

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.;
SAMSUNG ELECTRONICS AMERICA, INC.,
Petitioner

v.

OURARING, INC.
Patent Owner.

Case No. PGR2024-00030
U.S. Patent No. 11,868,178

**DECLARATION OF DR. BRIAN W. ANTHONY
IN SUPPORT OF PETITION FOR POST-GRANT REVIEW
OF U.S. PATENT NO. 11,868,178**

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I. INTRODUCTION

1. I have been retained by Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (collectively, “Samsung” or “Petitioner”), as an independent expert in this proceeding before the Patent Trial and Appeal Board (“PTAB” or “Board”). I understand that Samsung is requesting that the Board institute a post-grant review (“PGR”) proceeding of U.S. Patent No. 11,868,178 (“the ’178 Patent”) (Ex-1001), currently assigned to Ouraring Inc. (“Patent Owner” or “PO”).

2. I am not and have never been an employee of Samsung. I am being compensated at my usual and customary rate of \$500 per hour. No part of my compensation depends on the outcome of this proceeding, and I have no other interest in this proceeding.

3. I have been asked to provide my independent analysis of the ’178 Patent in light of the prior art publications cited below. I have also been asked to consider the state of the art and prior art available as of November 29, 2013. Based on the prior art discussed in this declaration, it is my opinion that Claims 1-18 of the ’178 Patent are unpatentable for the reasons provided below.

A. Qualifications

4. As indicated in my curriculum vitae (“CV”), included as Ex-1003, I am currently a Principal Research Scientist at the Massachusetts Institute of Technology (“MIT”). My CV includes additional information about my professional history and contains further details on my experience, publications, patents, and other qualifications to render an expert opinion. Herein, I highlight experiences relevant to the technology of the patent at issue.

5. I earned a Bachelor of Science in Engineering from Carnegie Mellon University in 1994 and a Master’s degree in Engineering from MIT in 1998. My thesis topic related to anisotropic wave guides and acoustic non-destructive testing. In 2006, I earned my Ph.D. in Engineering from MIT. My research focused on high-performance computation, signal processing, and electro-mechanical system design.

6. In 1997, I co-founded Xcitex Inc., a company that specialized in video-acquisition and motion-analysis software. I served as the Chief Technology Officer and directed and managed product development until 2006. Our first demo-product was an optical ring for human motion measurement used to capture user hand motion in order to control the user’s interaction with a computer. Many of the structural elements of our optical ring—developed nearly a decade prior to the ’178 Patent’s earliest possible priority date—addressed the same system issues as those described

and claimed in the '178 Patent. For example, our optical ring included optical structures for light blocking, light redirection, and light capture. We estimated human hand-motion based on how that motion changed the detected light. In our application we did not try to eliminate motion artifact, we tried to measure it. In developing our ring, we considered well-known problems such as extraneous light and motion, which are, unsurprisingly, also discussed in the '178 Patent.

7. I joined MIT in 2006 and have been the Director of the Master of Engineering in Advance Manufacturing and Design Program for over ten years. The degree program covers four main components—Manufacturing Physics, Manufacturing Systems, Product Design, and Business Fundamentals. Many of the courses, projects, and papers my students undertake involve technologies relevant to the '178 Patent, for example, sensor devices including non-invasive biosensors.

8. In 2011, I co-founded MIT's Medical Electronic Device Realization Center ("MEDRC") and currently serve as co-director. I am also the Director Technical Operation of the Center for Clinical and Translational Research (CCTR) at the Institute of Medical Engineering & Science, and Associate Director of MIT.nano at MIT. The MEDRC aims to create and deploy revolutionary medical technologies by collaborating with clinicians, the microelectronics, and medical devices industries. We combine expertise in computation; communications; optical,

electrical, and ultrasound sensing technologies; and consumer electronics. We focus on the usability and productivity of medical devices using, for example, image and signal processing combined with intelligent computer systems to enhance practitioners' diagnostic intuition. Our research portfolio includes low power integrated circuits and systems, big data, micro electro-mechanical systems, bioelectronics, sensors, and microfluidics. Specific areas of innovation include wearable, non-invasive and minimally invasive optical biosensor devices, medical imaging, laboratory instrumentation, and the data communication from these devices and instruments to healthcare providers and caregivers. My experience with these devices is directly applicable to the technology in the '178 Patent. For example, one current project related to this work is in laser-ultrasound imaging and tissue characterization. In this work, an eye and skin safe pulsed laser beam is directed at the body and reflected and transmitted signals are used to map internal tissue structures. In another current project, we use a patient-mounted mobile near infrared (NIR) camera to image and characterize the surface and subsurface structures of the skin.

9. Furthermore, my research focuses on computational instrumentation, including the development of instrumentation and measurement solutions for manufacturing systems and medical devices. Additionally, my teaching interests

include the design and modeling of large-scale systems in a wide variety of decision-making domains and developing optimization algorithms and software for analyzing and designing such systems. I teach or have taught courses in Electrical Engineering, Controls, Optics, Communications, and Signal Processing, all pertinent subject matter to the '178 Patent. I teach or have taught courses in Manufacturing Engineering, Smart Manufacturing, Industrial Internet of Things all pertinent subject matter to the '178 Patent.

10. I also co-founded the Center for Polymer Micro-fabrication at MIT. The Center's research focuses on polymer-based manufacturing processes and the large-scale commercialization of micro fluidic devices for chemical, biomedical, and photonic applications. My experience under these initiatives is directly applicable to the technology in the '178 Patent. We develop polymer based devices and sensors and use noninvasive monitoring techniques during the manufacturing process.

11. I have published approximately 100 papers, and have received a number of best paper and distinguished paper awards. I am a co-author of a number of papers that relate to the technology in the '178 Patent, such as:

- Ranger, Bryan J.; Feigin, Micha; Pestrov, Nikita; Zhang, Xiang; Lempitsky, Victor; Herr, Hugh M.; Anthony, Brian W., "Motion compensation in a tomographic ultrasound imaging system: Toward

volumetric scans of a limb for prosthetic socket design,” 2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), pp. 7204-7207;

- Shih-Yu Sun, Matthew Gilbertson, and Brian W. Anthony, “Probe Localization for Freehand 3D Ultrasound by Tracking Skin Features,” Book Section, Medical Image Computing and Computer-Assisted Intervention, MICCAI 2014, Springer, 2014, Vol. 8674. Lecture Notes in Computer Science, pp. 365-372;
- J. H. Lee, C. M. Schoellhammer, G. Traverso, D. Blankschtein, R. Langer, K. E. Thomenius, D. S. Boning, B. W. Anthony, “Towards Wireless Capsule Endoscopic Ultrasound (WCEU),” IEEE International Ultrasonics Symposium (IUS), Chicago, IL, 2014, pp. 734-737; and
- Zakrzewski, A., Anthony, B. W., “Quantitative Elastography and its Application to Blood Pressure Estimation: Theoretical and Experimental Results,” 2013 IEEE Engineering in Medicine and Biology Society (EMBC), pp. 1136-1139.

B. Materials Considered

12. In forming my opinions, I reviewed the following documents, in addition to others I have cited in my declaration. I also relied on my own knowledge of and experience in the field of mechanical engineering, biomedical engineering, optical engineering, the development of physiological monitoring devices such as non-invasive biosensors, sensor system design and signal processing.

Ex. No.	Description
Ex-1001	U.S. Patent No. 11,868,178 (“the ’178 Patent”)
Ex-1004	Prosecution History of U.S. Patent No. 11,868,178
Ex-1005	U.S. Patent Publication No. 20120016245 to Niwa (“Niwa”)
Ex-1006	U.S. Patent No. 8,954,135 to Yuen (“Yuen”)
Ex-1007	U.S. Patent No. 10,303,867 to Schröder (“Schröder”)
Ex-1008	Certified Translation of DE 102013012339.9 to Schröder
Ex-1009	Original DE 102013012339.9 to Schröder
Ex-1010	U.S. Patent Publication No. 20140244009 to Mestas (“Mestas”)
Ex-1011	U.S. Provisional Patent Application No. 61/768,279 to Mestas
Ex-1012	U.S. Patent No. 8,700,111 to LeBoeuf (“LeBoeuf”)
Ex-1013	U.S. Patent Publication No. 20120218184 to Wissmar (“Wissmar”)
Ex-1014	INTENTIONALLY LEFT BLANK
Ex-1015	INTENTIONALLY LEFT BLANK
Ex-1016	INTENTIONALLY LEFT BLANK

Ex. No.	Description
Ex-1017	INTENTIONALLY LEFT BLANK
Ex-1018	INTENTIONALLY LEFT BLANK
Ex-1019	INTENTIONALLY LEFT BLANK
Ex-1020	Claim Mapping Table
Ex-1021	INTENTIONALLY LEFT BLANK
Ex-1022	Parallel Citations (Schröder '867 to Certified Translation of DE 102013012339.9)
Ex-1023	<i>Dynamic Drinkware</i> -type analysis for Mestas
Ex-1024	U.S. Patent No. 4,830,014 to Goodman (“Goodman”)
Ex-1025	U.S. Patent No. 6,745,061 to Hicks (“Hicks”)
Ex-1026	U.S. Patent No. 7,190,986 to Hannula (“Hannula”)
Ex-1027	Volker Konig et al., <i>Reflectance Pulse Oximetry – Principles and Obstetric Application in the Zurich System</i> , 14 Journal of Clinical Monitoring (Aug. 1998) (“Konig”)
Ex-1028	U.S. Patent No. 6,608,562 to Kimura (“Kimura”)
Ex-1029	Kevin K. Tremper et al., <i>Pulse Oximetry</i> , 70 Journal of American Society of Anesthesiologists, Inc. (Jan. 1989) (“Tremper”)
Ex-1030	Y. Mendelson et al., <i>A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring</i> , Proceedings of 28 th IEEE EMBS Annual International Conference (Aug. 30-Sept. 3, 2006) (“Mendelson 2006”)
Ex-1031	Sokwoo Rhee et al., <i>Artifact-Resistant, Power-Efficient Design of Finger-Ring Plethysmographic Sensors Part I: Design and Analysis</i> , IEEE (2000) (“Rhee 2000 Part I”)

Ex. No.	Description
Ex-1032	Sokwoo Rhee et al., <i>Artifact-Resistant, Power-Efficient Design of Finger-Ring Plethysmographic Sensors Part II: Prototyping and Benchmarking</i> , IEEE Proceedings of 22 nd Annual EMBS Int'l Conference (July 23-28, 2000) ("Rhee 2000 Part II")
Ex-1033	Sokwoo Rhee et al., <i>Artifact-Resistant Power-Efficient Design of Finger-Ring Plethysmographic Sensors</i> , 48 IEEE Transactions of Biomedical Engineering (July 2001) ("Rhee 2001")
Ex-1034	U.S. Patent No. 6,699,199 to Asada ("Asada '199")
Ex-1035	Sokwoo Rhee, <i>Design and Analysis of Artifact-Resistive Finger Photoplethysmographic Sensors for Vital Sign Monitoring</i> , MIT (June 2000) ("Rhee Thesis 2000")
Ex-1036	C.T. Olofson et al., <i>Machining of Titanium Alloys</i> (1965) ("Olofson")
Ex-1037	H. Harry Asada et al., <i>Mobile Monitoring with Wearable Photoplethysmographic Biosensors</i> , IEEE Engineering in Medicine & Biology Magazine 28 (May-June 2003) ("Asada 2003")
Ex-1038	Denisse Castaneda et al., <i>A review on wearable photoplethysmography sensors and their potential future applications in health care</i> , Int J Biosens Bioelectron (2018)
Ex-1039	U.S. Patent No. 7,468,036 to Rulkov et al. ("Rulkov")
Ex-1040	U.S. Patent Publication No. 2006/0211924 to Dalke et al. ("Dalke")
Ex-1041	<i>Guidelines To Enhancing The Heart-Rate Monitoring Performance Of Biosensing Wearables</i> (2014)
Ex-1042	U.S. Patent No. 4,880,304 to Jaeb et al. ("Jaeb")
Ex-1043	Tom Lister et al., <i>Optical Properties of human skin</i> , Journal of Biomedical Optics (2012)

Ex. No.	Description
Ex-1044	John G. Webster, <i>Design of Pulse Oximeters</i> , CRC Press (1997)
Ex-1045	U.S. Patent Publication No. 20130211291 to Tran (“Tran”)
Ex-1046	WO 2001/017421A1 to Lindberg (“Lindberg”)
Ex-1047	WO 2011/132009 to Nyiradi (“Nyiradi”)
Ex-1048	U.S. Patent Application Publication No. 2014/0361945 to Misra et al. (“Misra”)
Ex-1049	U.S. Patent Application Publication No. 2014/0361934 to Ely et al. (“Ely”)
Ex-1050	European Patent No. 2281205 (Chen)
Ex-1051	Lawrence K. Au et al., <i>Episodic Sampling: Towards Energy-Efficient Patient Monitoring with Wearable Sensors</i> , Annual International Conference of the IEEE Engineering in Medicine and Biology Society (2009)
Ex-1052	Anastasios Petropoulos et al., <i>Flexible PCB-MEMS flow sensor</i> , Procedia Engineering 47 236-239 (2012) (“Petropoulos”)
Ex-1053	Tianjia Sun et al., <i>Wireless Power Transfer for Medical Microsystems</i> , Springer (2013) (“Sun”)
Ex-1054	U.S. Patent Pub. No. 2014/0187160 to Prencipe (“Prencipe”)
Ex-1055	H. Ardebili and Michael G. Pecht, <i>Encapsulation Technologies for Electronic Applications</i> , William Andrew (2009) (“Ardebili”)
Ex-1056	Ciprian Ciofu et al., Injection and Micro Injection of Polymeric Plastics Materials: A Review, Int’l J. Modern Mfg. Techs. 49 (2013)

Ex. No.	Description
Ex-1057	Richard J. Ross, LCP Injection Molded Packages—Keys to JEDEC 1 Performance, IEEE, 2004 Electronic Components and Technology Conference 1807 (2004)
Ex-1058	Tadamoto Sakai, Encapsulation Process for Electronic Devices Using Injection Molding Method, 12 Advances in Polymer Technology 61 (1993)
Ex-1059	N.J. Teh et al., Embedding of Electronics within Thermoplastic Polymers using Injection Moulding Technique, IEEE, 2000 Int'l Electronics Manufacturing Technology Symposium 10 (2000)
Ex-1060	U.S. Patent No. 6,201,698 to Hunter (“Hunter”)
Ex-1061	U.S. Patent No. 4,012,629 to Simms (“Simms”)

II. LEGAL STANDARDS

13. I am not an attorney and offer no legal opinions. For the purposes of this Declaration, I have been informed about certain aspects of the law that are relevant to my analysis, as summarized below.

14. I understand that earlier publications and patents may act to render a patent unpatentable for one of two reasons: (1) obviousness and (2) indefiniteness.

A. Claim Construction

15. As explained to me by counsel, claims are to be interpreted according to the *Phillips* claim construction standard. I understand that under this standard, the meaning of claim terms is considered from the viewpoint of a POSITA at the time

of the alleged invention. I have been informed and understand that claim construction is a matter of law and that the final claim constructions for this proceeding will be determined by the PTAB.

16. As explained to me by counsel, I have been informed that claim terms are generally given their ordinary and customary meaning as understood by one of ordinary skill in the art in light of the specification and the prosecution history pertaining to the patent. I understand, however, that claim terms are generally not limited by the embodiments described in the specification.

17. I understand that in addition to the claims, specification, and prosecution history, other evidence may be considered to ascertain the meaning of claim terms, including textbooks, encyclopedias, articles, and dictionaries. I have been informed that this other evidence is often less significant and less reliable than the claims, specification, and prosecution history.

B. Level of Ordinary Skill in the Art

18. When interpreting a patent, I understand that it is important to identify the relevant art pertaining to that patent, as well as the level of ordinary skill in that art at the time of the claimed invention. The “art” is the field of technology to which the patent is related.

19. I am informed and understand that the POSITA is a hypothetical person who is presumed to know the relevant prior art. I understand that the actual inventor's skill is not determinative of the level of ordinary skill. I further understand that factors that may be considered in determining level of skill include: (i) the types of problems encountered in the art; (ii) prior art solutions to those problems; (iii) the rapidity with which innovations are made; (iv) the sophistication of the technology; and (v) the educational level of active workers in the field. I understand that not all such factors may be present in every case, and one or more of them may predominate.

20. I understand that a POSITA is one who is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity.

21. A person of ordinary skill in the art at the relevant time ("POSITA") would have had at least a four-year degree in electrical engineering, mechanical engineering, biomedical engineering, optical engineering, or related field of study, or equivalent experience, and at least two years' experience in academia or industry studying or developing physiological monitoring devices such as non-invasive biosensors. A POSITA would have also been familiar with, for example, sensor

system design and signal processing. A higher level of education or skill might make up for less experience, and vice versa.

22. Based on my knowledge, skill, and experience, I have an understanding of the capabilities of a person of ordinary skill in the relevant art. For example, from my industry experience, I am familiar with what an engineer designing non-invasive biosensors would have known and found predictable in the art. From teaching and supervising my post-graduate students, I also have an understanding of the knowledge that a person with this academic experience possesses. Furthermore, I possessed the knowledge of a POSITA myself at least as of 1997.

C. Obviousness

23. As explained to me by counsel, I understand that a patent claim is obvious under 35 U.S.C. § 103, and therefore invalid, if the claimed subject matter, as a whole, would have been obvious to a POSITA as of the priority date of the patent based on one or more prior art references and/or the knowledge of a POSITA.

24. I understand that an obviousness analysis must consider (1) the scope and content of the prior art, (2) the differences between the claims and the prior art, (3) the level of ordinary skill in the pertinent art, and (4) secondary considerations, if any, of non-obviousness (such as unexpected results, commercial success, long felt but unmet need, failure of others, copying by others, and skepticism of experts).

25. As explained to me by counsel, I understand that a prior art reference may be combined with other references to disclose each element of the invention under 35 U.S.C. § 103. I understand that a reference may also be combined with the knowledge of a POSITA, and that this knowledge may be used to combine multiple references. I further understand that a POSITA is presumed to know the relevant prior art. I understand that the obviousness analysis may take into account the inferences and creative steps that a POSITA would employ.

26. In determining whether a prior art reference would have been combined with other prior art or other information known to a POSITA, I understand that the following principles may be considered:

- whether the references to be combined involve non-analogous art;
- whether the references to be combined are in different fields of endeavor than the alleged invention in the Patent;
- whether the references to be combined are reasonably pertinent to the problems to which the inventions of the Patent are directed;
- whether the combination is of familiar elements according to known methods that yields predictable results;
- whether the combination involves the substitution of one known element for another that yields predictable results;

- whether the combination involves the use of a known technique to improve similar items or methods in the same way that yields predictable results;
- whether the combination involves the application of a known technique to a prior art reference that is ready for improvement, to yield predictable results;
- whether the combination is “obvious to try”;
- whether the combination involves the known work in one field of endeavor prompting variations of it for use in either the same field or a different one based on design incentives or other market forces, where the variations are predictable to a POSITA;
- whether there is some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill in the art to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention;
- whether the combination requires modifications that render the prior art unsatisfactory for its intended use;
- whether the combination requires modifications that change the principle of operation of the reference;
- whether the combination is reasonably expected to be a success; and
- whether the combination possesses the requisite degree of predictability at the time the invention was made.

27. I understand that in determining whether a combination of prior art references renders a claim obvious, it is helpful to consider whether there is some teaching, suggestion, or motivation to combine the references and a reasonable expectation of success in doing so. I understand, however, that a teaching, suggestion, or motivation to combine is not required.

D. Indefiniteness

28. As explained to me by counsel, I have been informed and understand that a patent claim is indefinite and therefore invalid if the claim, read in light of the patent specification and the prosecution history, fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention. I understand that claims must particularly and distinctly set out what is claimed so that the public has fair notice of the claimed invention. I also understand that each term in a claim must find clear support or antecedent basis in the specification.

III. SUMMARY OF GROUNDS

29. I understand that Petitioner challenges the validity of Claims 1-18 of the '178 Patent. It is my opinion that the following grounds demonstrate that the claims of the '178 Patent are invalid.

Ground	Summary
1	Claims 1-3 and 17-18 are obvious over Schröder (Ex-1007).
2	Claims 1-3 and 13-16 are obvious over Schröder in view of Niwa (Ex-1005).
3	Claims 3 and 12 are obvious over Schröder in view of Mestas (Ex-1010).
4	Claims 1, 4-11 and 13-16 are obvious over Schröder in view of Yuen (Ex-1006).
5	Claims 1-3 and 13-18 are obvious over Niwa.
6	Claims 1-3 and 13-18 are obvious over Niwa in view of Schröder.
7	Claim 12 is obvious over Niwa in view of Mestas.
8	Claim 12 is obvious over Niwa-Schröder in view of Mestas.
9	Claims 4-11 are obvious over Niwa in view of Yuen.
10	Claims 4-11 are obvious over Niwa-Schröder in view of Yuen.

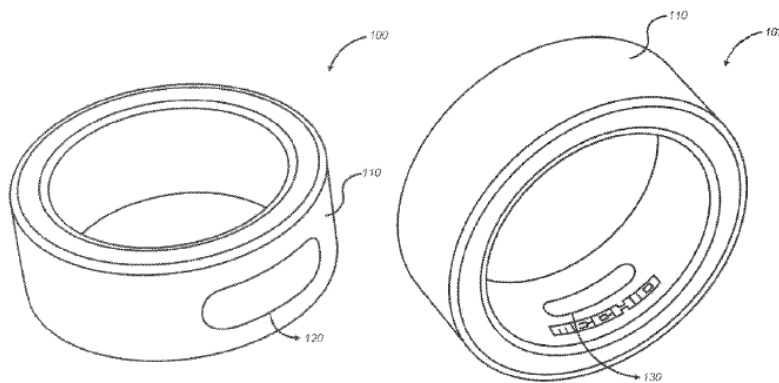
Ground	Summary
11	Claims 11 and 17-18 are invalid under 35 U.S.C. §112.

IV. THE '178 PATENT

A. Overview of the '178 Patent

30. The challenged claims of the '178 Patent are directed to a finger-worn electronic device. The '178 Patent touts the convenience and versatility of wearable electronics. Ex-1001, 1:39-42. The patent suggests that the prior art wearable devices were uncomfortable or intrusive and proposes a wearable electronic device “in the shape of a ring” that allows a user to wear a device for an extensive period of time. *Id.*, 1:50-55.

31. An example of a finger-worn electronic device is illustrated on the cover of the '178 Patent (which corresponds to Figures 1A-1B). As shown below, the ring has an interior wall facing the skin. *Id.*, 11:20.



32. All challenged claims require a finger-worn wearable ring device. Independent Claim 1 recites “a finger-worn wearable ring device” with an external housing defining the outer circumferential surface, an internal housing defining an inner circumferential surface, a battery, a printed circuit board or “PCB”,¹ and one or more sensors. Claim 1 also requires “a cavity formed between the internal housing component and the external housing component.” The battery and PCB are located in the cavity.

