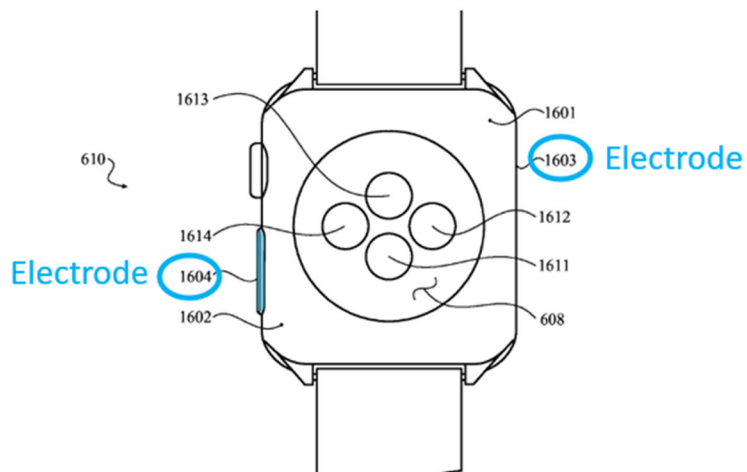
one or more light sources [and] one or more photodetectors” which a POSITA would understand to be a PPG sensor. *Id.* [0148], Fig. 16 (below). Rothkopf’s rear cover 608 includes emitter and detector windows for each of emitters and detector 1614, 1612, 1613 and 1611. *Id.*, [0201]. Further, Rothkopf teaches the “biosensor module may also include an optically transparent rear cover disposed over the array of windows and operative to pass light emitted from the array of light sources into the user.” *Id.* Because the emitters and detector are below the cover 608, a POSITA would understand Rothkopf teaches an optical emitter positioned below a first region of the carrier, windows 1611-1612, and an optical receiver positioned below a second region of the carrier member, window 1614.



132. Jung also teaches a biometric sensor carrier that includes a PPG sensor. The PPG sensor includes a light emitter and receiver and “may be disposed in a specific area in the *interior* of the biometric sensor 231.” EX1006, [0043]. Based on the above, a POSITA would understand Jung teaches a light emitter that may be *below* the first region of the carrier. *Id.*, [0045] – [0046].

g) Limitation 15g “a side electrode positioned along an exterior of the watch, the side electrode operably coupled to the processor and configured to detect a second voltage”

133. Rothkopf teaches “a third electrode 1603 and fourth electrode 1604 may be disposed along a periphery of the device body 610.” EX1005, [0196], Fig. 16 (below). The “third 1603 and fourth 1604 electrodes are configured to come into contact with the skin of the user’s other hand...(e.g., a forefinger and thumb).” *Id.* Further, Rothkopf teaches the electrodes are configured to detect electrical activity produced by the heart to produce an ECG. *Id.* [0198]. A person of skill would understand the “electrical activity” described by Rothkopf is a voltage level. EX1012, 47-2. Based on the above, a POSITA would understand Rothkopf teaches a side electrode positioned along an exterior of the watch, the side electrode operably coupled to the processor and configured to detect a second voltage.



h) Limitation 15h “the processor positioned within the watch and configured to: determine a biological parameter”

134. As explained above, Rothkopf teaches that “processing units 102 may receive signals from the optical sensor(s) and/or electrodes and process the signals to correlate the signal values with a physiological parameter of the user.” *Id.* [0198], Fig. 2 (showing processing units 102 as part of device 100). Based on the above, a POSITA would understand Rothkopf teaches a processor inside its wearable electronic device that determines a biological parameter.

135. Jung also teaches that “biometric information may include biometric electric potential information obtained through electrodes associated with an electrocardiogram (ECG) sensor” and “the biometric information processing module 123 may be integrated into the processor 121.” EX1006, [0040]. The electrical potential (voltage) information is used to determine an ECG, which is a biological parameter. A POSITA would have used these disclosures to include a processor positioned within the watch and configured to: determine a biological parameter in a combined Rothkopf/Jung device.

i) Limitation 15i “cause a change to the graphical output in response to determining the biological parameter”

136. Rothkopf teaches a display disposed within the housing and configured to display the health metric computed by its processor. EX1005, [0014], [0021],

[0093]. Based on the above, a POSITA would understand Rothkopf teaches a change to the graphical output in response to determining the biological parameter

137. Based on the foregoing, a POSITA would have arrived at the limitations of Claim 15.

12. **Claim 16 “The watch of claim 15, wherein: the carrier member defines a circular outer profile; the optical sensor comprises a light emitter configured to emit light through a first region of the carrier member; the optical sensor comprises an optical receiver configured to receive reflected light through a second region of the carrier member; and the rear electrode is positioned along a peripheral region of the carrier member and at least partially surrounds the first and second regions of the carrier member”**

138. As explained above with regard to Claim 9 (limitations 9f; 9h-j), a POSITA would combine Rothkopf with Jung in a device that includes these limitations.