33. The ’178 Patent recognizes that wearable electronic devices had “many applications for the wearer” and “help[ed] monitor activity within the wearer’s body.” *Id.*, 1:39-42. The patent suggests that its claimed device is inventive and patentable because the device allegedly overcomes the disadvantages of other wearable devices and can be worn for extended periods of time and can perform measurements on the finger. *Id.*, 1:50-55. As explained below, all of the claimed features are described in the prior art and the ’178 Patent claims are obvious in view of the prior art.

¹ See https://en.wikipedia.org/wiki/Printed_circuit_board (PCB refers to “printed circuit board”).

B. Prosecution History of the '178 Patent

34. I understand that the '178 Patent was filed as U.S. Application No. 18/323,385 (“the '385 Application”) and issued on January 9, 2024. Ex-1001, Cover. Patent Owner later filed and was granted a Certificate of Correction to correct Claim 17’s “a cavity” to “the cavity.” Ex-1004, 1363.

35. I further understand that the '178 Patent File History has been submitted as Ex-1004. The '385 Application was filed on May 24, 2023, claiming priority to two provisional applications, U.S. Application No. 62/006,835, filed June 2, 2014, and U.S. Application No. 61/910,201, filed November 29, 2013.

36. I understand that the earliest alleged priority date for the '178 Patent is November 29, 2013. I understand that assuming this earliest date, all prior art references asserted in this petition as invalidating references are prior art.

37. The Examiner allowed '178 Patent because “the prior art does not disclose nor suggest a finger-worn ring device with internal and external housing components, an inner circumferential cavity with a battery positioned and shaped to fit inside the cavity and including a circuit board disposed within the interior and exterior component and extending through a portion of the cavity.” Ex-1004, 1314. However, this was well-known in the art, as shown below.

38. None of the combinations relied upon in the Petition was before the Examiner during the prosecution of the '178 Patent.

39. The '178 Patent was allowed based on the applicant's arguments and Examiner's agreement that "the prior art does not disclose nor suggest a finger-worn ring device with internal and external housing components, an inner circumferential cavity with a battery positioned and shaped to fit inside the cavity and including a circuit board disposed within the interior and exterior component and extending through a portion of the cavity" (*see* Ex-1004, 1314), yet Schröder and Niwa each teach a wearable electronic ring device with a cavity defined by internal and external housing that houses a battery and a circuit board. In sum, the grounds presented in the Petition are material and not cumulative of previous art considered by the Examiner.

40. In my opinion, the Examiner erred by overlooking the clear and unambiguous teachings of Yuen. That is because Yuen clearly teaches the additional features of Dependent Claims 4-11 of the '178 Patent. Although Yuen was listed in the Information Disclosure Statement, the record is silent as to the Examiner's consideration or understanding of Yuen's teachings.

41. As I explain in detail below, the '178 Patent's claims would have been obvious in view of the prior art.

V. TECHNOLOGY BACKGROUND

A. Wearable Electronic Devices Were Known

42. Wearable electronic devices, along with the various design challenges they posed and the solutions proposed to address these challenges, were well-known to a POSITA by 2013. For example, it was known by 2013 that wearable photoplethysmographic biosensors could be used for the monitoring, diagnosis, and treatment of major and chronic diseases “by providing information enabling precise titration of therapy or detecting lapses in patient compliance.” Ex-1037, 28 (Asada 2003). Wearable biosensor devices were known to be useful in “sensing untreated elevated blood pressure” and “trigger[ing] an automated reminder for the patient to take...medication.” Ex-1037, 28 (Asada 2003); *see also* Ex-1030, 912 (Mendelson 2006) (“[T]he emerging development of compact, low-power, small-size, light-weight, and unobtrusive wearable devices may facilitate remote noninvasive monitoring of vital signs[.]”).

43. Wearable electronic devices in the form of a finger-ring structure were also known by 2013. For example, Harry Asada and his group at MIT developed a ring sensor by 2003 that was “capable of reliably monitoring a patient’s heart rate, oxygen saturation, and heart rate variability.” Ex-1037, 28 (Asada 2003); *see also* Ex-1034, 1:20-24 (Asada ’199) (“Finger-ring sensors may be employed, for

example, for monitoring such physiological parameters as blood flow, blood constituent concentration, and pulse rate, all of which may be measured by other means that are more cumbersome, and thus less comfortable, to a patient.”), 2:51-56 (“For purposes of the present description, the sensor will be referred to, without limitation, as a ring sensor, and the sensing modality, again without limitation, will be described in terms of a photoplethysmographic device for measuring a pulse using optical elements such as infrared light-emitting diodes (LEDs) and photodiodes.”). The prototypes of Asada’s finger-ring as of 2003 are depicted below. Ex-1037, Figs. 9-10, 15 (Asada 2003).

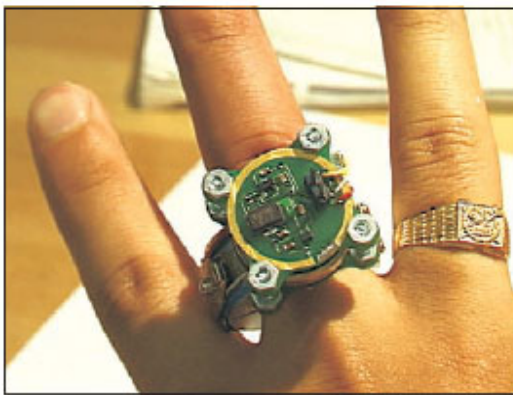


Fig. 9. First prototype ring sensor with RF transmitter powered by a coin-size cell battery.

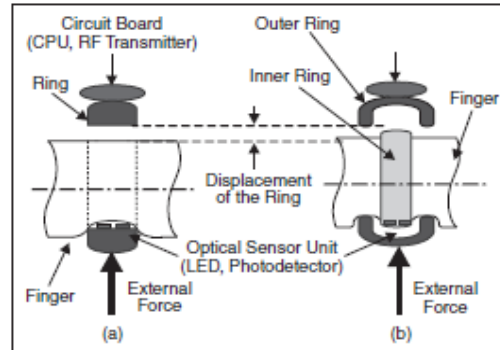


Fig. 10. Dislocation of ring sensors due to external load. (a) Traditional single-body design under external force. (b) New isolating double ring sensor under external force [31].

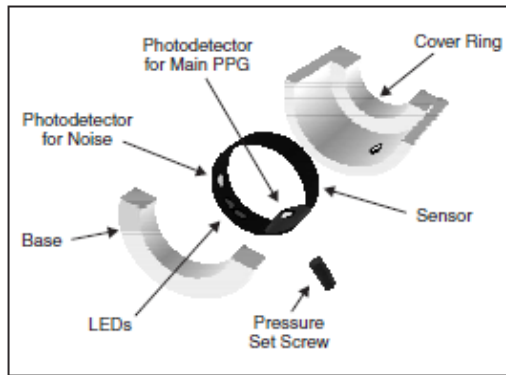


Fig. 15. The schematic of the Prototype C ring sensor.

44. Asada explains the motivations for implementing a wearable electronic device in the form of a ring, noting that “[c]ompactness, stability of signal, motion and other disturbance rejection, durability, data storage and transmission, and low power consumption” are “major design considerations.” Ex-1037, 28 (Asada 2003). He further notes that “[i]t is imperative that they are simple to use and comfortable to wear for long periods of time.” Ex-1037, 28 (Asada 2003). Moreover, he explains that “[s]ince continuous monitoring requires a device that must be noninvasive and worn at all times, a ring configuration for the sensor unit is a natural choice” because of its “low weight and small size,” and “rings are generally worn without removal more often than watches.” Ex-1037, 28 (Asada 2003). He also notes that recent studies “indicated that the finger is one of the best places for WBS sensor attachment” because “[t]he primary vasculature of the finger is located near the surface and therefore makes it optimal for monitoring arterial blood flow using noninvasive optoelectronic sensors,” thus making it “ideal for long-term

measurements.” Ex-1037, 30 (Asada 2003); *see also* Ex-1034, 1:20-24 (Asada ’199) (“A sensor worn as a finger ring sensor has particular advantages since a ring sensor may be worn by the patient at all times, hence the health status may be monitored 24 hours a day.”).

45. Asada explains that “[a]n obvious source of signal corruption results from the direct interaction of the sensor unit with the wearer’s surrounding environment; e.g., holding objects, touching surfaces, etc.” Ex-1037, 34 (Asada 2003). Therefore, “the body of the ring must separate the sensor unit in order to decouple the sensor unit from these interactions.” Ex-1037, 34 (Asada 2003). He therefore designed and implemented “a double ring configuration” such that “[t]he disturbance force is born by the outer ring and is not transmitted to the inner ring holding the sensor unit” and “the outer ring serves as an optical shield for protecting the sensor unit from the ambient light.” Ex-1037, 34 (Asada 2003).

46. Asada and his group also built and field-tested a transmittal PPG [photo-plethysmograph] ring sensor “[t]o improve motion artifact resistance and accuracy.” Ex-1037, 35 (Asada 2003). He redesigned a sensor band using “bio-compatible elastic materials to better hold the LED[s] and PD[s], maintain a proper level of pressure, optically shield the sensor unit, and secure the contact with the skin consistently in the face of finger motion,” resulting in a stable transmittal PPG.

Ex-1037, 35 (Asada 2003); *see also* Ex-1028, 1:13-16 (Kimura) (“This invention relates to a vital signal detecting apparatus for detecting a vital signal, having an attachable device to be attached for example to a finger, an ear, an arm, a leg, torso or a neck of a human subject.”).

47. Harry Asada’s graduate student, Sokwoo Rhee, also authored a thesis and a number of articles between 2000 and 2001 detailing the design, analysis, prototyping, and benchmarking, of finger-ring plethysmographic sensors. *See, e.g.*, Ex-1031 (Rhee 2000 Part I); Ex-1032 (Rhee 2000 Part II); Ex-1033 (Rhee 2001); Ex-1035 (Rhee Thesis 2000). Specifically, Rhee developed and presented “[a] miniaturized, telemetric, photoplethysmography sensor for long-term, continuous monitoring,” called “a ‘ring-sensor,’” which “is attached to a finger base for monitoring beat-to-beat pulsation, and the data is sent to a host computer via a RF transmitter.” Ex-1031, 1 (Rhee 2000 Part I); Ex-1032, 2796 (Rhee 2000 Part II); Ex-1033, 795 (Rhee 2001); Ex-1035, 14 (Rhee Thesis 2000). “The ring sensor is a miniaturized, telemetric, monitoring device worn by a patient as a finger ring.” Ex-1031, 1 (Rhee 2000 Part I); Ex-1035, 14 (Rhee Thesis 2000) (same); Ex-1033, 796 (Rhee 2001) (“This miniaturized sensor in a ring configuration is a rational design choice for 24-h continuous monitoring, since a finger ring is probably the only thing that a majority of people will be willing to wear at all times.”).

48. Rhee's thesis and papers address two major design issues: "one is to minimize motion artifact and the other is to minimize the consumption of battery power." Ex-1031, 1 (Rhee 2000 Part I); Ex-1033, 795 (Rhee 2001); Ex-1035, 2 (Rhee Thesis 2000). "An efficient double ring design is developed to lower the influence of external force, acceleration, and ambient light, and to hold the sensor gently and securely on the skin, so that the circulation at the finger may not be obstructed." Ex-1031, 1 (Rhee 2000 Part I); Ex-1033, 795 (Rhee 2001); Ex-1035, 2 (Rhee Thesis 2000). The structural details of Rhee's finger-ring sensor are discussed in more detail in the sections below.

1. Photoplethysmography (PPG) sensors were well known

49. A plethysmograph is a device used to measure changes in volume within the body or a specific organ. This measurement can be applied in various medical contexts to monitor and diagnose conditions related to blood flow, respiratory function, and other physiological parameters.

50. One specific type of plethysmograph is the photo-plethysmograph (PPG), which utilizes optical techniques to detect blood volume changes in the microvascular bed of tissue. PPG devices typically use a light source and a photodetector to measure the variations in light intensity as it is transmitted through or reflected off the tissue. These variations are caused by the pulsatile nature of

blood flow, hence the name “plethysmograph,” referring to the measurement of volume changes.

51. Photoplethysmography (PPG) is a well-known optical measurement method for monitoring heart rate. Ex-1038. Popularity around using PPG technology as an alternative to heart rate monitoring techniques have increased “due to the simplicity of its operation, the wearing comfort ability for its users, and its cost effectiveness.” *Id.*, 0002. Wearable PPG sensors can be placed at the body locations shown in Figure 1. *Id.*, 0003, 0014.

52. PPG uses “a light source and a photodetector at the surface of skin to measure the volumetric variations of blood circulation.” *Id.*, 0001. “The light source emits light to a tissue and the photodetector measures the reflected light from the tissue.” *Id.*, 0003. Atypical PPG sensors emit light to “detect cardiovascular diseases.” *Id.*, 0005. The most common LED colors used are red and green while some studies have also used yellow. *Id.* PPG also utilizes “infrared light to measure the volumetric variations of blood circulation” which provides information about the user’s cardiovascular system. *Id.*, 0002. Near-infrared light can also be used for early detection of physiological parameters such as cardiovascular diseases. *Id.* This is because “[l]ight with longer wavelengths penetrates more deeply into the tissue.” *Id.*, 0005. However, infrared light is more susceptible to motion artifacts caused by

“movement of the PPG sensor over the tissue, skin deformation, blood flow dynamics, and ambient temperature.” *Id.* In that instance, green LEDs have a shorter wavelength and may be a better option. *Id.* Thus, a POSITA would have understood it would have been beneficial to use both visible LEDs and infrared LEDs to gather various physiological data helpful to the user.

2. Beer’s Law

53. Beer’s Law describes the relationship between the absorbance of light by a substance and its concentration. The equation is: $A = \epsilon \cdot b \cdot c$. Where: (A) represents the absorbance of light. (ϵ) is the molar absorptivity (a constant specific to the substance). (b) is the path length (the distance the light travels through the sample). (c) is the concentration of the absorbing substance.

54. Beer’s law “describes the attenuation of light traveling through a uniform medium containing an absorbing substance.” Ex-1044 (WebsterDesign), 0054, Fig. 4.1. “Pulse oximeters determine the oxygen saturation of arterial blood by measuring the light absorbance of living tissue at two different wavelengths and using the arterial pulsation to differentiate between absorbance of arterial blood and other absorbers.” *Id.*, 0058. For example, when light from LEDs enters the tissue, it is scattered by both the moving red blood cells and the nonmoving tissue, and a part of this back scattered light is detected by the photodiode. *Id.*, 0102. The output

of the photodiode is processed by the pulse oximeter and measures the oxygen saturation of the pulsatile blood. *Id.*

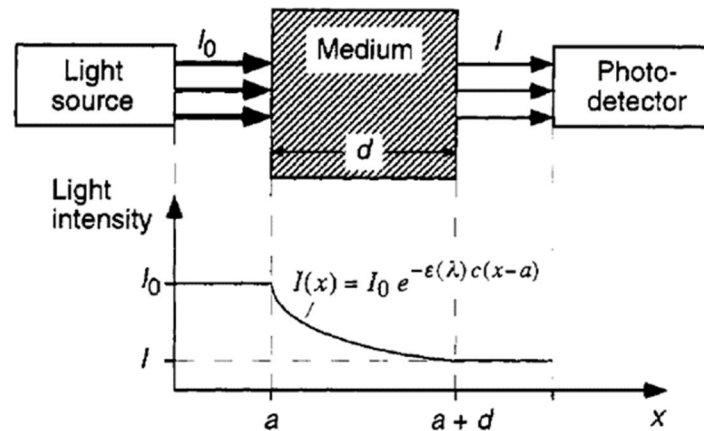


Figure 4.1 Beer's law: Incident light of intensity I_0 travels the distance a from a light source to the medium without being absorbed in the air. The light intensity decreases exponentially with distance in the absorbing medium. The intensity of the transmitted light I is determined by Beer's law. It stays constant after exiting the medium with optical path length d and can be measured by a photodetector.

55. The measured amount of oxygen in the blood differ from the results of the Beer's law theory because Beer's law does not assume light scattering but light scattering highly increases the absorbance of light. *Id.*, 0066. The skin surface, tissue, muscle, bone, and blood of the user causes light scattering which increases the absorbance of light. *Id.*, 0065. The intensity of the light scattered by the tissue “depends on such factors as the red blood cell concentration in the blood; on the size, shape, orientation, and index of refraction of the scattering particles; on the tissue thickness; and on the aperture cone of the detector.” *Id.*, 0066. Further, the

scattering effects of the light passing through blood depend on the wavelength of the light and the oxygen saturation. *Id.*, 0067.

3. Optical properties of human tissue

56. There are two biomolecules considered to dominate the absorption of visible light in skin: hemoglobin and melanin. Ex-1043 (Optical Properties), 0001. Hemoglobin is the dominant absorber of light in the dermis. *Id.* Melanin is a family of biomolecules that provide pigment to skin. *Id.*, 0001, Fig. 1. Melanin is generally contained within the “epidermis and produce[s] an absorption spectrum that gradually decreases from the ultraviolet (UV) to the infrared (IR) regions.” *Id.*, 0001. The optical properties of this layer result in absorption and scattering of light, which are characterized by the absorption and scattering coefficients. *Id.*, 0003. The absorption coefficient “characterizes the average number of absorption events per unit path length of photons traveling in the tissue.” Ex-1041 (Guidelines to enhancing), 0002. The absorption coefficient can also be calculated as a function of wavelength.

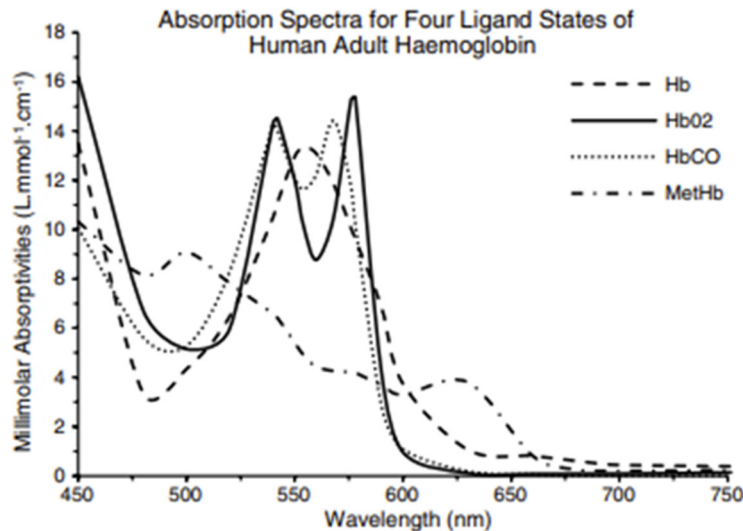


Fig. 1 Absorption spectra of deoxyhemoglobin (Hb), oxyhemoglobin (HbO₂), carboxyhemoglobin (HbCO), and methemoglobin (MetHb) in the visible region, from Ref. 27.

57. As shown in Figure 1, the peak absorption coefficients correspond to wavelengths around 540nm and 570nm. *Id.*, 0003. At the wavelength of around 540nm and 570nm, “the absorption change due to the blood volume change is the greatest and the photodiode measures the strongest pulsate signal.” *Id.*

4. Pulse oximetry and oxygen saturation (SpO₂)

58. Pulse oximetry measures peripheral arterial oxygen saturation (SpO₂) as an indicator of tissue oxygenation. How it works: Light at two different wavelengths (for example, 660 nm and 940 nm) illuminates oxygenated (oxyhemoglobin) and deoxygenated hemoglobin (deoxyhemoglobin) in blood. The ratio of light absorbance between these two forms of hemoglobin is calculated. This

ratio is compared with previously calibrated direct measurements of arterial oxygen saturation (SaO₂) to estimate peripheral SpO₂.

59. The calculation of arterial oxygen saturation (SpO₂) using a PPG involves analyzing the photoplethysmograph signal, which comprises both alternating current (AC) and direct current (DC) components. The AC component represents the pulsatile part of the signal, corresponding to the cardiac cycle, while the DC component represents the non-pulsatile part, including constant tissue and venous blood absorption.

60. To calculate SpO₂, the ratio of the AC to DC components of the PPG signal at two different wavelengths (typically red and infrared) is used. This ratio is indicative of the relative absorption of light by oxygenated hemoglobin (Oxy-Hb) and deoxygenated hemoglobin (Deoxy-Hb). By comparing these ratios at the two wavelengths, the proportion of Oxy-Hb to Deoxy-Hb can be determined.

61. The formula for calculating SpO₂ is derived from this ratio, often expressed as: $SpO_2 = (Oxy-Hb) / (Oxy-Hb + Deoxy-Hb) \times 100\%$.

5. Transmission of light as compared to the reflection of light

62. Light interacting with tissue at the microscale (wavelength scale) undergo absorption, reflection, or transmission.

63. Pulse oximetry devices, used to measure SpO₂, are designed to operate at the macroscale or sensor scale (emitter and detector scale) and are generally described as operating in two modes: transmission mode and reflection mode. Transmission Mode: In this mode, the light emitter and the detector are generally positioned on opposite sides of the tissue. Light from the emitter penetrates the tissue and takes a general path that passes through the tissue to the opposite side of the tissue, and the detector measures the light that has traversed the tissue. Reflection Mode: In this mode, both the light emitter and the detector are generally positioned on the same side of the tissue. Light from the emitter penetrates the tissue and takes a general path that passes through the tissue and back to the same side of the tissue, and the detector measures the light that has traversed the tissue.

64. From the perspective of light transmission through the tissue bed, there is no difference between these two modes. Once a photon has traveled a sufficient distance to lose its history (less than 1 mm in tissue for pulse oximetry wavelengths), it becomes irrelevant whether the detector is positioned opposite the emitter or on the same side. This is because, after traveling this distance, the photon's interactions with the tissue have caused it to diffuse in such a way that its path is randomized, and light is absorbed along whatever path the light takes.

65. Reflectance and transmission are best considered as practical design and manufacturing terms. They describe the physical arrangement of the emitters and detectors rather than any fundamental difference in the measurement process. Both geometries are used to measure the diffused absorption of light through a blood-perfused tissue bed, providing essential information about blood oxygen saturation levels.