13. **Claim 17 “The watch of claim 15, wherein: the rear electrode is a first rear electrode; the watch further comprises a second rear electrode positioned on the carrier member; and the first rear electrode and the second rear electrode are defined by a conductive coating deposited on a surface of the carrier member”**

139. As explained above with regard to Claims 9 and 12, a POSITA would combine Rothkopf with Jung in a device that includes these limitations.

14. **Claim 19 “The watch of claim 15, wherein: the rear electrode includes a conductive coating that includes one or more of an aluminum titanium nitride or a chromium silicon carbon nitride material; and the conductive coating extends along an edge of the**

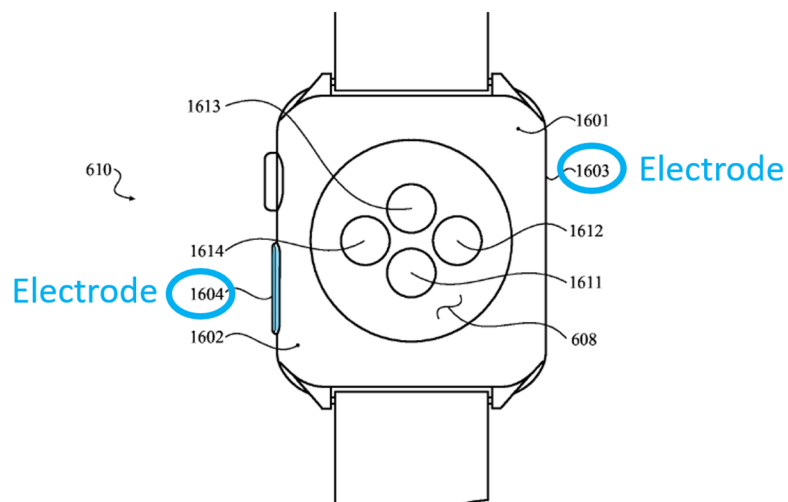
carrier member and along an interior surface of the carrier member”

140. As explained above with regard to Claim 5, a POSITA would combine Rothkopf with Jung in a device that includes these limitations.

D. Ground 2A: Claims 7 and 20 are unpatentable as obvious over Rothkopf and Jung and further in view of Pei

- 1. Claim 7 “The electronic watch of claim 1, wherein: the electronic watch further comprises a button having a conductive button cap; and the conductive button cap defines the third electrode”**

141. As explained above, Rothkopf teaches a third electrode (1603) and fourth electrode (1604) along a side of a device as shown in Fig. 16, but does not provide the details of the structure of these electrodes. EX1005, Fig. 16.



142. Pei teaches a mobile phone or watch that can include a “device input button ... which can also serve as an electrode.” EX1008, 3:44-66. Pei further

teaches “the pressable input button includes a conductive layer (e.g., a thin layer of silicon) configured to receive and/or transmit an electrical signal (e.g., from a finger)” EX1008, 4:42-44. The electrode button can be a mechanical button such as a home button, a volume button or a power button. *Id.*, 8:1-3. A POSITA would have used the teachings of Pei to implement an additional electrode in the form of a button in the Rothkopf and Jung combination device as suggested by Rothkopf. A POSITA seeking to implement the third and/or fourth electrode of Rothkopf as suggested by Rothkopf would have looked to Pei for implementation details and for the suggestion to use an existing button or crown as an electrode as a space saving technique because a watch is of limited size. A POSITA would have expected success in making this combination as it is a simple rearrangement of known compatible components in a predictable way to obtain a predictable result. Pei’s teaching of electrodes on a watch structure is similar in size and purpose to the watch structure and electrode teachings of Rothkopf and Pei teaches a POSITA how to incorporate electrodes on a watch structure as expressly suggested by Rothkopf. Thus, it would have been a simple rearrangement of known compatible components.

2. Claim 20 “The watch of claim 15, wherein: the watch further comprises a button; and the side electrode is positioned along a surface of the button”

143. As explained above with regard to Claim 7, a POSITA would have arrived at a combined device with these limitations.

E. Ground 2B: Claim 8

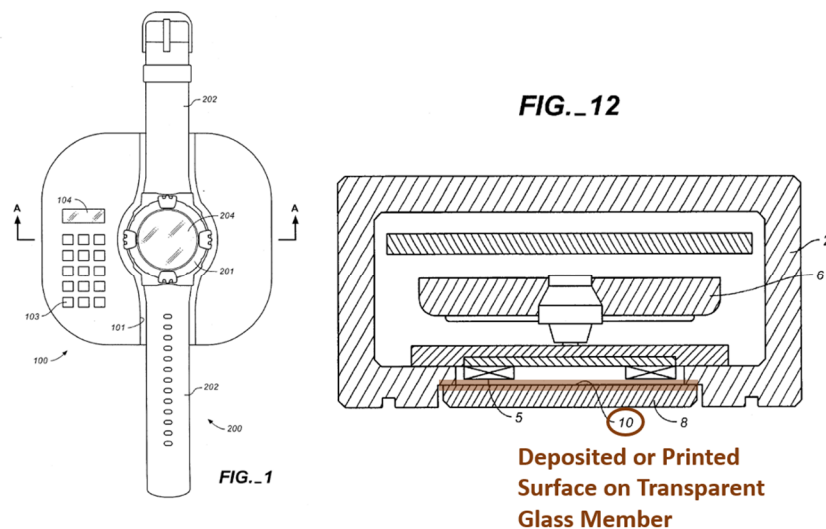
144. As discussed in this section, Rothkopf in combination with Jung and Honda teaches each and every element of claim 8 of the ‘054 patent and a POSITA would have arrived at the limitations of Claim 8 based on this combination of references.

1. **Claim 8 “The electronic watch of claim 1, wherein: the carrier member includes an opaque ink mask deposited along an inner surface of the carrier member surrounding the first and second regions; the first and second electrodes are positioned along an exterior surface of the carrier member that is over the opaque ink mask; and the exterior surface of the carrier member protrudes outward from an external surface of the housing member”**

145. Rothkopf teaches its “device may also include a transparent cover disposed over the cavity of the housing and may include a flat middle portion at a center of the transparent cover, a curved outer portion that emanates from and surrounds the flat middle portion and extends outwardly to an edge of the transparent cover, and a mask positioned relative to an internal surface of the transparent cover.” EX1005, [0015]. “The mask may have an outer boundary located proximate to the edge of the transparent cover and an inner boundary located within the curved outer portion of the transparent cover.” *Id.* Rothkopf further teaches that a mask can be opaque. *Id.*, [0122]. A POSITA would have understood that the mask disclosed in Rothkopf is over the display and that a mask could also be deposited on the inner surface of the rear cover 608 to form “an array of windows, each window including

an aperture or opening for a respective light source.” *Id.*, [202]. Although Rothkopf does not disclose its cover mask is an ink mask, a POSITA would have understood Rothkopf’s disclosure of an opaque mask would indicate use of an ink mask as one possible implementation.

146. The application of ink to a transparent material (such as glass) to make it opaque is a well-known process. EX1014. For example, Honda teaches an “electronic watch” which can “detect biological information including the pulse rate or the heart rate of the body through an unshown sensor” and including a cover glass which has a plated, printed or painted colored interior surface (10). EX1011, 1:13-15; 4:50-58; 6:18-20; 13:59-62; Fig. 1 and 12 (below). Honda teaches that the glass surface may be deposited (e.g., vapor deposition) or coated with a printed surface (e.g., inked). EX1011, 13:59-61. Honda explains, for example, a printed surface on an otherwise transparent cover over electronic devices is preferred from both an aesthetic point of view as well as to protect the electronic components from ultraviolet lights that can cause deterioration. EX1011, 13:53-64. Honda teaches the glass can be opaque and a POSITA would understand from both this teaching as well as the context of deposited or printed surface coating can also be opaque. EX1011, claims 12 and 16.



147. To the extent Rothkopf does not expressly teach an ink mask as claimed, a person of skill would have been motivated by the express teachings of Honda to paint or print (e.g., using an ink mask) the inside of the glass cover for aesthetic purposes and to protect the electronic device. EX1011, 13:53-59.

148. As explained above Rothkopf teaches “at least one pair of electrodes disposed on an exterior surface of the housing.” EX1005, [0023]. Further as discussed above, Rothkopf in combination with Jung places those electrodes on the outside of a transparent cover of the biosensor module (carrier member). Given the teachings of Honda, a POSITA would have opacified (e.g., using an ink mask) the interior glass including under the electrodes in the combined Rothkopf and Jung device described in Ground 2.

149. Further, Rothkopf teaches that its rear cover 608, which is part of the carrier member, can have a convex outer contour that protrudes outward from the

back external surface of the housing member 601. EX1005, [0123], [0201]. A POSITA would understand that the convex outer contour of the rear cover would make it protrude from the main housing.

F. Ground 2C: Claims 10-11 and 18

150. As discussed in this section, Rothkopf in combination with Jung, Francis and Lapetina teaches each and every element of claims 10-11 and 18 of the ‘054 patent and a POSITA would have arrived at the limitations of claims 10-11 and 18 and discussed below.

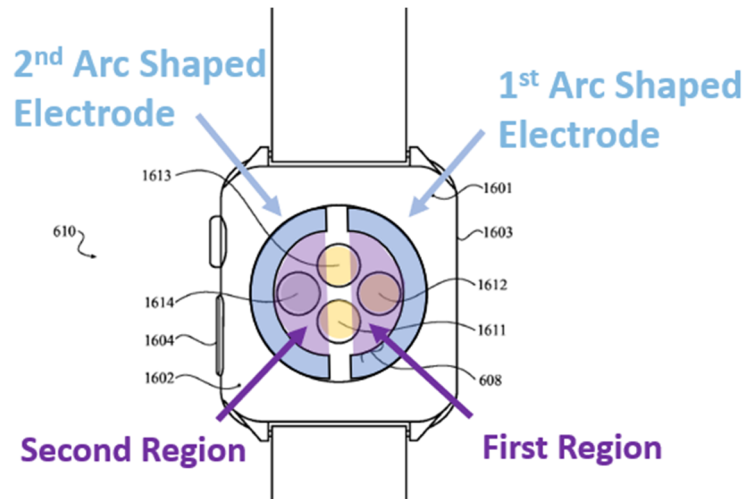
- 1. Claim 10 “The wearable electronic device of claim 9, wherein: the rear electrode is a first rear electrode; and the wearable electronic device further comprises a second rear electrode positioned on the carrier member and configured to ground the wearable electronic device to the user”**