66. Whether in transmission or reflection mode, pulse oximeters measure the same optical phenomena: the interaction of light with the blood and tissues. This interaction is key to determining oxygen saturation, as it relies on the differential absorption characteristics of oxygenated and deoxygenated hemoglobin

6. Multiple LEDs have been commonly used for biometric monitoring

67. Using multiple LEDs is beneficial to offset noise effects of ambient light and sunlight in real-time vital sign monitoring devices. For example, U.S. Patent No. 7,468,036 to Rulkov et al. (“Rulkov”) recommends a “greenlight LED and a pulsed infrared LED to offset noise affects of ambient light and sunlight.” Ex-1039, 6:56-58. Rulkov also uses multiple LEDs of green and infrared wavelengths, with a preferred embodiment in which the optical sensor includes “a plurality of light emitting diodes” (“LED”) based on green light, and further describes monitoring vital signs in which “the plurality of light emitting diodes comprises a plurality of

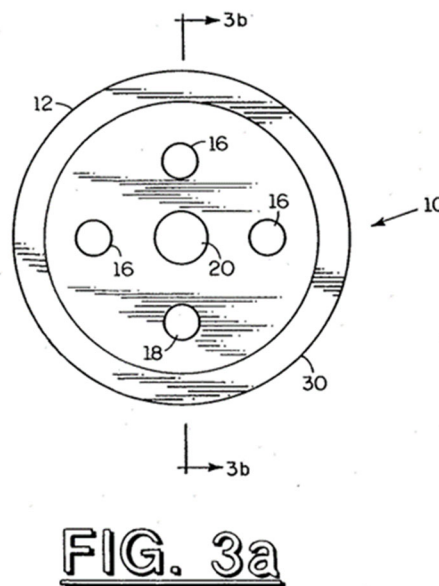
pulsed infrared light emitting diodes.” *Id.*, 6:49-58. A POSITA would have understood that multiple emitters each including multiple LEDs operating at different wavelengths advantageously provide “accurate” “real-time information to the user about the user’s health” by, for example, enabling offset of noise affects. *Id.*, 4:4-8.

68. U.S. Patent Publication No. 2006/0211924 to Dalke et al. (“Dalke”) also discloses the use of multiple spaced-apart LEDs operating at various wavelengths and/or intensities. Ex-1040. Dalke states “there can be any number of LED groups and any number of LEDs within a group” and further that such LEDs “may be grouped according to output intensity or wavelength or both.” Ex-1040 ¶ 75.

7. Separation distance between LEDs and the photodiode is a design consideration for the quality of the acquired data

69. From a system design and performance perspective, determining the ideal separation distance between the LEDs and photodiode is important. To enhance the quality of the plethysmogram signal one method includes placing the photodiode close to the LEDs. Ex-1041 (Guidelines to enhancing), 0005. However, if the photodiode is too close to the LEDs, the photodiode becomes saturated by measurements that do not relate to the heart signal of the user. *Id.* To have a constant LED intensity, “the total light detected by the photodiode decreases roughly

exponentially as the radial distance between the LEDs and the photodiode is increased.” *Id.* Thus, placing the photodiode farther apart from the LEDs can result in a plethysmogram with a larger signal that relates to the heart signals of the user. *Id.* As an example, U.S. Patent No. 4,880,304 to Jaeb et al. (“Jaeb”) uses this method and resolves the problem of low signal strength by placing its LEDs 16 and 18 in a radial pattern around detector 20 that detects the light of the LEDs. Ex-1042, 5:6-8.



B. Wearable Electronic Device Arrangements

70. In view of the various applications that wearable electronic devices can be used, there are various considerations that a POSITA must consider when designing a wearable electronic device. I have summarized only a few considerations of the electronic device arrangements below.

1. Wearable devices having inner and outer surfaces were known

71. Finger-ring structures having inner and outer surfaces with electronics housed inside within a cavity were known. For example, Rhee's thesis and papers teach a finger-ring sensor having inner and outer surfaces. Specifically, Rhee teaches, as shown in Figure 1 (Rhee 2000 Part II) and Figure 3 (Rhee 2001) below, that an "inner ring floats inside the outer ring" such that "[w]hen a patient wears the ring, both rings are put on the same finger." And, "[s]ince the outer ring covers the inner ring, the external force is born by the outer ring and does not directly act on the inner ring." Ex-1032, 2796 (Rhee 2000 Part II); Ex-1033, 799 (Rhee 2001); Ex-1035, 68 (Rhee Thesis 2000) (same).

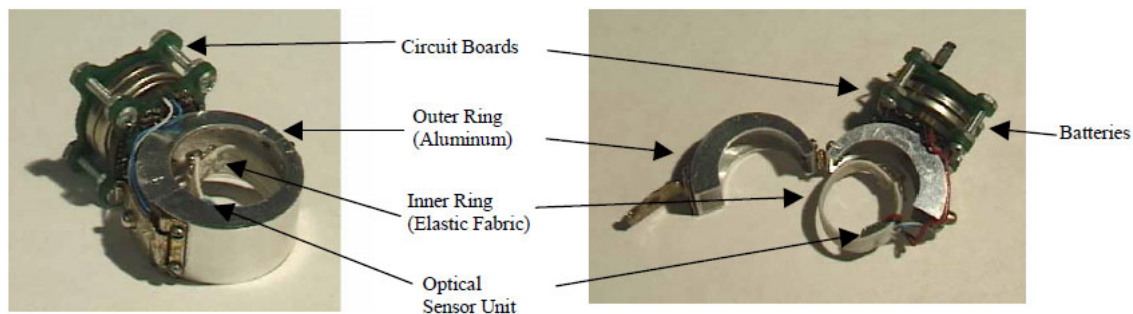


Figure 1 : Isolating ring sensor designed for motion artifact minimization

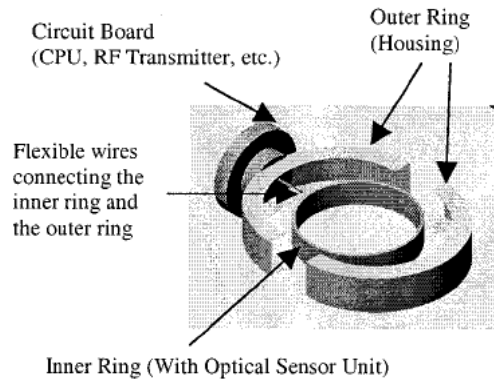


Fig. 3. Construction of isolating ring.

2. Various ways to assemble electronic parts within structural cavities were known

72. The formation of cavities, whether by single-structure formation or multi-structure assembly techniques, is essential for integrating electronic components, cabling, batteries, PCBs, and assemblies into the interiors and exteriors of mechanical surfaces, structures, and frames. This is crucial in the manufacturing of electromechanical devices ranging from cars and computer interface devices to phones, toys, watches, electronic medical devices, and other modern battery or wall-power operated devices. Manufacturing and assembly approaches vary based on tooling sizes, costs, and complexities.

73. Most objects seen in everyday life are non-planar. Therefore, it is necessary that the electronic systems fit a convenient form factor of the shape into which it will be integrated.

74. Creating a mechanical part from raw material involves bulk material removal, forming cavities or holes, and finishing to meet specifications. Techniques like milling, drilling, and EDM are commonly used. For difficult-to-machine materials, processes such as electro-discharge machining, laser beam machining, electron beam machining, shaped tube electrochemical machining, and electrochemical spark machining are employed. To meet stringent micro- to nanometer range requirements, advanced finishing techniques like abrasive flow machining, magnetic abrasive finishing, magnetic float polishing, magnetorheological abrasive finishing, and ion beam machining have been developed.

75. For the integration of electrical circuits into products, the use of electronics flexible systems as inserts to replace traditional rigid substrates in injection molding machines has become common.

76. Common Techniques include:

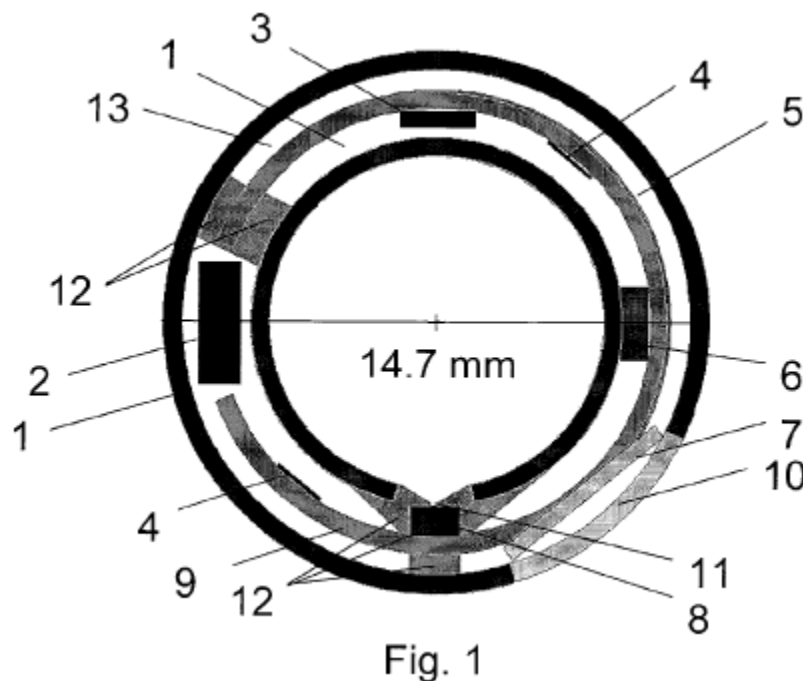
- a. Machining for Metals: Milling, drilling, EDM, and additive manufacturing.
- b. Formation for Plastics: Molding and thermoforming.
- c. Chip and PCB Packaging Techniques: Incorporating methods from semiconductor and PCB manufacturing.

77. There are many examples in the art of ways that electronics could have been assembled within a wearable electronic device by 2013. For example, U.S. Patent No. 4,830,014 to Goodman teaches that the light source and the photosensor

may be mounted to substrates using “sequential layers of surgical tape, opaque vinyl, and light filters” and “constructed of such small dimensions that both independently conform with a low aspect ratio to the flexible adhesive strip.” Ex-1024, 6:10-21 (Goodman).

78. Further, by 2013 it was well understood that in order to house electronic components within wearable devices, there must be an internal space like a cavity contained within the mechanical, or structural, elements. From a manufacturing and assembly perspective, a cavity can either be premade, with electronic components subsequently assembled and attached into it, or the electronic components themselves can be used to define the cavity during a molding process. Either approach ensures efficient integration of electronics into wearable devices, accommodating their compact and functional design requirements. For example, U.S. Patent Application Publication No. 2012/0218184 to Wissmar (Ex-1013), teaches electronic components “located in a cavity within the electronic finger ring.” Ex-1013 ¶28. Wissmar’s finger ring is a toroidal shaped finger ring structure made with “two different metallic shells: (i). 1 a, made of gold (Au) or silver (Ag), enclosing the major parts of the finger ring structure geometrically described as radially furthest away from the toroids centre, and (ii). 1 b, made of a titanium compound (Ti, TiW), being the metal enclosing facing the inner parts of the finger

ring structure.” *Id.* ¶73. As shown below in Figure 1, the “toroidal shaped finger ring structure 1 is comprised of different electronic components: a battery 2, a RF transceiver 3 and a micro processor 4, a microstrip line 5, an accelerometer 6, an internal antenna 7, a pressure sensor 8; all mounted on a flexible printed circuit board 9. In this embodiment, there is also an outer metal shell opening 10 serving as an RF window letting through unperturbed RF radiation.” *Id.* ¶73. The components shown in Figure 1 are housed within the cavity in the electronic finger ring.



79. Similarly, U.S. Patent No. 6,201,698 to Hunter teaches that “the side walls and the web together create a cavity [] to house the electronic circuit.” Ex-1060, 2:56-57.

80. U.S. Patent No. 4,012,629 to Simms also teaches a flashlight ring that includes “a hollow toroidal finger encircling member formed in four sectors” with each sector having its own electronic components inside. Ex-1061, Abstract.

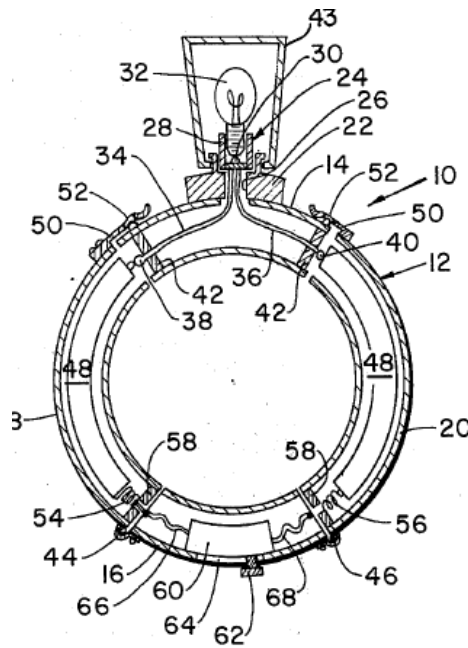
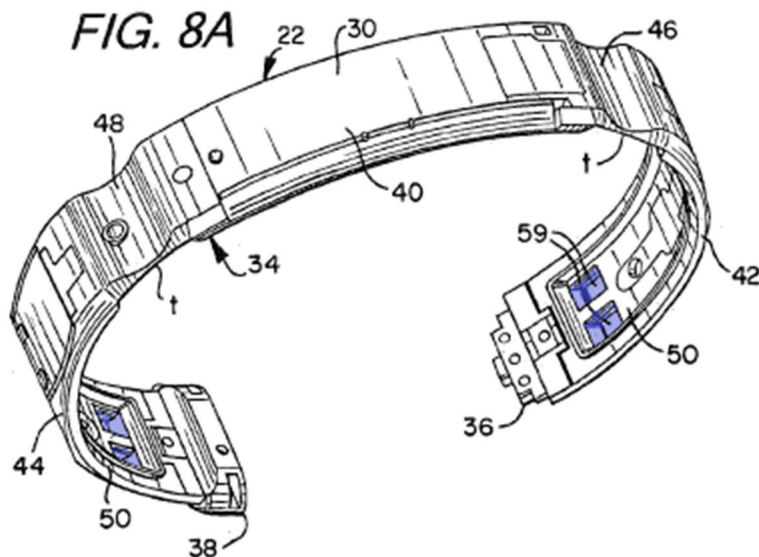


FIG. 2

81. Moreover, U.S. Patent Publication No. 20140244009 to Mestas teaches an electronic wearable device that has “compartments” for its electronic components. Mestas’s device has “compartments for power supplies, an outer encasement member 24, and a fastening mechanism 26 or latch member 26.” Ex-1010 ¶151; *see also id.* ¶183 (“light member compartment 180”). Further, Mestas explains that the batteries are inserted into the battery compartments. *Id.* ¶157. For example, as shown in Figure 8A, the “recessed compartments 50,52 are dimensioned to receive power supplies associated with the controller 14 . compartments 50,52

further have a pair of openings 59 to receive battery terminals or contacts to be described. The recessed compartments 50,52 may vary in size generally or with respect to one another. Thus, the recessed compartments 50,52 may have an increased size to accommodate larger power supplies having increased capacity.” *Id.* ¶156. “The batteries are positioned in the recessed compartments 50,52 wherein the contacts 150 extend through the openings 59 in the compartments 50,52 and engage the PCB member 140 to provide power to the device 10.” *Id.* ¶168. Therefore, it was well known to have compartments, or voids, inside a wearable electronic device in order to house specific electronic components.



82. Encapsulating electronics within a cavity of a structural element by, for example, injection molding, was well known by 2013. *See, e.g.*, Ex-1055, Ex-1056, Ex-1057, Ex-1058, and Ex-1059. I discuss this in more detail below in Section V.C.

83. Housing electronic parts within one component or between two components was known. For example, U.S. Patent No. 6,699,199 to Asada teaches that “one or more photo diodes 2 and one or more light-emitting diodes (LEDs) 4 are imbedded in a ring 10.” Ex-1034, 2:59-61 (Asada ’199). Moreover, U.S. Patent No. 6,745,061 to Hicks teaches that “[i]ncluded within the assembly 350 are upper and lower flexible members 304 and 300, respectively,” which are “thermally bound to one another sandwiching a leadframe 308 between their inside surfaces.” Ex-1025, 6:48-54 (Hicks). “This leadframe 308 contains active components (i.e., LEDs and a photodetector) for use in oximetry measurements.” Ex-1025, 6:48-54 (Hicks).

84. Electronic parts housed within a structural cavity in an electronic device could include, for example, microcontrollers, batteries, and RF communication components. For example, Rhee’s thesis and papers teach a ring sensor that included “optoelectronic components, a CPU, a RF transmitter, a battery, and a ring chassis,” wherein the “optoelectronic components, i.e. microphotodiodes and LEDs, detect the blood volume waveforms and oxygen saturation level at the patient’s digital artery. The CPU controls the LED lighting sequence as well as the data acquisition

and transmission process. These signals are locally processed by the on-board CPU and transmitted to a host computer for diagnosis of the patient's cardiovascular conditions." Ex-1031, 1 (Rhee 2000 Part I); Ex-1032, 2796 (Rhee 2000 Part II) ("The basic circuit configuration of the ring sensor is a standard photoplethysmographic circuit combined with a wireless transmitter. There are a single photodiode and LEDs of two different wavelengths, red and near infrared, involved in the circuit. ... The two channels of digital signals are transmitted via a RF transmitter. ... "[T]he whole system is designed and operated for low-power consumption. ... Each component has to be selected for low-power consumption and the whole system must be operated for minimum power consumption. The microprocessor coordinates the whole operation so that reliable measurement is performed with minimum power. ... The main circuit board and batteries, which are heavy and bulky in comparison to the sensor unit, sit on the outer ring."); Ex-1033, 796-97, 799, Fig. 1 (Rhee 2001) (same); Ex-1035, 14, 21-22, 68 (Rhee Thesis 2000) (same).

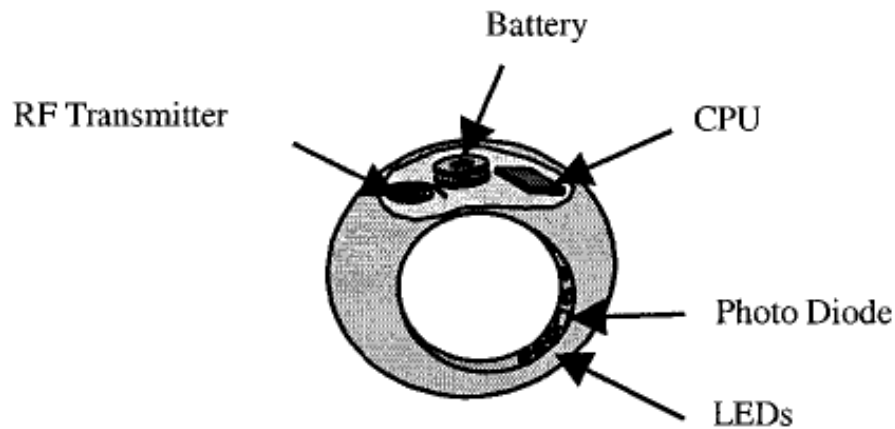


Fig. 1. Conceptual diagram of the ring sensor.

85. Moreover, Harry Asada and his MIT team by 2003 developed a finger-ring prototype having an “optical sensor unit, analog and digital processing units, and an RF transmitter, all of which are encapsulated in a compact body and powered by a tiny cell battery used for wristwatches”; and a PIC microcomputer for performing device controls and signal processing including “LED modulation, data acquisition, filtering, and bi-directional RF communication.” Ex-1037, 34 (Asada 2003); *see also* Ex-1034, 3:12-21 (Asada ’199) (“Referring now to FIG. 2, a cross-section is shown of finger ring sensor 20 as worn on finger 22 of a patient. In preferred embodiments of the invention, a sensor band 21 is worn in direct contact with the finger and holds one or more Detector S2 and 26, against the skin of the finger. sensor band 21 is encompassed by base ring 23 which, in turn, is encompassed by cover ring 25 which supports circuit module 29 containing battery

12, processor 6, and transmitter 8, all shown in FIG. 1, and serves also to shield detectors 2 and 26 from ambient light.”).

86. It was also known by 2013 that electronics in a wearable electronic device could be assembled at the bottom of the device (i.e., away from the skin surface). For example, the Konig reference teaches that, in transmission pulse oximetry “[t]he optical elements are located on the opposite sides of a body part” and “[t]he sensors are applied mainly to the fingers and toes.” Ex-1027, 405 (Konig).

3. Attaching electronics to a surface within an electronic device was known

87. A POSITA would have understood by 2013 that electronics should be attached to a surface in the device and that where that attachment occurs (for example, at the top or bottom of a cavity) would have been a matter of design and manufacturing choices. As an example, Harry Asada and his group at MIT state that “transmittal PPG configurations do not have the short circuit problems” of reflective PPGs because “the LED and PD are placed on the opposite sides of the finger” (i.e., at the bottom surface) such that “no direct path through the air can be created.” Ex-1037, 31 (Asada 2003). This type of design allows the use of “devices having a weak polarity, which is, in general, more robust against disturbances.” Ex-1037, 31 (Asada 2003). Moreover, transmittal PPGs are also “less sensitive to local disturbances acting on the finger, since the LED irradiates a larger volume of the

finger.” Ex-1037, 31 (Asada 2003). Importantly, Asada notes that “[d]esign trade-offs must be considered to find the best modulation scheme.” Ex-1037, 32 (Asada 2003).

88. Rhee’s thesis and papers teach, as shown in Figure 2 below, that in an original design (a) the “optoelectronic sensor unit, i.e. the LEDs and photodiodes, is attached directly to the body of the ring.” Ex-1031, 2 (Rhee 2000 Part I); Ex-1033, 796 (Rhee 2001); Ex-1035, 17 (Rhee Thesis 2000). Rhee notes that the problems with that design were fluctuations in the sensor reading, displacement of the ring relative to the skin surface, and difficulty shielding the sensor unit from ambient lighting. Ex-1031, 2 (Rhee 2000 Part I); Ex-1033, 797 (Rhee 2001). “To resolve these problems of the original ring design, a new design” was developed, called an “isolating ring configuration” (b), which “separate[s] the sensor unit from the rest of the ring body that is much heavier than the optical sensor unit alone.” Ex-1031, 2 (Rhee 2000 Part I); Ex-1033, 797 (Rhee 2001); Ex-1035, 17 (Rhee Thesis 2000). “The separation is achieved by having two rings that are mechanically decoupled to each other,” wherein “[t]he inner ring holds sensor unit alone, while the outer ring contains the CPU, signal processing unit, battery, and RF transmitter” and “[o]nly a thin, flexible cable connects the two rings.” Ex-1031, 2 (Rhee 2000 Part I); Ex-1033, 797 (Rhee 2001). Rhee teaches that the advantages of this design are that it

alleviates the influence of external forces applied to the ring (because the outer ring bears the force not the sensor unit on the inner ring), it alleviates the effect of acceleration on the sensor, reduces skin pressure, and reduces ambient lighting influence. Ex-1031, 2 (Rhee 2000 Part I); Ex-1033, 797 (Rhee 2001). Rhee additionally teaches that “[a] miniaturized sensor unit is attached to the inner ring whose mass is almost negligible,” which is “a small circuit board ... contain[ing] two light emitting diodes and a photodetector.” Ex-1032, 2796 (Rhee 2000 Part II); Ex-1033, 799 (Rhee 2001); Ex-1035, 68 (Rhee Thesis 2000).

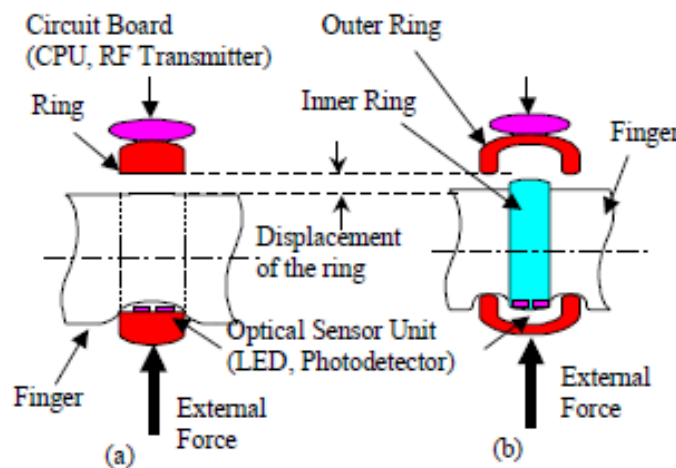


Figure 2 : Dislocation of ring sensors due to external load
(a) Traditional single body design under external force
(b) New isolating ring sensor under external force

89. There are also examples in the prior art where electronics were attached to the bottom surface. For example, U.S. Patent No. 6,608,562 to Kimura states that “[t]he photo diode 23 is disposed at the bottom of the inside of the attachable device 1 where it can receive the returning light.” Ex-1028, 6:60-62 (Kimura). U.S. Patent

No. 6,745,061 to Hicks also states that “[m]ounted on a top surface of the clear flexible substrate is at least one active pulse oximetry component,” which includes “at least one light emitter, such as a light emitting diode, and/or a light detector, such as a photodiode.” Ex-1025, 2:12-18 (Hicks). “Particularly, these active components are mounted on the top surface of the clear substrate such that they emit/detect light through the clear substrate and its bottom surface.” Ex-1025, 2:12-18 (Hicks); *see also* Ex-1025, 2:31-32 (Hicks) (noting that “the bottom surface of the clear flexible substrate” is “the patient side of the sensor”), 10:15-17 (“The traces 70-76 of the present embodiment are formed on the top surface of the clear substrate 80 using a conductive ink (e.g., epoxy with silver).”).

4. Flexible and rigid-flex printed circuit boards were well-known

90. Wearable electronic devices and sensors often present space, weight, and geometry constraints in the design, manufacturing, and placement of their electronic components. To address such constraints, the electronics can be placed on flexible printed circuit boards (“PCBs”), which were well-known by 2013.

91. Flexible PCBs are made from materials such as Kapton, which are used due to their thermal stability, mechanical flexibility, and electrical insulation properties. These properties enable them to conform to various shapes and endure bending and flexing during manufacturing assembly and use while maintaining its

digital or analog circuit functionality. Their flexibility is essential in applications requiring the PCB to adapt to non-flat surfaces without compromising the electronic performance. For example, Petropoulos describes the fabrication of a flexible PCB made of Kapton foil, which exhibits lower thermal conductivity (thus better thermal insulation) and is much thinner than a regular, rigid PCB. Ex-1052, 237 (Petropoulos).

92. By 2013, flexible PCBs and arrangements of flexible and rigid PCB (“rigid-flex” PCBs) were widely utilized in wearable electronic devices. For example, U.S. Patent No. 8,954,135 to Yuen teaches a wearable biosensing device where its light source(s) and/or associated detector(s) are disposed on a Flat Flex Cable or “FFC” or flexible PCB. In this embodiment, the flexible or pliable substrate (for example, FFC or flexible PCB) could connect to a second substrate (for example, PCB) within the device having other components disposed thereon (for example, the data processing circuitry).” Ex-1006, 12:35-42 (Yuen). This flexible structure allows the inner, “skin-side” surface of the device to conform or adapt to the shape of the user’s body (for example, arm, wrist, ankle or leg) that the device is secured to so that there is “little to no gap between the skin side of the device and the juxtaposed surface of the skin of the user.” Ex-1006, 12:24-42 (Yuen). Similarly, U.S. Patent No. 10,303,867 to Schröder teaches a flexible PCB, but

teaching that electronics such as antenna coil and a chip module in its biosensing “finger-ring” are applied on a “carrier foil” that “consists of a flexible plastic material, e.g. PET or Kapton,” through technologies such as a printing technique. Ex-1007, 12:27-37, 13:23-37 (Schröder). U.S. Patent Pub. No. 2014/0244009 to Mestas also teaches the use of flexible and rigid-flex PCBs in its wearable electronic biosensing device, where the electronics are disposed on a spine member “having substantially rigid portions and certain flexible portions or zones.” Ex-1010, ¶¶151, 153 (Mestas). Mestas further teaches that a rigid-flex printed circuit board (PCB) is wrapped onto the spine of the device and similarly includes rigid zones (annotated dark purple below) connected by flexible zones (light purple) for placing the various electronic components. *Id.*, Figs. 14, 15, ¶¶164, 177 (Mestas). The decision to utilize a rigid, flexible, or rigid-flex PCB is driven and balanced by an evaluation of the trade-offs between costs and benefits and system-design decision for an entire device.

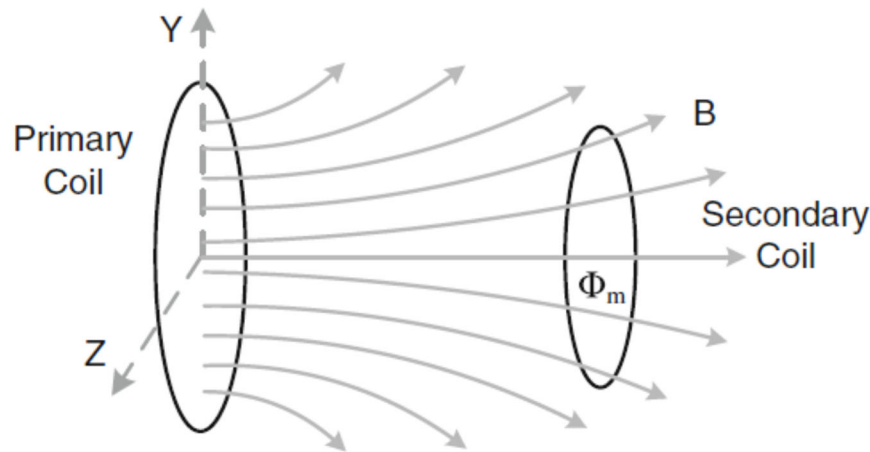
5. Wireless inductive charging was well-known

93. The benefits of wireless charging batteries powering electronic devices, in particular wearable electronic devices, were well known by 2013.

94. As noted in Sun’s *Wireless Power Transfer for Medical Microsystems* book from 2013, “wireless power transfer (WPT) . . . was invented over 100 years

ago.” Ex-1053, 1 (Sun). By 2013 wireless power transfer was used either for “real-time energy” or “to charge batteries” in biomedical devices. *Id.*, 140 (Sun). Near-field (as opposed to long-distance) wireless power transfer can be one of two types: inductive coupling or capacitive coupling. *Id.*, 5, Fig. 1.4 (Sun). While capacitive coupling relies on capacitors, inductive coupling, which Sun notes is the “best choice for biomedical app[lications],” relies on coils. *Id.*, Fig. 1.6 (Sun). As Sun further explains, “[t]he most well-known power antenna for biomedical applications is the magnetic inductive coil.” *Id.*, 42 (Sun).

95. Inductive coupling relies on magnetic flux coupling between a coil of a primary power transmitter and a coil of a secondary power receiver, which are not physically connected. *Id.*, 19 (Sun). The coil and its connected electronics on the receiving side picks up the time-varying magnetic field created by the coil on the transmitting side, thus transferring electromagnetic power wirelessly. *Id.*, 19, Fig. 2.2 (reproduced below).



96. Besides its use in biomedical devices, induction charging was also widely used by 2013 for charging batteries of wearable electronic devices and many types of cordless consumer electronics. For example, U.S. Patent Pub. No. 2014/0187160 to Prencipe teaches a wireless communication enabled smart ring with a “battery [that] is rechargeable by any suitable recharging method, including but not limited to induction (e.g., from a charging station or from ambient electromagnetic radiation). Ex-1054 ¶36 (Prencipe). Similarly, Mestas teaches a wearable athletic device that “may be configured for re-charging batteries via induction charging.” Ex-1010 ¶201 (Mestas). Similarly, Schröder teaches a biometric sensing “finger-ring” with a battery that “is preferably charged by means of [an] electromagnetic field,” using an antenna coil. Ex-1007, 11:46-67 (Schröder).

C. Wearable Electronic Device Materials

1. Machinability of metallic materials was known

97. Materials such as metals including titanium were known to be machinable by 2013. For example, Olofson's Machining of Titanium Alloys book from 1965 states that "[t]oday, tools and techniques are available for machining titanium efficiently." Ex-1036, 1 (Olofson). "In fact, some machining operations give more consistent results on titanium than they do on some grades of steel." Ex-1036, 1 (Olofson). "A bonus factor is the ease of attaining good surface finishes." Ex-1036, 1 (Olofson). "Rms [root mean square] values as low as 20 to 30 microinches can be obtained on some titanium parts without much trouble." Ex-1036, 1 (Olofson). Olofson's Table 1 "shows the approximate machinability relationships between the titanium alloys and the other alloys of interest." Ex-1036, 1 (Olofson) (comparing aluminum alloys, alloy steel, stainless steel, and titanium alloys among others).

2. Using a moldable filler material or potting material to cover electronics was known

98. Using a moldable filler material or "potting material" to cover the electronics in a device was known by 2013 including the motivations for doing so. Similar materials are suitable for both molding and potting processes in

manufacturing. Both molding and potting processes require materials with attributes such as thermal stability, electrical insulation, and mechanical strength.

99. By 2013, injection molding was “the most popular method for producing plastic products because of its high productivity and the manufacturability for making various complex shapes.” Ex-1056, 51 (Ciofu). The “[i]njection process is a cyclical process, during which succession occurs following operations: dosing of plastic material; heating and melting the plastic inside the cylinder; closing the mold; placing plastic material inside the mold cavity under pressure; melt solidification and cooling; mold opening; elimination product injected.” Ex-1056, 52 (Ciofu). Moreover, “[q]uality parameters (responses) are usually associated with evaluating the replication fidelity of the processes by completely filling the mould cavity.” Ex-1056, 55 (Ciofu), 57-57 (“feature engineering that refers to filling cavities is influenced by the part geometry, size and position of point size and shape filling and filling channels”); *see also, e.g.*, Ex-1058, 61 (Sakai) (“Plastic packaging for semiconductor products such as integrated circuits (ICs) has been commercially made by means of a transfer molding method using epoxy resin.”), 65 (applying “a quantitative analysis for molten polymer filling behavior in the cavities using a mold-filling simulation program commercially available such as Mold Flow”), 66 (“Figure 11 shows the experimental results using the 16-cavity side gate cold-runner

system”), Fig. 11; Ex-1059, 10 (Teh) (“Figure 1 illustrates an example of such injection moulded thermoplastic parts with an embedded electronic subassembly. This proposed encapsulation technology adapts conventional techniques of thermoplastic injection moulding and electronic printed wiring board (PWB) assembly in order to achieve economical efficiency and manufacturing viability.”), 11 (“As shown in Figure 2, injection moulding can be briefly described as a cyclic process of forming plastic into a pre-determined geometry by forcing high-temperature plasticized or molten polymer resin under an injection pressure into a specially shaped cavity (mould).”), Figs. 1-2.

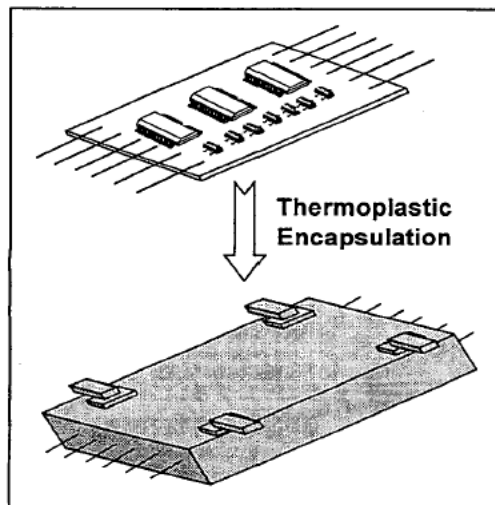


Figure 1. Illustration of the electronic overmoulding

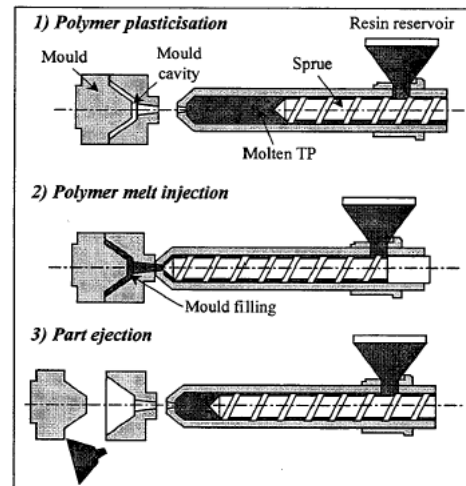


Figure 2. Schematic diagram of injection moulding

100. As Ardebili’s Encapsulation Technologies for Electronic Applications book from 2009 explains, “[p]otting involved positioning the electrical circuit in a container and pouring the liquid encapsulant into the cavity.” Ex-1055, 3 (Ardebili).

“Common materials used for potting . . . of electronic units are silicones, epoxies, and polyurethanes.” *Id.*, 90. A related encapsulation technique, “molding is a process of encapsulating microelectronic devices in a closed mold.” *Id.*, 129 (Ardebili). Molding compounds include similar materials: “resins, . . ., silicones, phenolics, and BPA epoxies.” *Id.*, 57 (Ardebili).

101. Ardebili also discusses encapsulating electronics within a cavity. *See, e.g.,* Ex-1055, 4 (Ardebili) (“The encapsulant, typically a thermosetting polymer, is cured in the cavity to form the final electronic package.”), 6 (“Plastic packages can be pre-molded or post-molded. In the pre-molding process, a package base is prepared from a pre-molded plastic (or sometimes a metal substrate). The chip is then placed on the base and connected to an I/O fan out pattern with wire. A pre-molded plastic lid or housing is attached on top, using an epoxy adhesive to protect the die and wire bonds, and forms a cavity inside the package. Figure 1.5 shows a pre-molded package. Pre-molded packages are most often used for high-pin-count devices or pin-grid arrays that are not amenable to flat lead-frames and simple fan out patterns.”), 31 (“Hermetic packages are cavity packages that are designed to seal against moisture and corrosive gases. They are made of materials that are highly moisture impermeable such as ceramics and metals. A metal or ceramic lid (or housing) is welded or attached to a package base to produce the hermetic seal.”),

437 (“Figure 8.12(a) shows another example of selective encapsulation of a MEMS [micro-electromechanical system] suspension sensor chip that includes a cavity constructed on the back surface. Figure 8.12(b) shows selective plastic encapsulation of a MEMS device stacked on an IC chip. Figure 8.13 shows a selective encapsulation method for a MEMS pressure sensor from Motorola [22]. A protective dam is constructed on the outer perimeter of the pressure sensor diaphragm, thus forming a cavity between the dam and the package housing. The cavity can be filled with plastic encapsulant material. The package housing is also made of plastic material.”).

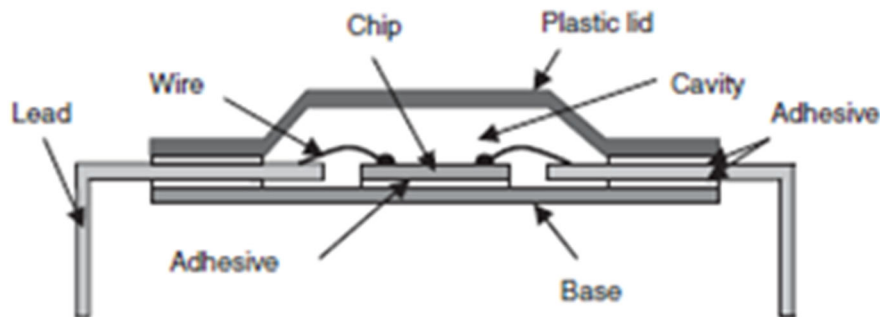


Figure 1.5 A pre-molded plastic package [9].

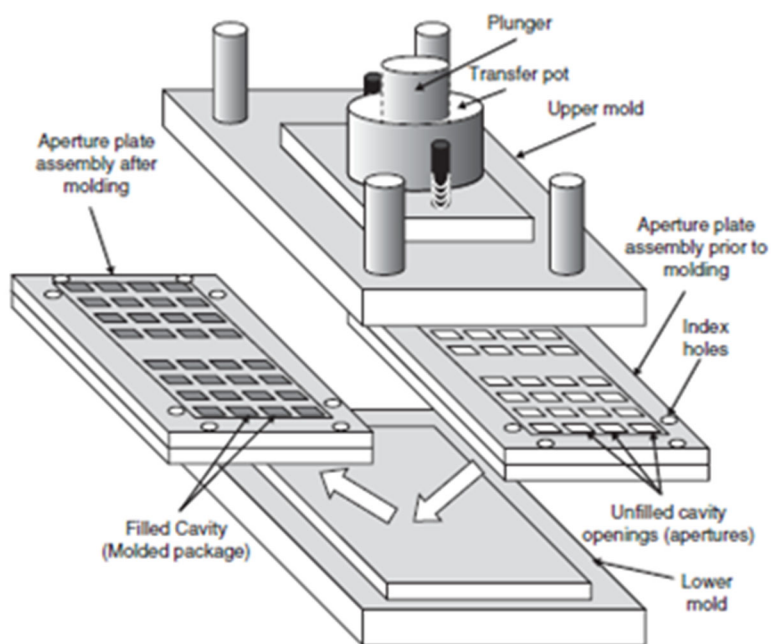


Figure 3.4 Aperture-plate (or cavity plate) molding setup [3].

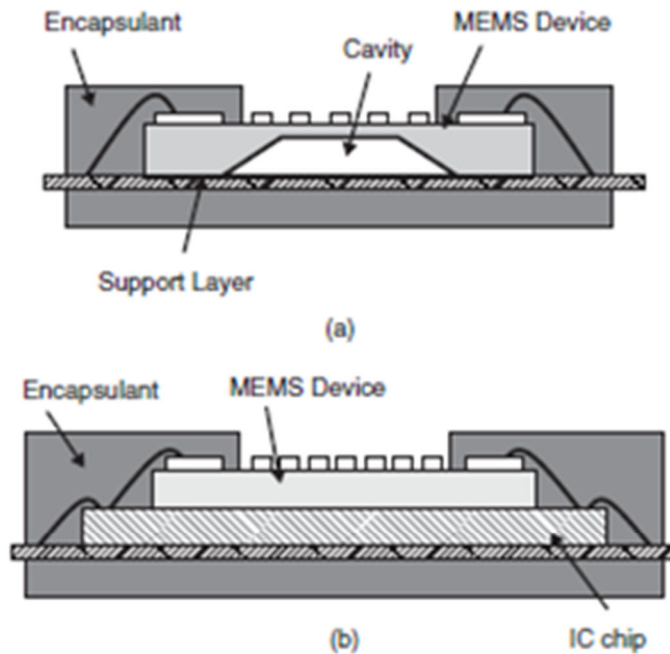


Figure 8.12 Plastic-encapsulated MEMS device package designs from Industrial Technology Research Institute: (a) MEMS device with a cavity; (b) 3D package with a MEMS device stacked on an IC chip [21].

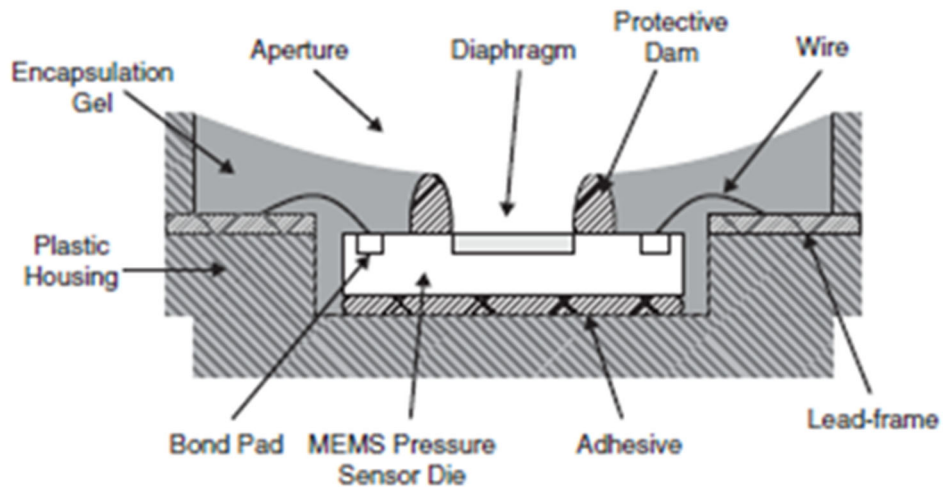


Figure 8.13 Plastic-encapsulated MEMS pressure sensor device from Motorola [22].

102. As applications of these encapsulation or coating techniques, for example, it was known that a light source and photosensor may be mounted to substrates using “sequential layers of surgical tape, opaque vinyl, and light filters.” Ex-1024, 6:10-21 (Goodman). “Thereafter, apertured, opaque vinyl and finally a transparent adhesive layer are placed over the entire photo-sensor” resulting in “a simple flexible adhesive strip apparatus which is in conformance to the blood perfused flesh, i.e., digit being interrogated for blood flow.” Ex-1024, 6:10-21 (Goodman); *see also* Ex-1057, 1809 (Ross) (“If the package body material is not tightly adhered to the penetrating leads on all four sides there will be a direct and open moisture path to the package interior and a gas leak path to the exterior of a sealed package during gross leak testing.”).

103. The advantages of using moldable filler or potting materials to cover electronic parts include “that the blood flow of a critically compromised patient may be measured with limited risk of measurement error incurred by motion artifact; the foam layer between the adhesive and the substrate provides a tight, nonpressure exerting, skin seal which prevents motion artifact”; “the foam layer between the adhesive and the substrate provides a light-tight seal between the skin and the sensor, thus protecting the components and resulting measurement from the deleterious effects of ambient light”; and “an opaque photographic coating applied to the

foam/adhesive side of the flexible substrate prevents measurement inaccuracies by diminishing light refraction and rebound.” Ex-1024, 7:32-49 (Goodman); *see also* Ex-1059, 11 (Teh) (discussing “the technological and economic implications of ... overmoulding technology ... in the production of highly integrated polymer encapsulated electronics products”), 12 (the advantages of encapsulating electronics within structural moulding is “Reduced package size,” “Lower manufacturing costs,” “Better product durability,” “Improved system robustness,” and “Product recyclability”).