151. Claim 10 depends from Claim 9 and adds a second rear electrode that is configured to ground the wearable electronic device. As explained above with regard to Claim 10 in Grounds 1A and Claim 9 in Ground 1A and 2, Rothkopf in combination with Jung teach a first and second rear electrode positioned on the carrier member and Francis and Lapetina explain that one of those electrodes would be considered a ground electrode by a person of skill. Based on the above references, a POSITA would have arrived at the limitations of Claim 10.

- 2. Claim 11 “The wearable electronic device of claim 10, wherein: the first rear electrode defines a first arc that partially surrounds the**

optical sensor system; and the second rear electrode defines a second arc that partially surrounds the optical sensor system”

152. As explained above in limitation 9g Ground 2, a POSITA would combine Rothkopf with Jung in a device that includes a first rear electrode that defines a first arc that partially surrounds the optical sensor system and a second rear electrode that defines a second arc that partially surrounds the optical sensor system. The combination device as explained above in Ground 2 would look like the following figure.



3. Claim 18

153. As explained above with regard to Claim 10, a POSITA would have arrived at a combined device with these limitations based on a combination of Rothkopf, Jung, Francis, and Lapetina.

G. Ground 3: Claims 1-5, 9, 13-16, 19 are unpatentable as obvious in view of Rothkopf and Paulke

1. Claim 1

a) Limitation 1a-f

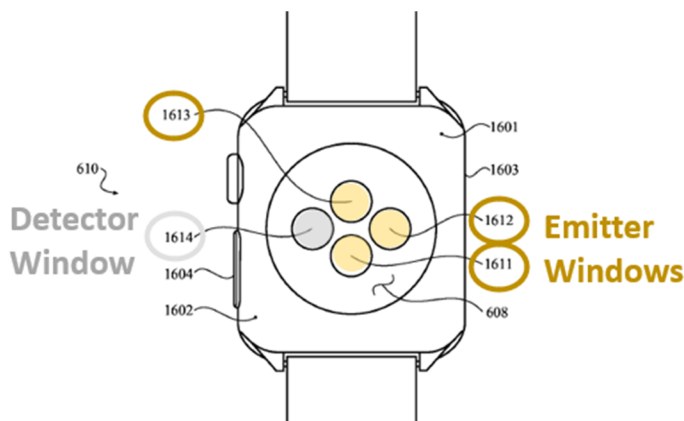
154. Rothkopf teaches this limitation as explained above with regard to limitation 1a-f respectively of Ground 2.

b) Limitation 1g “a second electrode positioned on the carrier member, operably coupled to the processor and configured to detect a second voltage, the first and second electrodes at least partially surrounding a first region of the carrier member and a second region of the carrier member”

155. As explained above in limitation 1f of Ground 2, Rothkopf teaches a second electrode (“pair of electrodes”) positioned on the carrier member (rear cover 608) and operably coupled to the processor to detect a second voltage.

156. As further explained above in Ground 2, Rothkopf does not illustrate the exact configuration of the electrodes located on the biosensor module. Rothkopf does illustrate where emitters and detectors are located on the biosensor module in Fig. 16 (below). Rear cover 608 includes emitter and detector windows 1614, 1612, 1613 and 1611. In the embodiment of Fig. 16, electrodes 1601 and 1602 are not located on the biosensor module. But, as explained above, Rothkopf describes an embodiment where the electrodes are positioned on the cover 608. EX1005, [0201]. Additionally, Rothkopf teaches that “one or more of the electrodes may be placed

on a top surface or other surface of the device” and “to contact the user’s skin.”
EX1005, [0197], [0201], [0084], [0148].



157. A POSITA seeking to implement the teaching of Rothkopf to locate the electrodes on the biosensor module would look to other mobile electronic device references that teach the use of electrodes on a biosensor carrier assembly similar to that of Rothkopf.

158. Paulke teaches a biosensor module carrier. Paulke states that any “suitable number and/or type(s) of biosensors may be included in the biosensor module, such as but not limited to ... electrocardiography, ... optical reflectance of blood vessels, oxygen saturation sensors, etc.” and the wearable device may include a processor that may process physiological measurements (such as ECG). EX1007, 12:6-13, 6:11-13. Fig. 1F of Paulke, reproduced with annotates below, shows an arrangement for three biosensors 120. Paulke suggests, for example, the two biosensors 120 (annotated in blue) may be first and second electrodes (such as for galvanic or ECG measurements) and biosensor 120 (annotated in green) may be for

optical reflectance of blood vessels or oxygen saturation (PPG). EX1007, 14:26-15:18.