104. U.S. Patent No. 6,745,061 to Hicks (“Hicks,” Ex-1025) teaches that the coating could be an epoxy or an ink. For example, Hicks states that “the flexible sensor may contain a light blocking layer applied to the top surface of the clear flexible substrate to minimize the effect of ambient light sources upon the sensor,” which “may include a separate substrate interconnected to the clear flexible substrate or some sort of opaque coating applied to the top surface of the clear flexible substrate.” Ex-1025, 2:42-48 (Hicks). Hicks further teaches that “traces 70-76 of the present embodiment are formed on the top surface of the clear substrate 80 using a conductive ink (e.g., epoxy with silver).” Ex-1025, 10:15-17 (Hicks). Moreover, Hicks teaches that “[d]uring the ink deposition process, the remainder of the surface of the clear substrate 80 not covered by the conductive traces 70-76 (and not to be

covered by the LED 40, 42 or Photodetector 38) may also be covered by an opaque nonconductive ink.” Ex-1025, 10:20-27 (Hicks). “That is, the non-patient side of the clear substrate 80 may be ‘painted’ to provide a light blocking shield for the sensor 30.” Ex-1025, 10:20-27 (Hicks); *see also* Ex-1025, 9:6-15 (Hicks) (“The release liner 84, the interconnecting layer 82, the foam layer 86 and the clear substrate layer 80 are formed of materials that are substantially transparent to ultraviolet (UV) light. This allows UV light to pass through these layers 80-86 such that any adhesives used to attach the LEDs 40, 42 and photodetector 38 to the electrical traces 70-76 and/or to the clear substrate 80 (i.e., adhesive drop 110) may be cured with light (i.e., UV or visible depending on the adhesives) applied through the bottom of the flexible substrate 50 at or near the end of the manufacturing process.”), 12:2-13 (“[T]his embodiment further uses a cover layer 94 covering the top surface of the clear substrate. ... The cover layer 94 covers substantially the entire top surface of the clear substrate 80, excluding the portion of the clear substrate that makes up the integral connector 94. This cover film layer 94 is generally an opaque flexile layer made up of a material similar to the clear substrate 80 and is utilized for its light blocking characteristics.”).

105. U.S. Patent No. 8,954,135 to Yuen (Ex-1006) is another example of a moldable filler material or “potting material” used to seal the electronic components

inside a wearable device. For example, Yuen describes that its biometric monitoring device “may be filled with gel that allows the sensor to experience pressure changes outside of the gel. The use of a gel filled altimeter may give the device a higher level of environmental protection with or without the use of an environmentally sealed vent. The device may have a higher survivability rate with a gel filled altimeter in locations including but not limited to those that have high humidity, a clothes washer, a dish washer, a clothes dryer, a steam room, the shower, a pool, and any location where the device may be exposed to moisture, exposed to liquid or submerged in liquid.” Ex-1006, 20:65-21:8.

106. Yuen further emphasizes the importance of having a watertight seal of the device. *See, e.g.*, 15:1-4 (“structural integrity of the device while accommodating watertight seal for the sensor package”), 20:52-64 (“prevents and/or minimizes water and other liquids penetration into the device housing”). Yuen describes that its “package or module of the optical sensor would be connected to the device with a pressure sensitive adhesive and a liquid gasket. (See, FIG. 7). Screws, rivets or the like may also be used, for example, if a stronger or more durable connection is required between the optical sensor package/module and the device body. Notably, the present inventions may also use watertight glues, hydrophobic

membranes such as Gore-Tex, O-rings, sealant, grease, or epoxy to secure or attach the optical sensor package/module and the device body.” Ex-1006, 15:5-14.

107. Numerous other examples of the types of coatings that may be used to cover electronics in an electronic device are taught in the art. *See, e.g.*, Ex-1034, 4:54-5:2 (Asada ’199) (“Lightweight cover 25 is preferably made of cast acrylic. The inner diameter widens to couple to base unit. The main function of the cover is to protect the sensors from outside elements. ... Base unit 23 is preferably made of the same cast acrylic material as cover 25 and is toleranced to provide a secure fit by means of friction. ... Moreover, this component aids in shielding the ambient light, which the cover unit could not handle.”); Ex-1026, 4:47-55 (Hannula) (“In one embodiment of the present invention, the inner side 125 of layer 112 is covered with a laminated opaque film. The opaque film blocks ambient light that may interfere with photodetector 116. The opaque film may comprise polyethylene. The opaque film may be black or some other dark color that helps block ambient light and reduces shunted light. Dark in color is understood here to be of a nature with little reflectance of the wavelengths of light sensed by the sensor’s photodetector.”); Ex-1028, 1:46-50 (Kimura) (“A surface treatment (such as painting black) for preventing the reflection of light has been carried out on the inside of this attachable device 1. The sensor 2 has a light-emitting diode 22 and a photo diode 23 mounted

in a package 21 molded inside the attachable device 1.”); Ex-1029, 0013 (Tremper) (“Clinically, ambient light artifact can be minimized by covering the sensor with an opaque shield.”); Ex-1057, 1807 (Ross) (Liquid Crystal Polymer (LCP) was known to be a “class of high performance, high temperature thermoplastic polymers which can be formulated to provide injection molding compounds having properties uniquely advantageous for electronic cavity packages. ... [T]his polymer class, together with ancillary materials such as metal leadframes and adhesives, ... combine to produce a range of cavity package configurations that can compete in the same performance arena as ceramics.” Ex-1057, 1807 (Ross); Ex-1055, 78 (Ardebili) (“Coloring agents are added to the molding compound to distinguish between different device types in packages and eliminate device visibility through the normally pale yellow epoxy encapsulant. The colors are produced by the addition of thermally stable organic dyes or pigments.”).

3. Windows and transparent materials were commonly used for emission and detection

a. Windows for optical transmission, such as light emission and detection

108. As discussed further below, optical sensors are used to obtain continuous measurements of a patient/user’s biometric data. For example, U.S. Patent No. 4,880,304 to Jaeb et al. (“Jaeb”) explains how “it is extremely important

to be able to obtain continuous measurements of a patient's tissue oxygenation” Ex-1042, 1:15-17. Jaeb notes that although an actual blood sample is considered the most accurate method, it is “undesirable in cases where it is necessary to monitor blood oxygen saturation over long periods of time.” *Id.*, 1:20-34. Therefore, Jaeb disclosed how a noninvasive oximeter “capable of detecting significant changes in the blood oxygen content would be especially useful.” *Id.*, 1:31-34. Jaeb taught a “optical sensor which has increased sensitivity and which is resistant to the effects of ambient light” by having the sensor housing having “central protrusion in which a plurality of light emitting diodes and an optical sensor are mounted in a vertical configuration.” *Id.*, 2:49-53. This allows the sensor to be placed on the patient’s tissue so that the “sensor face containing the LEDs and detector protrudes slightly into the tissue” “thereby increasing the signal strength of the detected signal.” *Id.*, 3:54-65, 5:13-17. Therefore, the sensor face is directly exposed to the user’s skin.

109. Jaeb explains that the placement of the LEDs and sensor is important to prevent problems related to signal strength and susceptibility to interference. *See, e.g.*, Ex-1042, 4:59-62. For example, as shown in Figure 2B, when the “lower face of the housing 12 contains LEDs 16 and 18 which emit light in the red and infrared spectra [sic], respectively, and an optical sensor 20 for detecting light reflected by

subsurface tissue” causes issues of interference by “by ambient light entering from the perimeter of the sensor housing.” *Id.*, 4:51-58, 5:1-3.

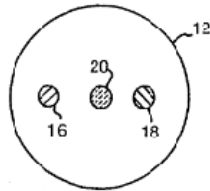


FIG. 2a

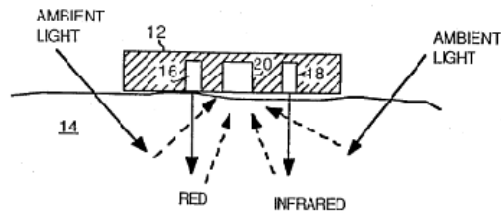


FIG. 2b

110. Jaeb explains and shows in Figures 3a and 3B that a light absorbing pad 30 can be attached to the lower face of the sensor to reduce “Interference due to ambient light entering from the edges of the sensor.” Ex-1042, 5:17-21. However, Jaeb further explains that “[i]nterference due to ambient light is further reduced by recessing the LEDs 16, 18 and the detector 20 within the housing and by coating the respective LEDs with a polymer sealant 32. The coating provides improved optical index matching and also provides an electrical and biological seal between the sensor and the tissue.” *Id.*, 5:21-27.

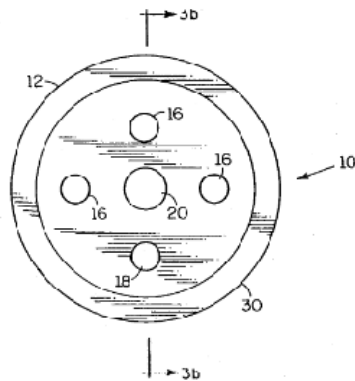


FIG. 3a

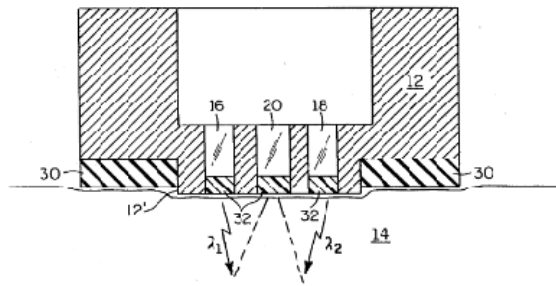


FIG. 3b

111. U.S. Patent No. 8,954,135 to Yuen (Ex-1006) is another example of using transparent material over LED sensors. Yuen acquires the user's biometric data by light from optical sensors, or LEDs, emitted through a "window" made of "plastic or a glass layer." Ex-1006, 10:55-66. Specifically, Yuen describes a window "in the housing to facilitate optical transmission between the optical sensors and the user." *Id.* The window permits the light to be emitted by one "or more LEDs, onto the skin of the user and a response or reflection to pass into the housing to be sampled, measured and/or detected by, for example, one or more photodiodes." *Id.*; see also *id.*, Claim 6 ("the window includes a first portion having first optical properties and a second portion having second optical properties different from the first optical properties.").

112. Yuen discusses three light sources separate from one another emitting different wavelengths of light: "an LED that emits light having wavelengths

corresponding to the green spectrum,” “an LED that emits light having wavelengths corresponding to the red spectrum,” and “an LED that emits light having wavelengths corresponding to the IR spectrum.” Ex-1006, 10:29-31, 10:34-39. Yuen’s biometric monitoring device has optical sensors “arranged on the skin side” so light is emitted upon the user’s skin and detected by a light detector to measure a “user’s heart rate, respiration, heart rate variability, oxygen saturation (SpO2), blood volume, blood glucose, skin moisture and/or skin pigmentation level.” Ex-1006, 10:7-21. In this situation there are thus multiple windows for each LED. Yuen claims “the window includes a first portion having first optical properties and a second portion having second optical properties different from the first optical properties” where the “the first portion of the window and the third portion of the window are spaced apart and separated by the second portion of the window.” *Id.*, claims 6, 11.

113. Yuen explains that its optical window can be in the form of a protrusion also:

The light emitter(s) and/or detector(s) of the optical sensor may be disposed or arranged in the protrusion juxtaposed the window or light transmissive structure. As such, when attached to the user's body, *the window portion of the protrusion* of the biometric monitoring device engages the user's skin with more force than the surrounding device body—thereby providing a more secure physical connection between the user's skin and the optical window. That is, a protrusion improves sustained and/or

fixed contact between the biometric monitoring device and the user's skin (for example, the skin of a predetermined portion of the user's body) which may reduce the amount of stray light measured by the photodetector, decrease motion between the biometric monitoring device and the user, and/or provide improved local pressure to the user's skin; all of which may increase the quality of the cardiac signal of interest.

Ex-1006, 13:39-62.

114. Yuen explains that the windows can also be used on the exterior of the housing. As shown in Figure 12 below, an “optical heart rate monitor ... disposed or located on one or more external or environmental side surfaces of the biometric monitoring device.” Ex-1006, 12:62-65. “The user may touch an optical window (behind which optical elements of the optical heart rate monitor are located) with a finger on the opposing hand to initiate a heart rate measurement (and/or other metrics related to heart rate such as heart rate variability) and/or collect data which may be used to determine the user's heart rate (and/or other metrics related to heart rate).”

Ex-1006, 12:65-13:5.

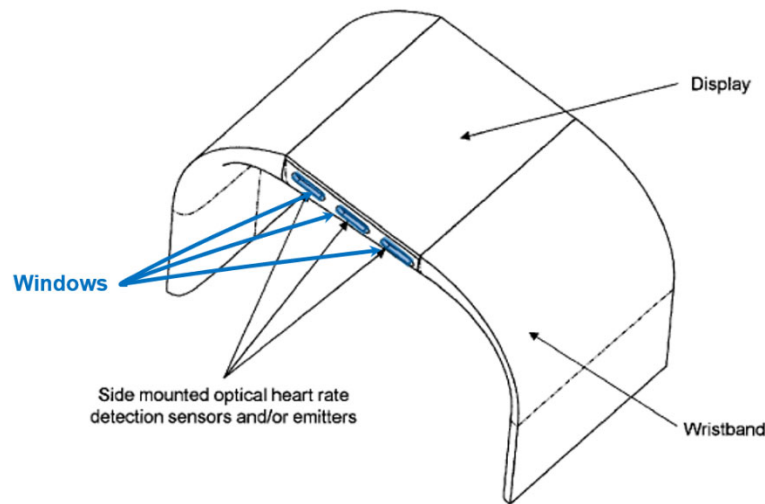


FIG. 12

115. Yuen explains that the light transmissive structure has an “optically opaque portion (including certain optical properties) and an optically transparent portion (including optical properties different from the optically opaque portion.” Ex-1006, 11:49-33. Such a structure is provided by a “double-shot or two step molding process wherein optically opaque material is injected and optically transparent material is injected” to form a “light transmissive structure having an optically opaque portion (including certain optical properties) and an optically transparent portion (including optical properties different from the optically opaque portion).” Ex-1006, 11:33-36. This allows the windows to have “different transmissive properties for different wavelengths depending on the direction of light travel through the structure. For example, in one embodiment, the optically opaque material may include a property of being reflective to a specific wavelength range

so as to more efficiently transport light from the light emitter(s) and from the user's body back to and detected by the detector (which may be of a different wavelength(s) relative to the wavelength(s) of the emitted light).” Ex-1006, 11:36-46; *see also id.*, Claims 7-8 (the windows can be “optically opaque” to certain wavelengths, such as light in the visible spectrum).

116. U.S. Patent Publication No. 20130211291 to Tran (“Tran,” Ex-1045) also discusses an “optical heartbeat detector” with an “optical transducer is positioned on a finger, wrist, or ear lobe.” Es-1045 ¶295. In the finger pulse oximeter, Tran’s device “emits lights from a window in the infrared spectrum and receives reflected light in a second window. When the heart beats, blood flow increases temporarily and more red blood cells flow through the windows, which increases the light reflected back to the detector. The light can be reflected, refracted, scattered, and absorbed by one or more detectors. Suitable noise reduction is done, and the resulting optical waveform is captured by the CPU.” Es-1045 ¶295.

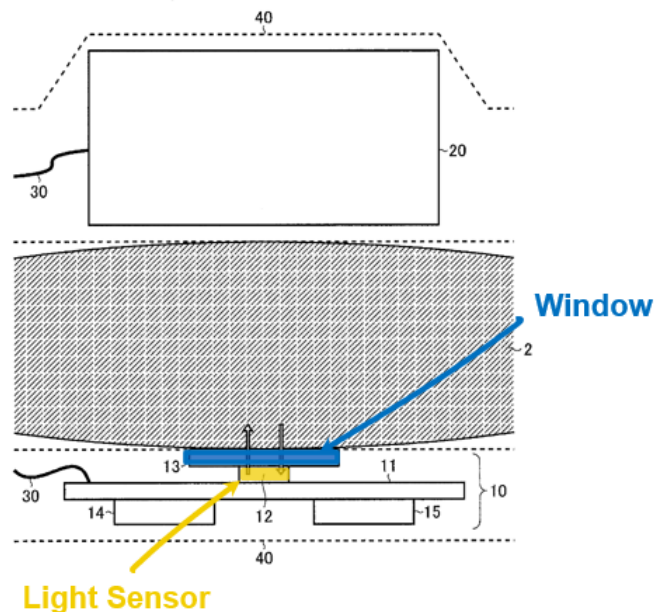
117. U.S. Patent Publication No. 20120016245 to Niwa (“Niwa,” Ex-1005) is another example of using a transparent window. Niwa teaches a wearable electronic sensing device with light-emitting and light-receiving components to acquire a plethysmogram—e.g., information relating to blood volume—of the wearer. *See* Ex-1005. Niwa teaches a ring-shaped device that surrounds “the ball

side of the finger 2 (i.e., palm side) when the finger ring type housing 40 is worn” for the plethysmogram measurement. Ex-1005 ¶192.

118. As shown in Figure 27, Niwa shows a “measurement window 13.” Specifically, Niwa’s finger ring has a first unit 10 which is a “unit to measure the plethysmogram mainly, which is contained within the finger ring type housing 40 to be set to the ball side of the finger 2 (i.e., palm side) when the finger ring type housing 40 is worn on the third joint of the third joint of the finger 2.” *Id.* The first unit 10 is supplied with power from the second unit 20. Ex-1005 ¶193. The first unit 10 includes “substrate 11, a light sensor 12, an amplifier circuit 14, and a processing circuit 15” and a “translucency portion which forms the measurement window 13.” Ex-1005 ¶200. The measurement window is provided at the light emitting/receiving surface of the light sensor.” Ex-1005 ¶30. Niwa discusses that the measurement window 13 is made “with the translucency portion (i.e., a glass plate or an acrylic plate) which is provided at the light emitting/receiving surface of the light sensor 12” in order for the light sensor 12 “to perform measurement of the plethysmogram (i.e., detection for the emitted light to the finger 2 and a reflected light go back from the finger 2) via this measurement window 13.” Ex-1005 ¶210. The thickness of the measurement window 13 depends on the design “in view of the depth of focus of the light sensor 12.” *Id.* As shown below in Figure 27, the

measurement window (blue) allows for the light to be emitted from the light emitting portion (yellow) to the user's finger when pressed to the measurement window. Ex-1005 ¶117.

FIG.27



119. Similarly, WO2001017421A1 (“Lindberg”) (filed Sept. 7, 2000), explains using “transparent silicone” over the light sources and detectors. Lindberg relates to a non-invasive method for determination of SpO₂ by:

- a) directing light beams against the mixture;
- b) determining at least one blood characteristic other than SpO₂ including hemoglobin of the mixture by analyzing the intensity of the light reflected from the mixture, or the intensity of the light reflected from the mixture in combination with the intensity of the light transmitted through the mixture; and

c) determining oxygen saturation, SpO₂, of the mixture by analyzing the intensity of the light transmitted through the mixture.

Ex-1046, 0005 (page numbered 4).

120. Lindberg directs light beams using “light sources” comprising of a first light source for emitting a first light beam with a wavelength in the red light range and a second light source for emitting a second light beam in the infrared light range. Ex-1046, 0007 (page numbered 6); *see also id.*, 0010 (page 9) (explaining that the light sources may be light emitting diodes). The apparatus comprises a first detector for detecting the intensity of the light of the red light beam and a second detector for detecting the light from the infrared light beam. Ex-1046, 0007 (page numbered 6). Lindberg explains that when using the light sources and detectors “for reflection” they are incorporated and covered with transparent silicone. *Id.*, 0020 (page numbered 9). Therefore Lindberg describes using a transparent material such as silicone over the LEDs.

121. WO 2011/132009 to Nyiradi (Ex-1047) is another example of having an LED under a translucent material. Specifically, Nyiradi teaches a “driving indicator with LED integrated in bracelet for cyclists and motorcyclists.” Ex-1047, 0002. The bracelet can have a “plastic arm strap 11” made of a “transparent, translucent version of the special plastic” so that it “becomes possible for the light

of the LED 4 placed into [t]he plastic arm strap 11 itself to penetrate the material of the plastic arm strap 11.” Ex-1047, 0012 (numbered page 11).

122. Therefore, windows and transparent materials for optical transmission were well-known in order to focus the light from a light-emitting component, such as a light emitting diode, to be emitted through and reflected back to the light receiving component, such as a photodetector.

b. Windows for RF transmission and detection

123. Windows were also commonly used for radio frequency transmission. For example, U.S. Patent Application Publication No. 2012/0218184 to Wissmar (Ex-1013), teaches an electronic finger ring with electronic components packaged and integrated within the ring for radio frequency (RF) transmission. Ex-1013, Abstract. Wissmar’s finger ring is a toroidal shaped finger ring structure, “constituted of two different metallic shells: (i). 1 a, made of gold (Au) or silver (Ag), enclosing the major parts of the finger ring structure geometrically described as radially furthest away from the toroids centre, and (ii). 1 b, made of a titanium compound (Ti, TiW), being the metal enclosing facing the inner parts of the finger ring structure.” Ex-1013 ¶73.

124. As shown below in Figure 1, the “toroidal shaped finger ring structure 1 is comprised of different electronic components: a battery 2, a RF transceiver 3

and a micro processor 4, a microstrip line 5, an accelerometer 6, an internal antenna 7, a pressure sensor 8; all mounted on a flexible printed circuit board 9. In this embodiment, there is also an outer metal shell opening 10 serving as an RF window letting through unperturbed RF radiation.” Ex-1013 ¶¶73. All electronic components, including “an antenna,” are mounted on a flexible printed circuit board (FPCB). Ex-1013 ¶¶71, 91. The antenna is specifically “located under the portion of the ring which has no outer shell metal” to allow “unperturbed RF radiation” when the outer shell is made of a metal that would otherwise prevent RF radiation from passing. Ex-1013 ¶91.

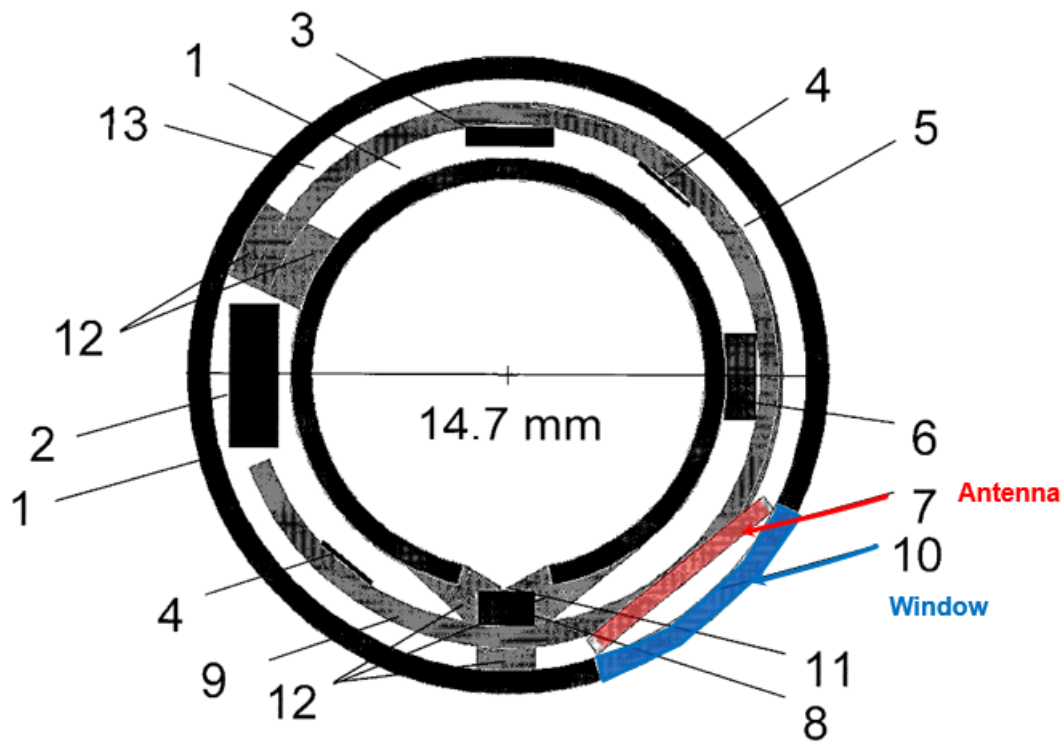


Fig. 1

125. Similarly, U.S. Patent Application Publication No. 2014/0361945A1 to Misra et al. (“Misra,” Ex-1048) explicitly teaches a radio-frequency transparent window from 2013. Specifically, Misra explains that antenna architecture is an “integral part of portable electronic devices” and how housings and structural components are often made from conductive metals, which can serve as a ground for an antenna. Ex-1048 ¶2. However, “nonconductive regions that are transparent to radio-frequency (RF) radiation ... provide a good radiation pattern and signal strength” such as conventional “antenna windows in portable electronic devices include a plastic antenna window or a plastic split in a housing forming a gap in the conductive metal.” *Id.* Misra explains that the break in cosmetic metal surface “breaks the consistent visual profile,” so that POSITAs desired “an RF transparent window that provides good signal quality to an antenna inside the housing of a portable electronic device while also providing structural support and visual consistency to the housing.” *Id.* ¶3. Misra provides a patch for a device in an electronic housing that has a thickness to provide a selected radio-frequency transmissivity and structural support. *See, e.g., id.* ¶¶4-8. Therefore, Misra provided an antenna window to provide radio frequency transmissivity.

126. Moreover, U.S. Patent Application Publication No. 2014/0361934 to Ely et al. (“Ely,” Ex-1049) describes an electronic device house with a “window

aligned with the radio-frequency (RF) antenna. Ex-1049 ¶5. Ely describes how antenna windows in aluminum enclosures are challenging. *Id.* ¶31. Ely provides a solution by providing a window that “non-conductive material filling a gap in the aluminum layer and a thin aluminum oxide layer adjacent to the aluminum layer and to the non-conductive material. The non-conductive material and the thin aluminum oxide layer form an RF-transparent path to allow transmission of substantially all RF radiation through the window.” *Id.* In order to make the window, Ely explains that the process includes “anodization of the exterior housing and then etching away on the interior of the housing antenna windows at desired locations for antenna windows, followed by filling in the etched portions with plastic, paint, or other suitable material to maintain structural integrity. The aluminum oxide can be substantially clear or transparent, allowing the filling material to show through. The resulting housing is cosmetically pleasing and without cracks or apparent plastic portions.” *Id.* ¶31. The window in the aluminum housing “allows transmission of substantially all RF radiation through the window portion.” *Id.* ¶7. Ely describes how the antenna windows may not only have the antenna but also have other sensors included in the electronic device. *Id.* ¶¶33, 40, 51.

127. In summary, windows in electronic device housings are particularly helpful for RF transmission.

D. Adjustment of Operational Parameters Was Known

128. Adjusting a sensor's operational parameters or measurement periodicity based on information from a sensor or battery was well known prior to 2013.

129. For example, European Patent No. 2281205 to Chen ("Chen," Ex-1050) discusses "general principles that can reduce the power consumption" of a sensor system, including using passive sensors to detect activity to then turn on other sensors and varying the sampling rate of sensors "depending on the current state"—e.g., "when little or no motion is occurring." Ex-1050 ¶33. Chen describes a system that "selectively provide[s] power to one or more other sensors and/or process in response to" a sensor detecting "motion of a user." *Id.* ¶14. Chen further explains that "power consumption of the system is significantly reduced (and hence the battery lifetime is increased) during periods when there is no or little motion." *Id.* ¶15; *see also id.* ¶20 ("Preferably, the system is configured to stop power being supplied to one or more of the other sensors and processor in the event that the passive vibration sensor detects that the motion has ceased."). Chen also describes "increas[ing] a sampling rate of the one or more sensors in response to the passive vibration sensor detecting motion." *Id.* ¶22; *see id.* ¶33 ("[T]he sampling rate of the sensors can be varied depending on the current state in order to minimize the power

consumption when little or no motion is occurring.”). Thus, adjusting a sensor’s measurement periodicity was also routine in monitoring applications.

130. For example, as explained in 2009 by Lawrence Au, “[e]nergy efficiency presents a critical design challenge in wireless, wearable sensor technology.” Ex-1051, Abstract. Au explains that to maximize monitoring system’s lifetime and maintain accuracy, “wearable sensors require hardware support that allows dynamic power control on the sensors ... as well as monitoring algorithms to control these components intelligently.” *Id.* Au suggested using “episodic sampling, ... a context-aware scheduling technique where context classification occurs only episodically,” rather than the “traditional continuous sampling.” *Id.*, 2. For example, the experiment performed in Au compared episodic sampling against continuous sampling for both low-dynamic activity (“rest”) and high-dynamic activity (“running”). *Id.*, 4. The experiment classified the activity based on measurements from a heart rate sensor, respiratory sensor, and wearable accelerometer. *Id.*, 4, Fig. 1. In some instances, episodic sampling extended battery life. *Id.*, 4, Fig. 5.

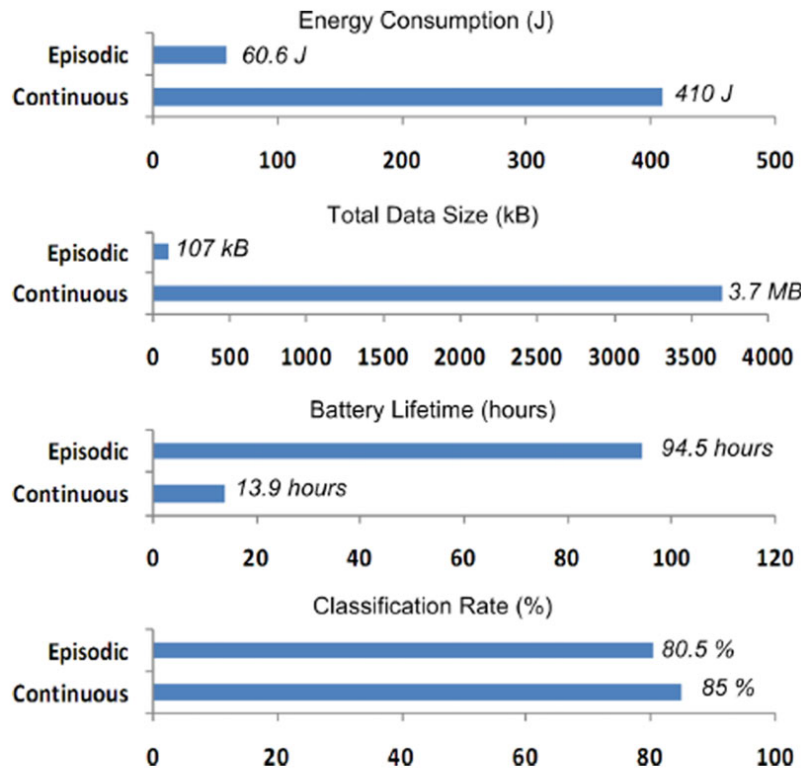


Fig. 5.
Experimental Results - Continuous vs. Episodic Sampling

131. The experiment acknowledged that although there was a savings in energy and data transmission, the accuracy of the context classification decreased. *Id.*, 5; see also *id.*, 4 (“The apparent tradeoff is the classification accuracy.”). This illustrates that increasing the sampling rate increases the accuracy of the measurements. Therefore, it was well-known adjusting a sensor’s operational parameters or measurement periodicity based on a user’s activity or sensor information could reduce power consumption of a device.

VI. CLAIM CONSTRUCTION

132. I do not believe that any claim term requires explicit construction to resolve the issues presented in this Petition. I apply the plain and ordinary meaning to each other claim term, as that plain and ordinary meaning would have been understood by a POSITA.

133. I reserve the right to offer opinions on any claim constructions proposed in this proceeding or to offer opinions on additional constructions in the district court.

VII. BRIEF DESCRIPTION OF THE APPLIED PRIOR ART

A. Schröder (Ex-1007)

134. Schröder (U.S. Patent No. 10,303,867) was filed January 25, 2016 as the U.S. national stage application of International Patent Application PCT/EP2014/001693 filed June 18, 2014, which claims priority to foreign application DE 102013012339 filed July 25, 2013. As explained to me by counsel, I understand that Schröder qualifies as prior art under 35 U.S.C. §102(a)(2). Schröder's German counterpart is essentially identical to the U.S. filing. See generally Ex-1007 (U.S. issued patent); Ex-1009 (German application); Ex-1008 (certified translation of German application). The figures are identical, and the specification is equivalent. Because the described subject matter is identical, as explained to me by counsel, I understand that Schröder's '867 Patent should be

considered to have been effectively filed as of its German priority date of July 25, 2013, because the '867 Patent is entitled to claim a right of priority to DE 102013012339 under 35 U.S.C. §365.

135. Schröder teaches a biometric sensing device, depicted in Figures 1 and 5 below, which is a “finger-ring” “worn by a user, e.g., permanently on the finger.” Ex-1007, 3:61-63, Fig. 1 (“finger-ring” 2 communicating with smartphone 4); Ex-1008, 8:4-5, Fig. 1.

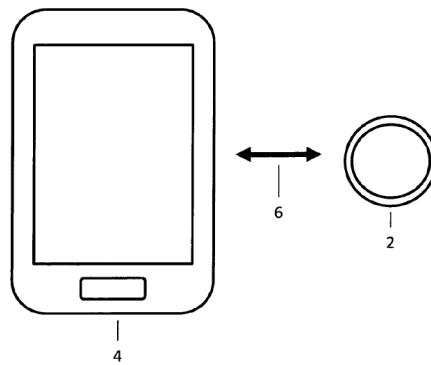


Fig. 1

136. As shown in Figure 7 below in cross-section, Schröder’s finger ring consists of “two ring halves 16 and 18” with a recess within which “inlay 12 is inserted.” Ex-1007, 12:7-9, 12:10-12 (“The finger-ring 2 consists in principle of at least one component 16, 18 into which at least one inlay 12 is inserted, whereby one component can be a ring half 16, 18.”), 12:26-28 (“The inlay 12 is ... inserted into at least one recess provided therefor within at least one component.”); *see also id.*, 8:58-59 (a chip module is inserted into the recess). Ring halves 16 and 18 are

manufactured by casting, milling, or embossing and “interconnected by a suitable technology, e.g., by plugging, gluing, screwing, crimping, etc.” Ex-1007, 12:10-22. The first ring half can be made of a metal such as silver, gold, titanium, or steel and the other half can be made of “PET, PVC, [or] carbon.” *Id.*, 15:10-11, 15:13-15. Schröder’s ring halves can be formed in a U-shape to enclose inlay 12 between the components 16 and 18. *Id.*, 12:45-55.



Fig. 7

137. Inlay 12 consists of “flexible carrier material” like PET and Kapton and can have a “chip module 10 with at least one antenna coil 8.” Ex-1007, 12:28-33, 12:61-65. Schröder’s finger ring has an “energy storage device” such as a battery that supplies chip module 10 with energy from an outside “electromagnetic field of a reader.” Ex-1007, 11:46-56. The energy storage device is charged by its direct connection to antenna coil 8 via a rectifier circuit. Ex-1007, 11:63-68. A battery powers chip module 10 and is charged wirelessly. Ex-1007, 11:46-50, 11:55-56.

138. The finger ring also has “biometric sensors” such as an infrared diode and sensor to “capture[,] e.g., at least a partial vein image in the finger while the finger-ring 2 is being pushed over a finger.” Ex-1007, 9:62-10:4; Ex-1008, 21:13-

16. Additionally Schröder’s finger ring has an LED and/or optical display to display security codes or “application specific data” such as “[one-time passwords], PIN numbers, hash values, random numbers, payment amounts, contents of an electronic purse” may be displayed as a sequence of colors by an LED or displayed by an “optical display unit.” Ex-1007, 8:32-53.

B. Niwa (Ex-1005)

139. Niwa (U.S. Patent Publication No. 2012/0016245) was filed July 13, 2011, and published January 19, 2012. As explained to me by counsel, I understand that Niwa qualifies as prior art under §102(a)(1) and §102(a)(2).

140. Niwa teaches a wearable electronic sensing device with light-emitting and light-receiving components to acquire a plethysmogram—e.g., information relating to blood volume—of the wearer. Ex-1005. Niwa teaches a “finger ring type housing” that contains light-emitting and light-receiving components located at first unit 10 and a battery at second unit 20. *Id.* ¶29. Cable 30 electrically connects first unit 10 and second unit 20. Ex-1005 ¶¶62, 194-95. Second unit 20’s battery supplies power to the first unit. *Id.* ¶¶62, 193, 213, 218. Figures 22 and 26 depict Niwa’s ring-shaped device that surrounds the finger. *Id.* ¶192.

FIG.22

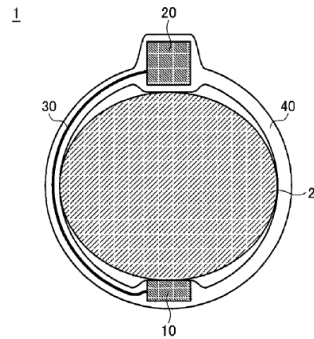
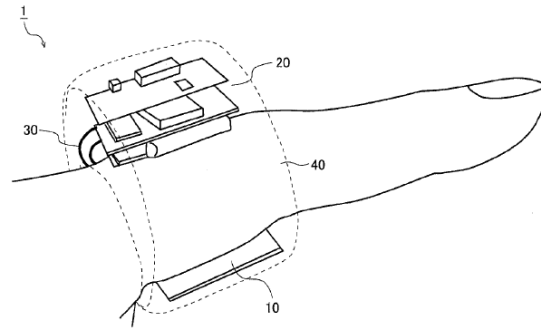
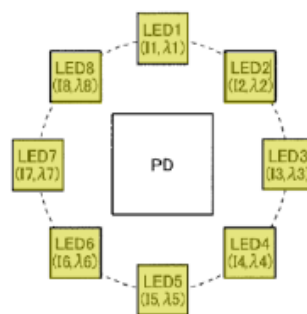


FIG.26



141. Niwa teaches various configurations for light-emitting portions and light-receiving portions in the first unit 10. Ex-1005 ¶¶120, 147. For example, Niwa's Figure 3 shows light-emitting portions having different wavelengths from one-another and have different radial positions.

FIG.3



C. Mestas (Ex-1010)

142. Mestas (U.S. Pat. Pub. No. 2014/0244009) was filed February 21, 2014, claiming priority to Provisional App. No. 61/768,279, filed February 22, 2013. As

explained to me by counsel, I understand that Mestas was published August 28, 2014, and qualifies as prior art to the '178 Patent under 35 U.S.C. §102(a)(2). Mestas's provisional application is essentially identical to the published application. *See generally* Ex-1010 (published Mestas application); Ex-1011 (provisional). The figures and the specification are identical.² As explained to me by counsel, I understand that because the described subject matter is identical, Mestas's disclosures were effectively filed as of Mestas's provisional application, and Mestas is thus available as a patent prior art reference under 35 U.S.C. §102(a)(2) as of its provisional filing date of February 22, 2013.

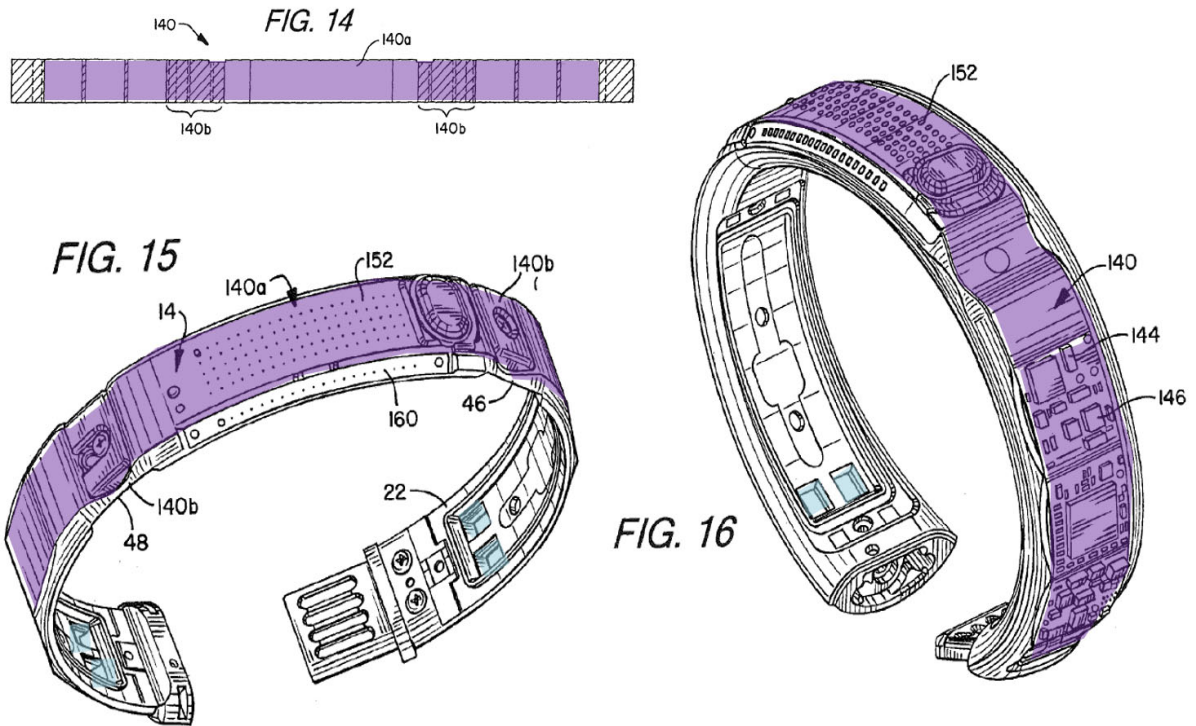
143. Mestas teaches a wearable electronic device, depicted in Figure 15 below, which is an arm-band or a wrist-band, and can be used to monitor user biometrics such as heart rate. Ex-1010 ¶148, Figs. 1, 15. Mestas teaches that the “wearable athletic device may be worn in a variety of locations on a user's body including on a user's chest (e.g., a chest strap), around a user's wrist, around a user's arm, on a user's head, on a user's ankle or thigh, and the like.” *Id.* ¶143.

² The only difference between the two is the Mestas published application separately numbers all paragraphs in the Brief Description of Drawings, whereas the provisional does not. *Compare* Ex-1010 ¶¶9-137 with Ex-1011 ¶7.

FIG. 1



144. As shown below in Figures 14-16, Mestas's wearable computing device has housing 12 that includes an inner spine member 22 to support the internal components. Ex-1010 ¶151. PCB member 140 (purple) is "wrapped around and mounted to the spine member 22." *Id.* ¶164. Curved batteries are "positioned in the recessed compartments 50,52" of the spine member so that the battery's contacts "engage the PCB member 140 to provide power to the device 10." *Id.* ¶¶168, 177.



D. Yuen (Ex-1006)

145. Yuen (U.S. Patent No. 8,954,135) was filed June 24, 2013 and issued February 10, 2015. As explained to me by counsel, I understand that Yuen qualifies as prior art under 35 U.S.C. §102(a)(2).³

146. Yuen teaches a wearable electronic device that monitors physiological and/or environmental data from or on the wearer. Ex-1006, 1:19-27. Yuen's device

³ Counsel has advised me that the Yuen reference (Ex-1006) was cited on an Information Disclosure Statement with 139 other references (Ex-1004, 0632-0638) but not used in a rejection during prosecution. Counsel has further advised me that the Examiner's Office Actions and Notice of Allowance are silent on Yuen's teachings. It is my opinion that Yuen's teachings renders Claims 1, 4-11, and 13-16 obvious for the reasons discussed below.

has a battery and a processor. *Id.*, 12:18-61, 14:42-16. Yuen describes using magnets to align the device to a charger or dock. *Id.*, 14:42-49, 28:40-49.

147. Yuen also describes adjusting a sensor's operation based on information derived from the sensor data, e.g., heart rate, sleep state, or user activity. *Id.*, 6:57-7:6, 10:14-25, 21:14-45. Yuen further teaches adjusting "operating conditions" of a sensor upon the device or sensor being placed in "a lower power mode." *Id.*, 9:15-35. Figure 15 below shows a flow chart of how a sensor's operation changes based on detected user activity or heart rate. *See id.*, 3:52-62.

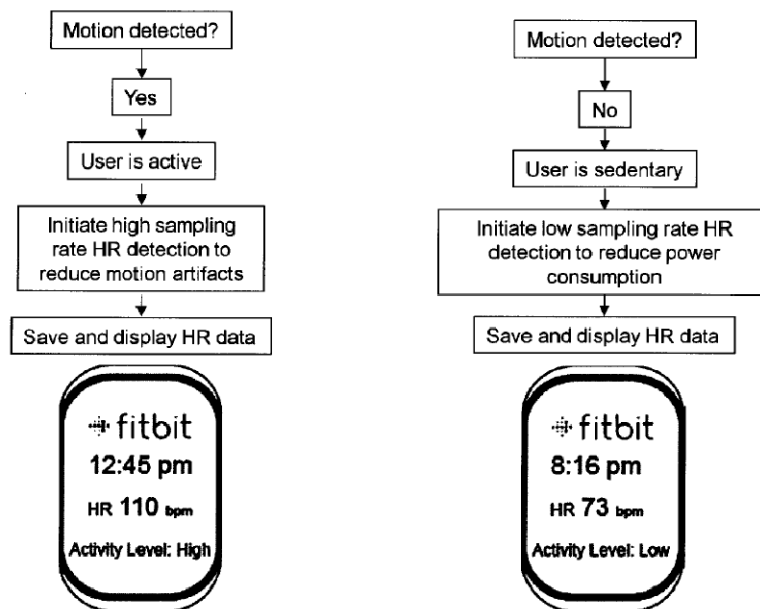


FIG. 15

148. Yuen further describes sensors, including "a plurality of photodetectors and photoemitters placed along the circumference of the interior of the band." Ex-1006, 19:8-10, Fig. 11.