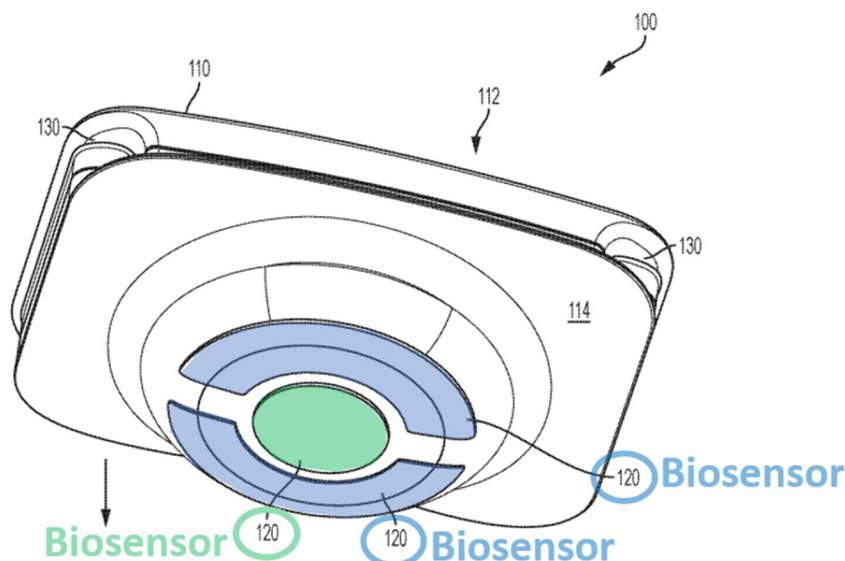
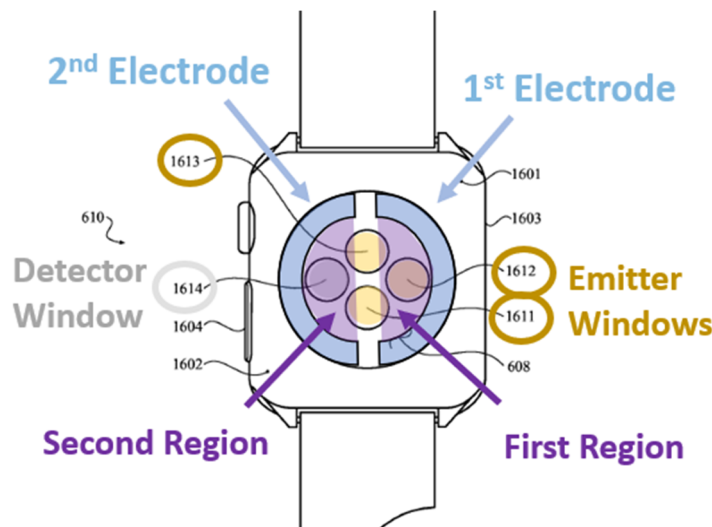


FIG. 1F

159. The illustrated embodiment above of the biosensor module of Paulke is located on the strap of a wrist-worn wearable device. However, Paulke discloses that the “wearable article may be a wrist-worn watch.” EX1007, 6:16-17. A POSITA would have been motivated to incorporate the features of the Paulke design into the carrier of Rothkopf. Rothkopf itself, for example, teaches the desirability to provide a “wearable electronic device that is configured to provide an expansive feature set integrated or incorporated into a compact form factor.” EX1005, [0004]. Rothkopf further explains “a consumer product may integrate or combine multiple subsystems into a single device to provide a wide range of functionality, including biometric sensing.” *Id.*

160. A POSITA would be motivated to use the teachings of Paulke to implement the carrier assembly taught by Rothkopf. A person of skill would position the electrodes as taught by Paulke in order to maintain contact with the user's skin. EX1007, 6:5-7. A POSITA would have a reasonable expectation of success as the combination is a basic rearrangement of compatible components in a predictable way to obtain a predictable result. Paulke's carrier structure is similar in size and purpose to the carrier structure of Rothkopf and Paulke teaches a POSITA how to incorporate electrodes on a carrier structure as expressly suggested by Rothkopf. Accordingly, success in making the combination would have been expected. A POSITA would end up with a sensor arrangement shown below using the teachings of Jung in the system of Rothkopf:



c) Limitation 1h-k

161. Rothkopf teaches limitation 1h-k as explained with regard to the limitations 1h-k of Ground 2.

162. Based on the above, a POSITA would have arrived at the limitations of Claim 1 based on a combination of Rothkopf and Paulke.

2. Claims 2-5

163. Rothkopf by itself or in combination with Lapetina teach the limitations of Claims 2-5 for the same reasons discussed above in Ground 2 with regard to these claims.