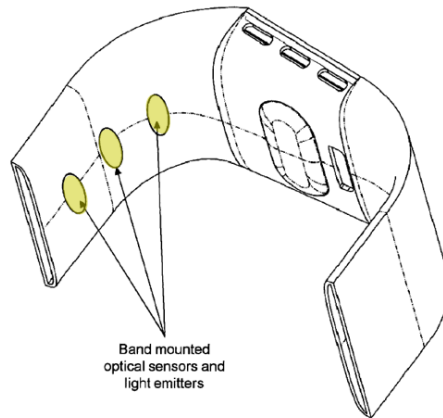


FIG. 11

VIII. DETAILED EXPLANATION OF THE UNPATENTABILITY GROUNDS

A. Ground 1: Claims 1-3 and 17-18 are obvious over Schröder in view of knowledge of a POSITA.

1. Independent Claim 1

a. Element 1[pre]: A finger-worn wearable ring device, comprising:

149. It is my opinion that Schröder teaches⁴ the preamble of Claim 1 to the extent that it is limiting.

150. Schröder discloses an “external secure unit” worn as a “finger-ring.” Ex-1007, 2:60-64, Fig. 1 (element 2). Schröder explains that the ring shape is advantageous for being able to “always [be] taken along” because “it is always

⁴ I use the term “teaches” as including both express teachings or those fairly suggested to a person of ordinary skill in the art.

located on one's body.” *Id.*, 2:64-67, 3:61-62 (“The finger-ring 2 is worn by a user e.g., permanently on the finger.”).

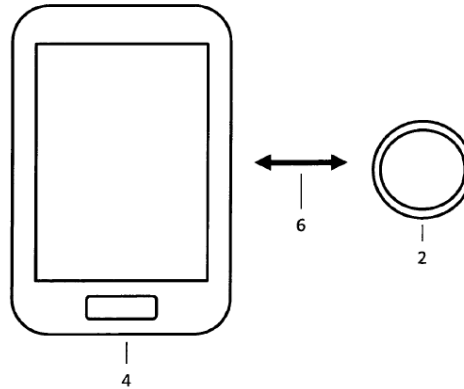


Fig. 1

151. In my opinion, a POSITA would have recognized Schröder’s “finger-ring” to be a device. Schröder describes the external secure unit as connected with a smartphone. *Id.*, 3:57-4:22.

b. Element 1[a]: an external housing component defining an outer circumferential surface of the finger-worn wearable ring device;

152. It is my opinion that Schröder teaches Element 1[a].

153. Schröder teaches a “finger-ring” that has an external housing defining the outer circumferential surface. Schröder’s finger-ring consists of “two ring halves 16 and 18” with a recess so that “inlay 12 is inserted.” Ex-1007, 12:7-9. In my opinion, a POSITA would have recognized that the ring half 18 is an external

housing component (green) that defines an outer circumferential surface of the finger-worn wearable ring device because it is the side of Schröder's "finger-ring" that is exposed to the outside environment and provides an enclosing structure to inlay 12.

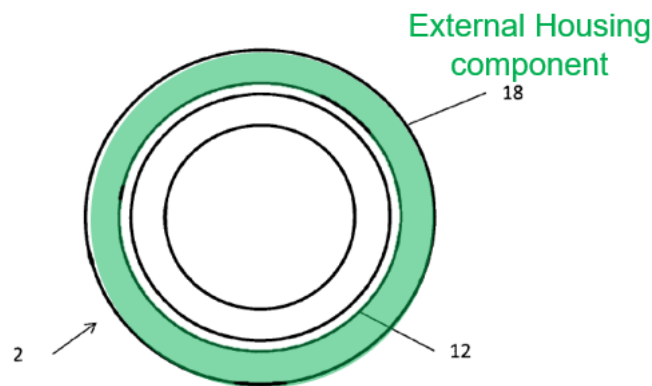


Fig. 4

154. Indeed, a POSITA would have understood that an external housing was routinely used on a ring device to protect internal components from the elements. Further, in my opinion, an external housing component defining an outer circumferential surface would be obvious given the ring shape of the device. Wearers of a ring device would want the exterior of the ring to be smooth for comfortable wear and durable for long-term use. As I described above in Section V.B.1, this was a factor considered by POSITAs when developing wearable electronic monitoring devices.

- c. Element 1[b(i)]: an internal housing component defining an inner circumferential surface of the finger-worn wearable ring device, the internal housing component coupled with the external housing component,**

155. It is my opinion that Schröder teaches Element 1[b(i)].

156. Schröder teaches an internal housing component defining an inner circumferential surface of the finger-worn wearable ring device. Schröder’s “finger-ring 2 is worn by a user, e.g., permanently on the finger.” Ex-1007, 3:61-62; *see id.*, 7:38-39 (“a user wears the external secure unit...directly on his body”), 10:52-56 (“continually worn on the body, e.g., on the finger.”). Schröder’s “finger-ring” consists of “two ring halves 16 and 18” with a recess so that “inlay 12 is inserted.” *Id.*, 12:7-9. As shown in Figure 4 below, ring half 16 (green) is the internal housing component defining an inner circumferential surface of the finger-worn wearable ring device because it is the inside ring that contacts the user’s skin when the user is wearing the “finger-ring.”

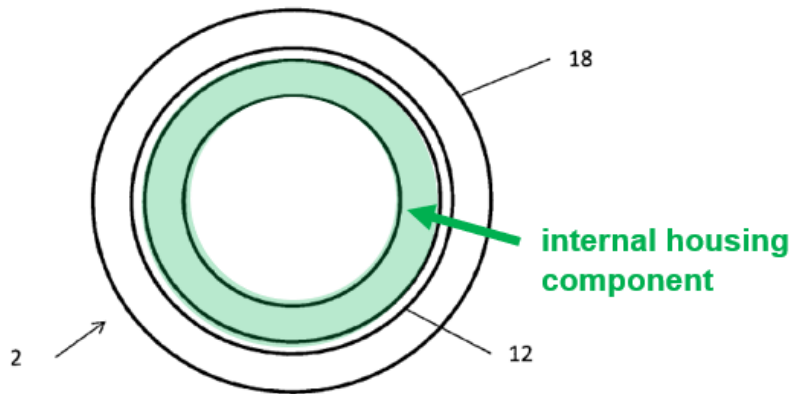


Fig. 4

157. Schröder's internal housing component is coupled with the external housing component to form the "finger-ring." As shown below in Figure 5, Schröder's inner ring half 16 and outer ring half 18 "are interconnected by a suitable technology, e.g., by plugging, gluing, screwing, crimping, etc." Ex-1007, 12:20-22. Schröder's internal housing component is thus coupled with the external housing component, as illustrated by the abutting components 16 and 18 forming the "finger-ring" in Figure 5.

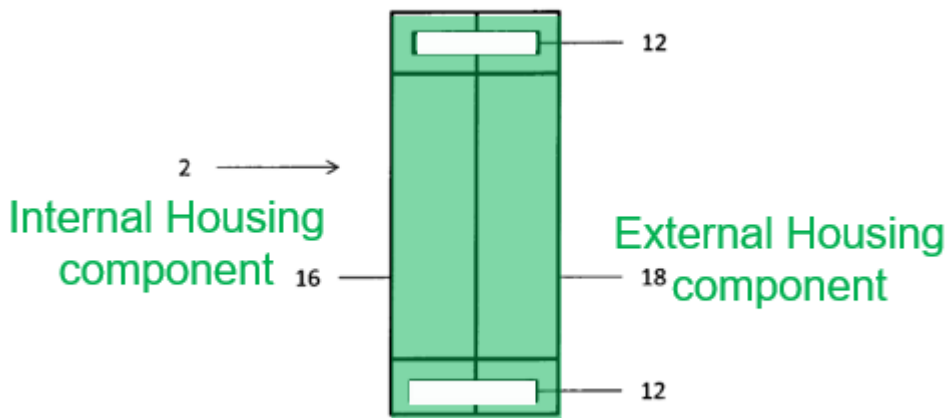


Fig. 5

158. As I explained in the Technology Background Section (*see* Section V), housing electronic parts in a cavity within or between two components was known. For example, U.S. Patent No. 6,699,199 to Asada teaches that “one or more photo diodes 2 and one or more light-emitting diodes (LEDs) 4 are imbedded in a ring 10.” Ex-1034, 2:59-61 (Asada ’199). Moreover, U.S. Patent No. 6,745,061 to Hicks teaches that “[i]ncluded within the assembly 350 are upper and lower flexible members 304 and 300, respectively,” which are “thermally bound to one another sandwiching a leadframe 308 between their inside surfaces.” Ex-1025, 6:48-54 (Hicks). “This leadframe 308 contains active components (i.e., LEDs and a photodetector) for use in oximetry measurements.” Ex-1025, 6:48-54 (Hicks).

- d. Element 1[b(ii)]: wherein at least a portion of the inner circumferential surface of the internal housing component is configured to contact a tissue of a user when the finger-worn wearable ring device is being worn by the user;**

159. It is my opinion that Schröder teaches Element 1[b(ii)].

160. Schröder's internal housing component contacts the user's tissue when the finger-worn wearable ring device is being worn. Schröder's "finger-ring 2 is worn by a user e.g., permanently on the finger." Ex-1007, 3:61-62; *see id.*, 7:38-39 ("a user wears the external secure unit...directly on his body"), 10:52-56 ("continually worn on the body, e.g., on the finger"). Schröder also describes a biometric sensor "integrated into the finger-ring 2 e.g., such that the biometric sensor captures e.g., at least a partial vein image in the finger while the finger-ring 2 is being pushed over a finger." *Id.*, 9:62-66. In my opinion, a POSITA would have understood that the interior portion of the "finger-ring" that is "permanently," "directly," and "continuously" worn on the finger and that has a biometric sensor that captures a vein image of the finger comes into contact with the user's tissue.

- e. **Element 1[c]: a battery positioned within a cavity formed between the internal housing component and the external housing component, wherein the battery comprises a shape and size configured to fit within the cavity between the outer circumferential surface of the external housing component and the inner circumferential surface of the internal housing component, and wherein the battery extends through at least a first portion of the cavity of the finger-worn wearable ring device;**

161. It is my opinion that Schröder teaches Element 1[c].

(1) A battery positioned within a cavity formed between the internal housing component and the external housing component

162. Schröder's "finger-ring" has a battery positioned within a cavity between the internal and external housing components. In my opinion, a POSITA would have understood that a wearable electronic device has electronic components housed in its interior. Housing electronic components inside a device is typical to protect the components inside and to make the wearable device more comfortable. As described above in Section V.B.2, it was well known to assemble electronic parts within a structural cavity, and the cavity became essential for electronic systems to fit in a convenient form factor. Moreover, it is my opinion that electronic components housed inside a device are necessarily in a cavity within the device. As discussed above, Schröder's "finger-ring" consists of "two ring halves 16 and 18 respectively hav[ing] a recess into which inlay 12 is inserted." Ex-1007, 12:7-9; *see*

also id., 8:56-57 (inlay 12 “arranged” in the interior). Inlay 12 has a “chip module 10 with at least one antenna coil 8 with at least one further electronic device.” *Id.*, 12:61-65; *see id.*, 8:58-60 (“chip module 10 is inserted into a recess of the finger-ring 2”). Schröder further describes “a ring-shaped body in whose interior the chip module 10 and the antenna coil 8 and any further electronic devices are arranged.” *Id.*, 14:47-49. It is my opinion that a POSITA would have understood that Schröder’s “finger-ring” has a cavity between the internal and external housing components to allow the internal components to be arranged inside of the “finger-ring.” As I described above in Section V.B.1-2, there are various ways to assembly electronic parts within structural cavities. Similarly, Figure 7 below illustrates a cavity (red) between the internal and external housing units (green).



Fig. 7

163. Schröder teaches a battery positioned within a first portion of the cavity of the “finger-ring.” Schröder’s “finger-ring” has a battery “connected to the chip module 10.” Ex-1007, 11:46-50; *see also id.*, 11:58-61 (powering a display). Schröder further teaches a battery is charged wirelessly “by means of the reader’s

electromagnetic field.” *Id.*, 11:54-55. Schröder teaches that its battery is “connected directly to the antenna coil 8 via a rectifier circuit, with the chip module 10 connecting the energy storage device to the antenna coil 8.” *Id.*, 11:63-66.

164. In my opinion, it would have been obvious that because the energy storage unit (i.e., battery) powers chip module 10 and chip module 10 resides in inlay 12, the battery is also positioned inside the ring. And, it is my opinion that it would have been obvious because the battery, which powers the electrical components within the ring, is charged wirelessly, the battery must be inside the “finger-ring.”

165. As I explained in the Technology Background Section (*see* Section V), finger-ring structures having inner and outer surfaces with electronics housed inside within a cavity were known. For example, Rhee’s thesis and papers teach a finger-ring sensor having inner and outer surfaces. Specifically, Rhee teaches, as shown in Figure 1 (Rhee 2000 Part II) and Figure 3 (Rhee 2001), that an “inner ring floats inside the outer ring” such that “[w]hen a patient wears the ring, both rings are put on the same finger.” And, “[s]ince the outer ring covers the inner ring, the external force is born by the outer ring and does not directly act on the inner ring.” Ex-1032, 2796 (Rhee 2000 Part II); Ex-1033, 799 (Rhee 2001); Ex-1035, 68 (Rhee Thesis 2000) (same).

(2) Wherein the battery comprises a shape and size configured to fit within the cavity between the outer circumferential surface of the external housing component and the inner circumferential surface of the internal housing component

166. Schröder teaches a battery of a shape and size that fits within the cavity between the outer circumferential surface of the external component and the inner circumferential surface of the internal housing component. In order to fit inside the “finger-ring,” the battery must be configured in size and shape to fit within the cavity. As I discussed above, a POSITA would understand that within the body of the “finger-ring,” the battery can be assembled into a preformed cavity. A POSITA would have understood Schröder’s Figures 6-8 as showing a cavity that is between the outer circumferential surface of the external housing component and the inner circumferential surface of the internal housing component. The battery must be arranged within the cavity between the internal and external housing components. Otherwise, if the battery is not configured to fit within the “finger-ring,” the “finger-ring” either has (1) a battery that sticks out or is exposed to the environment or (2) a wired connection to power its components, which is contrary to the intent of having a portable, wearable device.

167. As I explained in the Technology Background Section, in order to inductively charge a battery, there must be a coil of a primary power transmitter and

a coil of a secondary power receiver. Ex-1053, Ex-1054. Here, a POSITA would have understood that the battery is thus arranged inside the cavity of the “finger-ring” in order to power the interior electrical components. The battery is not a structural or housing component, but sits within a cavity of a structural element. A POSITA would have understood that within the body of the “finger-ring,” the battery can be assembled into a preformed cavity. A preformed cavity within the body of the “finger-ring” is shaped to accommodate the battery and other components.

(3) Wherein the battery extends through at least a first portion of the cavity of the finger-worn wearable ring device

168. It is my opinion that Schröder teaches a battery that extends through at least a first portion of the cavity. A POSITA would have understood that the battery’s location within the cavity is the “first portion” of the cavity because the battery necessarily occupies space in the cavity. Ex-1007, 12:8-10.

f. Element 1[d]: a printed circuit board disposed between the internal housing component and the external housing component, wherein the printed circuit board extends through at least a second portion of the cavity of the finger-worn wearable ring device different from the first portion; and

169. It is my opinion that Schröder teaches Element 1[d].

(1) Wherein the battery extends through at least a first portion of the cavity of the finger-worn wearable ring device

170. Schröder's "finger-ring" has a PCB in the cavity between the internal and external housing components. Schröder states that "inlay 12 serves as a carrier." Ex-1007, 8:54-57. Schröder also describes an "antenna coil 8 is applied to the carrier by a suitable technology, e.g., by a printing technique, a wirelaying technique, an etching technique, a milling technique. The chip module 10 is connected to the antenna coil 8 by means of a suitable technology, e.g., by soldering, gluing, crimping." *Id.*, 12:35-40. In my opinion, a POSITA would have understood Schröder as teaching a PCB.

171. As explained above, it is my opinion that a POSITA would have understood that a cavity exists between the internal and external housing components, e.g., where the inlay is arranged. For example, Schröder's inlay 12 is explicitly arranged "in the interior of the finger-ring." *Id.*, 8:54-57, 12:61-65. Inlay 12 consists of "flexible carrier material like PET and Kapton," which are commonly understood to be the material making up a PCB. *Id.*, 12:28-29. It was well-known that Kapton is a material used in making printed circuit boards. *See* §V.B.4. It is my opinion that a POSITA would have understood that Schröder's inlay corresponds to the claimed PCB.

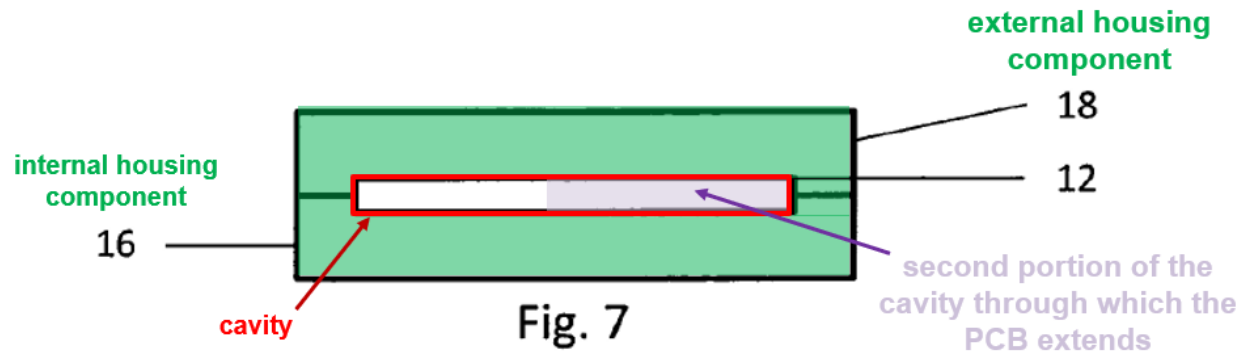
(2) Wherein the printed circuit board extends through at least a second portion of the cavity of the finger-worn wearable ring device different from the first portion

172. It is my opinion that Schröder teaches a PCB that extends through a second portion of the cavity different from the first portion of the cavity (where the battery is located). As explained above, Schröder teaches inlay 12 is a PCB disposed between the internal housing component and the external housing component because it is between the interior ring half 16 and exterior ring half 18.

173. As a matter of common sense, two solid components cannot occupy the same space at the same time. As applied to Schröder, the battery exists within the cavity of the “finger-ring,” and therefore takes up a “first” portion of the cavity. Likewise, Schröder’s PCB—by existing within the cavity of the “finger-ring”—takes up a “second” portion of the cavity. Because the PCB cannot occupy the same portion as the battery, and vice versa, their respective portions of the cavity must be different. It is my opinion that a POSITA would have understood that the PCB extends through a “portion of the cavity” that is necessarily different from the “portion of the cavity” occupied by the battery.

174. In my opinion, a POSITA would have understood that Schröder’s PCB extends through at least a second portion of a cavity (Schröder’s “recess,” light purple below) that is between the inner and outer housing components (green), but

does not extend through the entire cavity of finger-ring 2 in order to allow space for other electrical components. Schröder's Figure 7 (cross-section) below illustrates this.



175. In my opinion, a POSITA would have been motivated to arrange electrical components within the cavity of the “finger-ring” for various design reasons. For example, a POSITA would have been motivated to place a battery in a part of the cavity that is far from a PCB holding other electrical components because that configuration allows for better thermal management (e.g., the other electrical components would raise the temperature around the battery, thus impacting the battery’s performance). Under this motivation, annotated Figure 5 (cross-section) below illustrates a first portion where the battery exists in relation to a second portion where the PCB resides (different from that of the first portion).

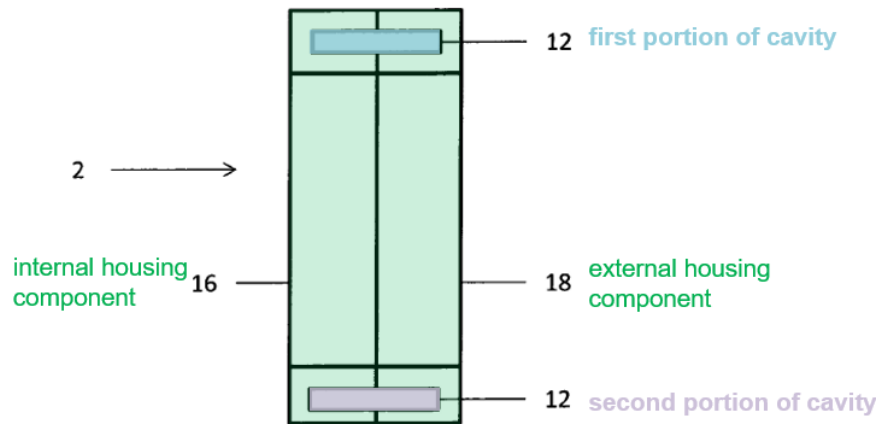


Fig. 5

It is my opinion that this arrangement of the battery and the PCB would have been obvious. Indeed, Niwa describes an arrangement where the battery and a PCB are in different parts of the ring. *See* Ex-1005 ¶¶67-68, Figs. 27-28 (showing battery in second unit at top of the ring and PCB of the first unit at bottom of the ring).

176. Schröder teaches a battery and a PCB are present in the cavity; thus the cavity existing between the internal and external housing components must provide space for both the battery and PCB. It is my opinion that a POSITA would have understood that Schröder teaches a first and second portion of the cavity as being the respective locations of the battery and PCB.

- g. Element 1[e]: one or more sensors electrically coupled with the printed circuit board and the battery and configured to acquire data from the user through the internal housing component.**

177. It is my opinion that Schröder teaches Element 1[e].

(1) One or more sensors electrically coupled with the printed circuit board and the battery

178. In my opinion, Schröder teaches a “finger-ring” that has a sensor electrically coupled to the PCB and the battery to acquire user data. Specifically, Schröder has “biometric sensors” such as an infrared diode and sensor “integrated into the finger-ring” to “capture[] e.g., at least a partial vein image in the finger while the finger-ring 2 is being pushed over a finger.” Ex-1007, 9:62-10:4. Schröder states, “[t]he biometric sensor is connected suitably to the chip module 10.” *Id.*, 9:58-59. In my opinion, a POSITA would have understood that the sensor would be electrically coupled to the PCB and battery because the sensor needs to be provided with power in order to operate. *See also id.*, 9:60-62 (“arranged on the chip module or it can be arranged in the finger-ring 2 separately from the chip module 10”).