3. Claim 9

a) Limitation 9a-f

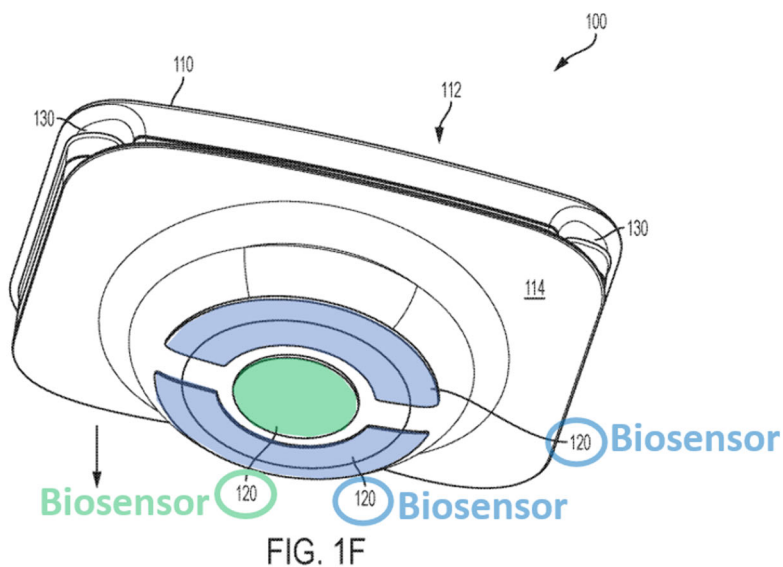
164. Rothkopf teaches this limitation as explained above with regard to limitation 9a-f respectively of Ground 2.

b) Limitation 9g “a rear electrode positioned on the carrier member and configured to receive a first voltage signal from a wrist of a user”

165. Rothkopf teaches this limitation as explained above with regard to limitation 9g of Ground 1. A person of skill seeking to implement the teaching of Rothkopf to locate the electrodes on the biosensor module would look to other mobile electronic device references that teach the use of electrodes on a biosensor carrier assembly similar to that of Rothkopf.

166. Paulke teaches a biosensor module carrier. Paulke states that any “suitable number and/or type(s) of biosensors may be included in the biosensor module, such as but not limited to ... electrocardiography, ... optical reflectance of

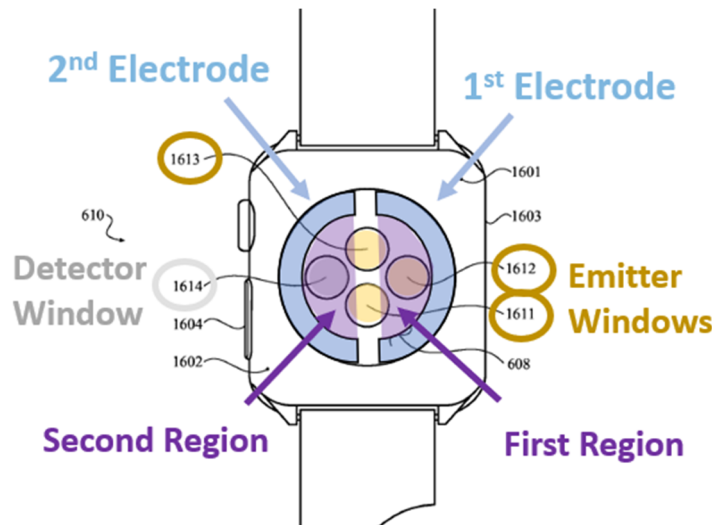
blood vessels, oxygen saturation sensors, etc.” and the wearable device may include a processor that may process physiological measurements (such as ECG). EX1007, 12:6-13, 6:11-13. Fig. 1F of Paulke, reproduced with annotations below, shows an arrangement for three biosensors 120. Paulke suggests, for example, the two biosensors 120 (annotated in blue) may be first and second electrodes (such as for galvanic or ECG measurements) and biosensor 120 (annotated in green) may be for optical reflectance of blood vessels or oxygen saturation (PPG). EX1007, 14:26-15:18.



167. The illustrated embodiment above of the biosensor module of Paulke is located on the strap of a wrist-worn wearable device, and not housed in the wearable device, such as a watch. However, Paulke discloses that the “wearable article may be a wrist-worn watch.” EX1007, 6:16-17. A POSITA would have been motivated to incorporate the features of the Paulke design into the carrier of Rothkopf.

Rothkopf itself, for example, teaches the desirability to provide a “wearable electronic device that is configured to provide an expansive feature set integrated or incorporated into a compact form factor.” EX1005, [0004]. Rothkopf further explains “a consumer product may integrate or combine multiple subsystems into a single device to provide a wide range of functionality, including biometric sensing.” *Id.*

168. A POSITA would be motivated to use the teachings of Paulke to implement the carrier assembly taught by Rothkopf. A POSITA would position the electrodes as taught by Paulke in order to maintain contact with the user’s skin. EX1007, 6:5-7. A POSITA would have a reasonable expectation of success as the combination is a basic rearrangement of compatible components in a predictable way to obtain a predictable result. Paulke’s carrier structure is similar in size and purpose to the carrier structure of Rothkopf and Paulke teaches a POSITA how to incorporate electrodes on a carrier structure as expressly suggested by Rothkopf. Accordingly, success in making the combination would have been expected. A POSITA would combine the references to arrive at the sensor arrangement shown below:



- c) **Limitation 9h-j** “an optical sensor system comprising: an optical emitter positioned below a first region of the carrier member; and an optical receiver positioned below a second region of the carrier member”

169. Rothkopf teaches this limitation as explained above with regard to limitation 9h-j of Ground 1. Paulke also teaches a biosensor module carrier. Paulke states that any “suitable number and/or type(s) of biosensors may be included in the biosensor module, such as but not limited to ... electrocardiography, ... optical reflectance of blood vessels, oxygen saturation sensors, etc.” and the wearable device may include a processor that may process physiological measurements (such as ECG). EX1007, 12:6-13, 6:11-13.

d) Limitation 9k

170. Rothkopf teaches this limitation as explained above with regard to limitation 9k of Ground 1.

e) Limitation 9l

171. Rothkopf teaches this limitation as explained above with regard to limitation 9l of Ground 1. Paulke also teaches a processor for processing the physiological measurements included in the wearable article. EX1007, 6:11-13.

172. For the reasons discussed above, a POSITA would have arrived at the limitations of Claim 9 based on Rothkopf and Paulke.

4. Claims 13-14

173. Rothkopf teaches this limitation as explained above with regard to Claims 13 and 14 respectively of Ground 1.

5. Claim 15

a) Limitation 15a-c

174. Rothkopf teaches this limitation as explained above with regard to Claim 15a-c of Ground 2.

b) Limitation 15d “a carrier assembly coupled to the housing member and comprising: a carrier member protruding outward from an external surface of the housing member”

175. Rothkopf teaches this limitation as explained above with regard to Claim 15d of Ground 2. Additionally, as shown in Fig. 1F of Paulke below (with annotations), Paulke teaches a carrier member protruding (red) outward from an external surface of a housing member (white).

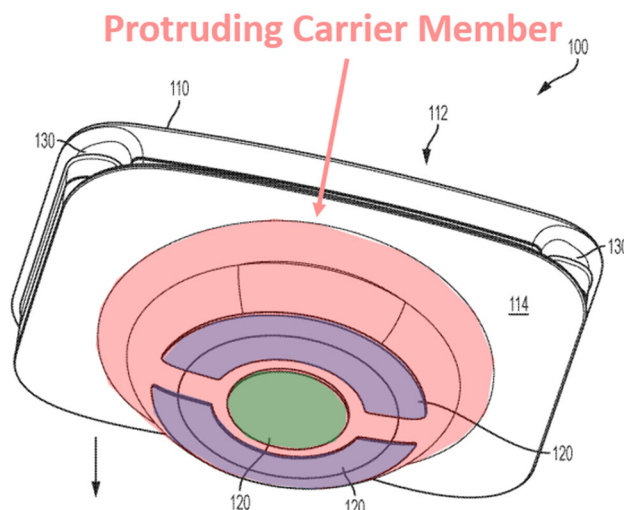


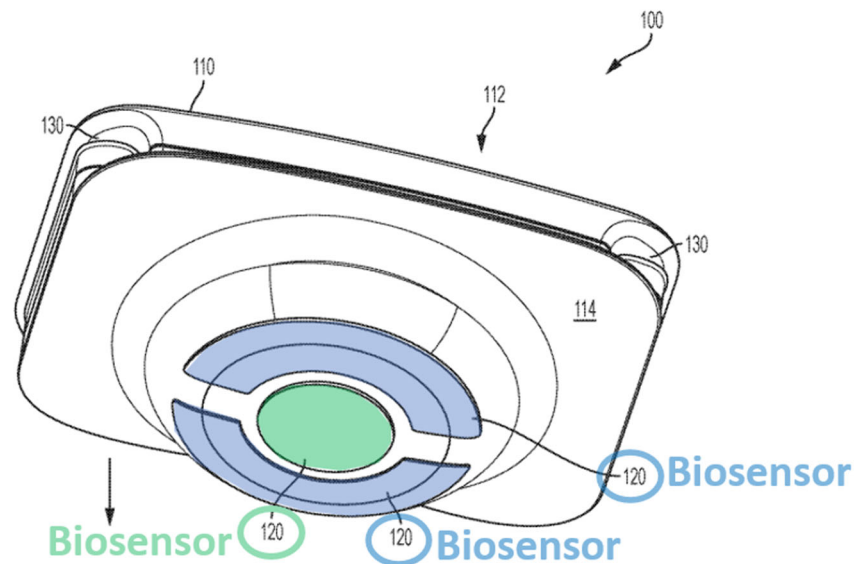
FIG. 1F

- c) **Limitation 15e “a rear electrode positioned on the carrier member, the rear electrode operably coupled to a processor and configured to detect a first voltage”**

176. Rothkopf teaches this limitation as explained above with regard to Claim 15e of Ground 2.

177. Paulke also teaches a biosensor module carrier. Paulke states that any “suitable number and/or type(s) of biosensors may be included in the biosensor module, such as but not limited to ... electrocardiography, ... optical reflectance of blood vessels, oxygen saturation sensors, etc.” and the wearable device may include a processor that may process physiological measurements (such as ECG). EX1007, 12:6-13, 6:11-13. Fig. 1F of Paulke, reproduced with annotations below, shows an arrangement for three biosensors 120. Paulke suggests, for example, the two biosensors 120 (annotated in blue) may be first and second electrodes (such as for

galvanic or ECG measurements) and biosensor 120 (annotated in green) may be for optical reflectance of blood vessels or oxygen saturation (PPG). EX1007, 14:26-15:18.

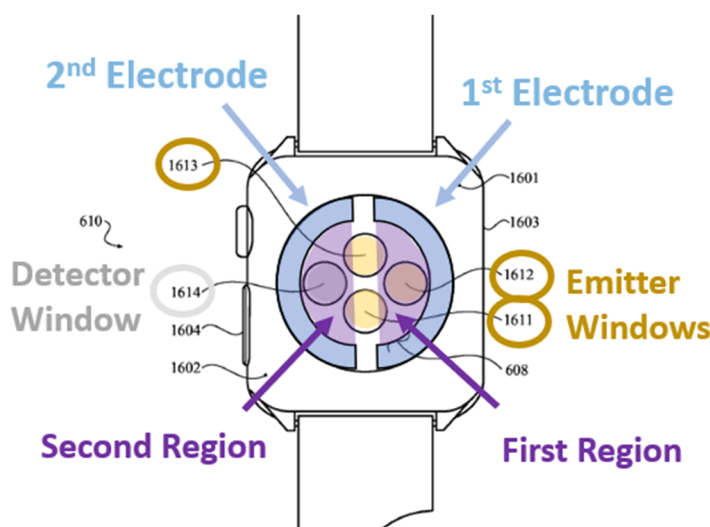


178. The illustrated embodiment above of the biosensor module of Paulke is located on the strap of a wrist-worn wearable device, and not housed in the wearable device, such as a watch. However, Paulke discloses that the “wearable article may be a wrist-worn watch.” EX1007, 6:16-17. A POSITA would have been motivated to incorporate the features of the Paulke design into the carrier of Rothkopf. Rothkopf itself, for example, teaches the desirability to provide a “wearable electronic device that is configured to provide an expansive feature set integrated or incorporated into a compact form factor.” EX1005, [0004]. Rothkopf further explains “a consumer product may integrate or combine multiple subsystems into a

single device to provide a wide range of functionality, including biometric sensing.”

Id.

179. A POSITA would be motivated to use the teachings of Paulke to implement the carrier assembly taught by Rothkopf. A POSITA would position the electrodes as taught by Paulke in order to maintain contact with the user’s skin. Paulke, 6:5-7. A POSITA would combine these references and arrive at the arrangement shown below:



A POSITA would have expected success in making this combination as it is a mere rearrangement of compatible components in a predictable way to obtain a predictable result. Paulke’s carrier structure is similar in size and purpose to the carrier structure of Rothkopf and Paulke teaches a POSITA how to incorporate electrodes on a carrier structure as expressly suggested by Rothkopf. Accordingly, success in making the combination would have been expected.

d) Limitation 15f-i

180. Rothkopf teaches this limitation as explained above with regard to Claim 15f-i of Ground 2.

181. For the reasons discussed above, a POSITA would have arrived at the limitations of Claim 15 based on Rothkopf and Paulke.

6. Claim 16

182. As explained above with regard to Claim 9 (limitations 9f; 9h-j) of Ground 3, Rothkopf in combination with Paulke teach all of the limitations of Claim 16 and a POSITA would have arrived at this claim.

7. Claim 19

183. As explained above with regard to Claim 5, Rothkopf in combination with Paulke teach the limitations of Claim 19 and a POSITA would have arrived at this claim.

H. Ground 3A: Claims 7 and 20 are unpatentable as obvious over Rothkopf and Paulke and further in view of Pei

184. For same reasons discussed above with regard to Claim 7 in Ground 2, Rothkopf and Paulke in combination with Pei teach all of the limitations of Claims 7 and 20 and a POSITA would have arrived at this claim.

I. Ground 3B: Claim 8 is unpatentable as obvious over Rothkopf and Paulke and further in view of Honda

185. For same reasons discussed above with regard to Claim 8 in Ground 2, Rothkopf and Paulke in combination with Honda teach all of the limitations of Claim 8 and a POSITA would have arrived at this claim.

J. Ground 3C: Claims 10-11 and 18 are unpatentable as obvious over Rothkopf and Paulke and further in view of Francis and Lapetina

186. For same reasons discussed above with regard to Claims 10-11 and 18 in Ground 2C, Rothkopf and Paulke in combination with Francis and Lapetina teach all of the limitations of Claims 10-11 and 18 and a POSITA would have arrived at these claims.

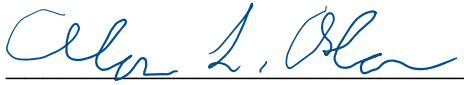
X. CONCLUSION

187. For at least the foregoing reasons, a person of ordinary skill in the art would have found Claims 1-20 of the '054 patent to be unpatentable.

188. I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: Feb. 23, 2023

By: Alan L. Oslan



Alan L. Oslan