(2) One or more sensors configured to acquire data from the user through the internal housing component

179. Schröder teaches a “finger-ring” with a sensor configured to acquire data from the user through the internal housing component. Schröder teaches that its biometric sensor “captures” a vein image of the user’s finger when the “finger-ring 2” is pushed over the wearer’s finger. Ex-1007, 9:62-66, 10:9-11. Schröder also describes capturing the wearer’s fingerprint. *Id.*, 10:28-29. To capture a vein image or fingerprint image (i.e., acquire data from the user), the sensor of the

“finger-ring” is configured in a way as to capture these images through the internal housing component.

180. The housing components of Schröder’s “finger-ring” is made of “plastic or metal.” Ex-1007, 12:16. As discussed above, the sensor has light-emitting and light-receiving components. In my opinion, a POSITA therefore would have recognized that Schröder’s sensor acquires data from the user through the internal housing component by acquiring information through the ring half 16 that touches the finger. Thus Schröder teaches one or more sensors electronically coupled with the PCB and battery, and configured to acquire data from the user through the internal housing component.

2. Dependent Claims 2-3 and 17-18

- a. Claim 2: The finger-worn wearable ring device of claim 1, wherein the first portion of the cavity of the finger-worn wearable ring device is non-overlapping with the second portion of the cavity of the finger-worn wearable ring device.**

181. It is my opinion that Schröder teaches Claim 2.

182. Schröder teaches that the first portion of the cavity does not overlap with the second portion of the cavity of the finger-worn wearable ring device. In my opinion, a POSITA would have understood that there were a finite number of ways—here, only two ways—to design the cavity in a finger-worn wearable ring

device and each would have been obvious to try. Therefore, there are only two ways to position the battery and PCB within the housing of Schröder's "finger-ring": they are either in overlapping portions of the cavity or in non-overlapping portions of the cavity. *See also supra* §V.B.1-3.

183. As described in the above sections addressing Elements 1[c] and 1[d], Schröder teaches that the battery is located in a first portion of the cavity and the PCB is located in a second, different portion of the cavity. This concept of non-overlapping portions and overlapping portions in a cavity is obvious and apparent in the prior art. For example, in Niwa, Figures 27 and 28 provide cross-section views of possible ways to orient electrical components within a finger ring. There are some substrates (PCBs) that overlap with the battery in the first unit. *See* Ex-100X, Fig. 28. But Niwa's Figure 27 shows another substrate 11 that clearly does not overlap with the battery of the first unit. *See infra* §XIII.E.2.a (Ground 5).

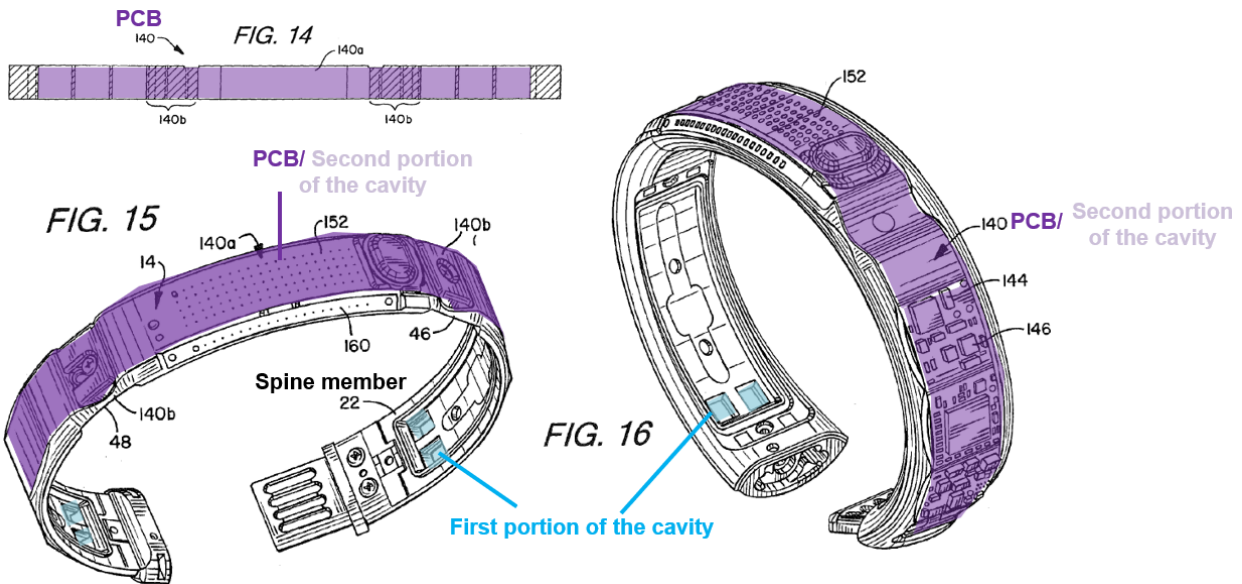
184. There are many motivations to have the first and second portions of the battery not overlap based on the factors a POSITA would have considered when designing a wearable electronic device (as I discussed above in Section V.B.2). First, a POSITA would have been motivated to design the first portion of the cavity that has the battery to not overlap with the portion of the cavity that has the PCB in order to have a thinner, more compact finger-worn wearable ring device to reduce

the volume of the cavity, making the ring more comfortable to wear. Second, by not overlapping these portions, a designer can save on material costs as there are less components and substrates to accommodate. Third, a POSITA would have been motivated to design non-overlapping portions for better battery performance. In the context of thermal management, if the battery portion overlaps a portion with other electrical components, the battery will warm up faster because there is less space around the battery to allow for temperature variation than if battery portion was non-overlapping. Fourth, a POSITA would have been motivated to prevent overlap to ease assembly. Given the small form factor of the ring, preventing overlap simplifies the design and assembly by using less parts and not requiring as much careful assembly. Fifth, non-overlapping portions could help reduce noise or to be less obstructive of the multiple paths or wavelengths the sensor(s) are emitting or receiving. Taken together, it is my opinion that the non-overlap of the portions of the cavity is not the product of innovation, but of ordinary skill and common sense.

- b. Claim 3: The finger-worn wearable ring device of claim 1, wherein the first portion of the cavity of the finger-worn wearable ring device at least partially overlaps with the second portion of the cavity of the finger-worn wearable ring device.**

185. It is my opinion that Schröder teaches Claim 3 for the same reasons, as described above in Elements 1[c] and 1[d], and Claim 2. *See supra* §§VIII.A.1.e-f, VIII.A.2.a.

186. As I explained above, by 2013, designers of wearable electronic devices were well versed in arranging electronic components in small form factors. *See* §V.B.2. Similarly, it was well known in the art to overlap portions of a cavity within an electronic device. For example, Mestas describes a wearable computing device has a housing 12 that includes an inner spine member 22 that supports the internal components of the device. Ex-1010 ¶151 (Mestas). A POSITA would have understood that the space inside housing 12 occupied by spine member 22 and other electronic components is a “cavity.” Mestas then describes batteries “positioned in the recessed compartments 50,52 [light blue] wherein the contacts 150 [not labelled] extend through the openings 59 [not labelled] in the compartments 50,52 and engage the PCB member 140 to provide power to the device 10.” *Id.* ¶168. The battery contacts “are biased against mating contacts associated with PCB member 140.” *Id.* ¶177.



187. A POSITA would have understood Mestas's wearable electronic device of having two different portions of the cavity: the portion that the battery occupies and the portion that the PCB occupy. In my opinion, a POSITA also would have understood that a first portion of the cavity overlaps with a second portion of the cavity because the PCB member wraps around the entire length of the spine member (defining the second portion) and the first portion (where the batteries are mounted) is positioned on the interior side of the spine member. As it was known in the art to overlap a portion of the cavity occupied by the battery with a portion of the cavity occupied by the PCB, it would have been obvious to do so in Schröder's "finger-ring."

188. In my opinion, a POSITA would have been motivated to design the first portion of the cavity that has the battery to at least partially overlap with the portion

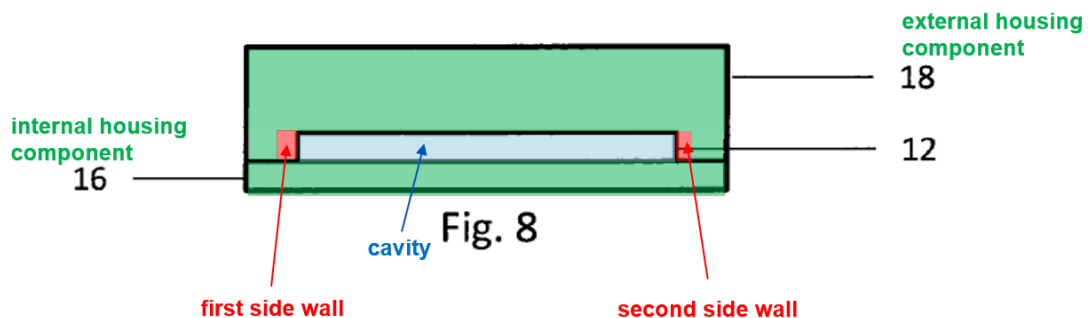
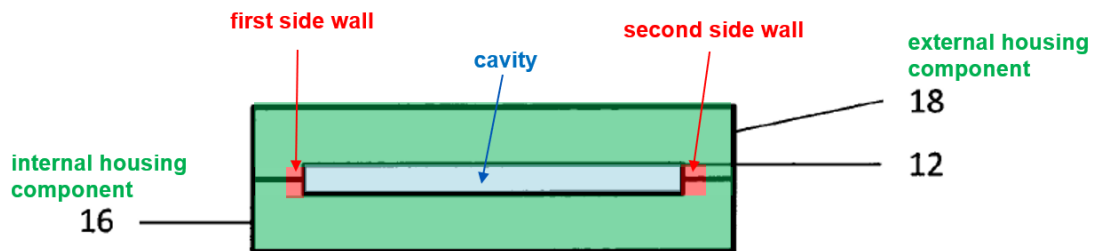
of the cavity that has the PCB to reduce the risk of electrical components and the PCB losing mechanical or electrical connections to each other. First, a POSITA would have been motivated to have the portions overlap to better utilize the limited form factor of the “finger-ring.” For example, the overlap would allow for a smaller form factor because the components would occupy less space. Relatedly, if keeping the original volume, overlap would allow for more components to fit in the space. This, in turn, could lead to increased functionality for the “finger-ring.” Second, overlap would allow for a more reliable connection between the PCB and battery. It is well known that the further electrical components are from each other, the more likely the electrical or mechanical connection coupling these components gets compromised (e.g., probability of shorts). On the other hand, if there is overlap, the connection coupling these components can shorten in length, thus increasing the reliability of the connection. In my opinion, the overlap of portions of the cavity is not the product of innovation, but of ordinary skill and common sense.

- c. **Claim 17: The finger-worn wearable ring device of claim 1, wherein the external housing component and the internal housing component define the cavity configured to at least partially surround the battery, and the printed circuit board, wherein one of the external housing component or the internal housing component comprises: a first side wall and a second side wall that extend between the internal housing component and the external housing component, wherein the cavity is defined at least in part by the outer circumferential surface, the inner circumferential surface, the first side wall, and the second side wall.**

189. It is my opinion that Schröder teaches Claim 17.

190. Schröder's "finger-ring" has a cavity between the internal and external housing components which house and thus surround Schröder's inlay 12 (PCB) and battery. *See* §VIII.A.1.e-f (elements 1[c]-1[d]). As I explained for Claim 1, Schröder's ring halves 16 and 18 correspond to the claimed internal and external housing components. These ring halves 16 and 18 are manufactured by "casting, milling, or embossing" and are "interconnected by a suitable technology, e.g., by plugging, gluing, screwing, crimping, etc." Ex-1007, 12:10-22. Schröder provides various designs for the shape of the ring halves, such a U-shape with inlay 12 being arranged between the components 16 and 18. *Id.*, 12:45-55. As shown in Figure 7 below, the U-shaped housing components are connected to each other and thus form "side walls" (red) that extend from external housing component 18 to internal

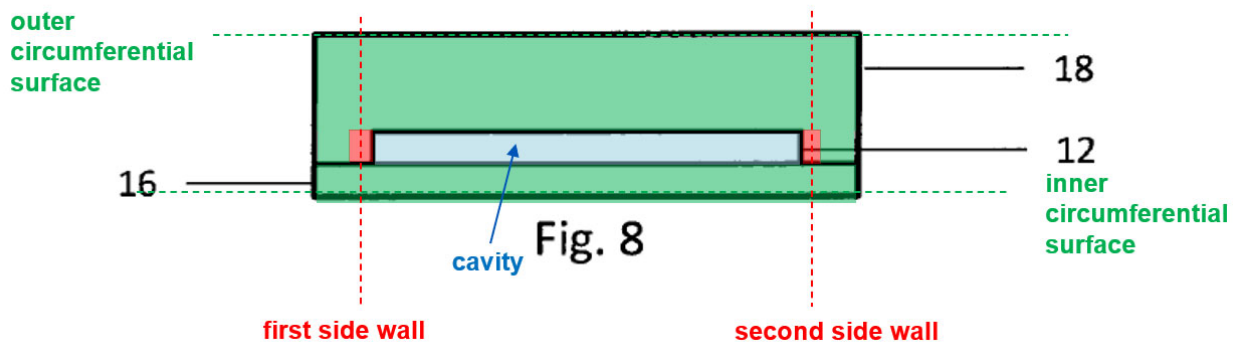
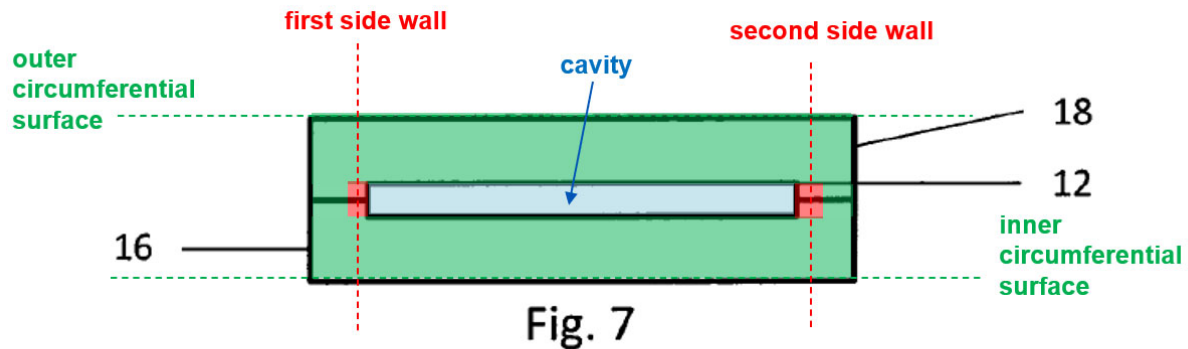
housing component 16 and surround the cavity (occupied by inlay 12). Similarly, in Figure 8, external housing portion 18 is a U-shape component that extends and connects to internal housing component 16 and defines the cavity by surrounding inlay 12 therefore having “side walls” (red) to form the connection. *Id.* In my opinion, Schröder teaches a first side wall and a second side wall that both extend between the internal and external housing components. A POSITA would have also understood that the cavity would therefore be defined at least in part by the outer circumferential surface, the inner circumferential surface, the first side wall, and the second side wall.



- d. Claim 18: The finger-worn wearable ring device of claim 17, wherein the first side wall, the second side wall, or both, are substantially perpendicular to the inner circumferential surface, the outer circumferential surface, or both.**

191. Schröder teaches Claim 18.

192. Schröder's first and second side walls are substantially perpendicular to the inner and outer circumferential surfaces. As stated above for Claim 17, the side walls are the part of the U-shaped components that extend from external housing component 18 to internal housing component 16 and surround the cavity to connect the housing components. Annotated Figures 7 and 8 below illustrate how the side walls (red) are substantially perpendicular to the inner and outer circumferential surfaces, i.e., outside surfaces of the internal and external housing components (green).



193. A POSITA would have found been motivated to implement side walls that are substantially perpendicular to the inner and/or outer circumferential surface to strengthen the structure of the cavity and extend the longevity of the components. For example, a cavity with a strong structure allows for better thermal management (less components overheating) and lessens the likelihood of weakening of the components' physical connections (less contact from other components).

B. Ground 2: Claims 1-3 and 13-16 are obvious over Schröder in view of Niwa.

1. A POSITA would have been motivated to combine Schröder with the teachings of Niwa and would have had a reasonable expectation of success.

194. A POSITA would have been motivated to apply the teachings of Niwa to Schröder (“Schröder-Niwa”), and would have had a reasonable expectation of success in doing so because each relates to the same well-known technologies.

195. A POSITA would have been motivated to combine Schröder with Niwa because they are analogous art and teach improvements to the same type of devices. Both Schröder and Niwa are directed to wearable biometric sensing devices having similar structural components including, for example, inner and outer housing components, a cavity, and electronic components (e.g., battery and PCB) within the cavity. *See, e.g.*, Ex-1007 (Schröder), 11:46-48 (battery), 12:26-42 (PCB), Figs. 4-10 (showing device’s structure); Ex-1005 (Niwa) ¶¶ 67-68 (circuits and substrate), 194-95 (FPC [Flexible Printed Circuits], i.e., a PCB), 213 (battery), Figs. 22, 26-29 (showing device’s structure). Schröder’s “finger-ring” includes a “recess” (i.e., cavity) within at least one of its components (16, 18) where an electronic part (e.g., chip module 10 and/or inlay 12) is inserted. Ex-1007 (Schröder), 12:10-32, 15:26-28. Schröder further teaches using injection-molding to cover the electronic part and cavity with a resin or plastic to form “a ring-shaped body.” *Id.*, 14:38-49. Niwa

likewise teaches a cavity that houses electrical components. Ex-1005 (Niwa) ¶¶201, 205. Niwa further teaches a battery and a PCB arranged in non-overlapping portions of a cavity, as well as partially overlapping portions of a cavity. *Id.*, Figs. 27, 28. Depending on the POSITA's design criteria, it would have been obvious to implement either arrangement in Schröder.

196. Niwa further offers additional design and manufacturing benefits to Schröder's "finger-ring." Niwa explains that, for the comfort of the ring's wearer, "it is desirable to restrain the largeness of the first unit 10 and the second unit 20 not to protrude from the third joint of the finger 2." Ex-1005 (Niwa) ¶206. Furthermore, a POSITA would have been motivated to avoid overlap between the first and second portions of the cavity for many reasons: material costs, ease of assembly, thermal management, or smaller form factor. *See also* Ex-1007 (Schröder), 3:9-11; Ex-1005 (Niwa) ¶206. For example, no overlap of cavity portions means there are less components to purchase and to assemble into the cavity. There would also be fewer components to heat up the cavity (and other components).

197. Moreover, Niwa provides beneficial configurations for Schröder's LEDs and sensor. Ex-1007 (Schröder), 8:30-53 (LEDs), 9:54-10:11 (sensor). Schröder's teachings involve methods of capturing information about finger veins. This methodology specifically targets the patterns of veins within the finger. Niwa

teaches a sensor with multiple light emitting portions with different wavelengths and positioning. Ex-1005 (Niwa) ¶¶32 (“multiple light emitting portions provided at different places”), 34 (sensor layout with central photo-receiving portion), 35 (“each output intensity of the multiple light emitting portions differs from one another”). Niwa discusses capturing pulse oximetry data. *See id.* ¶170. Building on this understanding, a POSITA would have recognized that Niwa’s teachings also indirectly involve capturing information about veins. Pulse oximetry is a non-invasive method used to measure the oxygen saturation level of the blood and heart rate through photoplethysmography (PPG), a technique that detects blood volume changes in the microvascular bed of tissue. PPG technology is sensitive to changes in blood volume within tissues, which includes the venous structures targeted by Schröder’s vein image. A POSITA would have understood that both Schröder’s and Niwa’s techniques involve data collection from veins. This understanding would indicate that advances or techniques developed in one application (like pulse oximetry) could potentially inform or enhance methodologies in the other (like vein pattern biometrics), highlighting the interconnectedness of these imaging and sensing technologies in capturing venous information. Based on these teachings, it would have been obvious to modify Schröder’s sensor to emit different wavelengths from different light emitting components and/or place the light emitting components

and photodetector at different circumferential positions. A POSITA would have been motivated to make this modification to capture a broader range and/or more accurate data. A POSITA also would have been motivated to integrate Niwa's sensor into Schröder's "finger-ring" for better utilization of the limited space inside the "finger-ring." A POSITA would also have been motivated to adopt Niwa's configuration with light-emitting components and light-receiving component at different radial positions to prevent ambient light from interfering with the sensor measurement or to prevent visible light from disturbing the wearer.

198. A POSITA would have had a reasonable expectation of success in combining Schröder and Niwa. A POSITA would have understood that these wearable electronic devices, specifically a ring shape, are restricted by form factors. A POSITA would have understood, therefore, that these references disclose interrelated teachings based on routine technologies that would have been amenable to various well-understood and predictable combinations to provide smaller and more comfortable wearable devices.

2. Independent Claim 1

a. Elements 1[pre]-1[c] and 1[e]

199. As described above, Schröder teaches Elements 1[pre]-1[c] and 1[e].

See supra §VIII.A.1.

- b. Element 1[d]: a printed circuit board disposed between the internal housing component and the external housing component, wherein the printed circuit board extends through at least a second portion of the cavity of the finger-worn wearable ring device different from the first portion**

200. As described above, Schröder teaches Claim 1. *See supra* §VIII.A.1.

201. Schröder in combination with Niwa also teaches Element 1[d]: “a printed circuit board disposed between the internal housing component and the external housing component, wherein the printed circuit board extends through at least a second portion of the cavity of the finger-worn wearable ring device different from the first portion.”

202. Niwa’s finger ring has a substrate disposed between the internal housing component and the external housing component. Niwa describes components and circuits that are “mounted” onto the surface or back side of the “substrate.” *See, e.g.*, Ex-1005 (Niwa) ¶¶68, 69, 213. Niwa also describes an “electrical connection...established between the surface and back side of the...substrate...by means of the through hole and the via hole.” *Id.* ¶214. This direct attachment of electronic components is characteristic of a printed circuit board (PCB), which is commonly used as a mounting surface in electronic devices due to its ability to provide both physical support and electrical connections for components. The presence of a cable connected to the substrate to establish an

electrical connection with another unit, and the use of through holes and via holes to establish connections between the surface and back side of the substrate, further supports the understanding of the substrate as a PCB. These features are typical of PCBs, which are designed to facilitate complex electrical pathways and connectivity within a compact space. These elements combined—direct mounting of components, sophisticated electrical connectivity, emphasis on compactness, and strategic component placement for functionality—clearly align with the characteristics of a PCB, leading a POSITA to understand that the substrate mentioned is indeed a printed circuit board (PCB).

203. As shown in Figures 27 and 28 (cross-sections) below, Niwa utilizes substrates in first unit 10 and second unit 20, all of which exist within finger ring type housing 40. Ex-1005 ¶¶194-95, 207. A POSITA would have understood that the claimed PCB corresponds to a substrate in Niwa because its substrate is a PCB disposed between the internal and external housing components which electrically connects components and circuits.

FIG.27

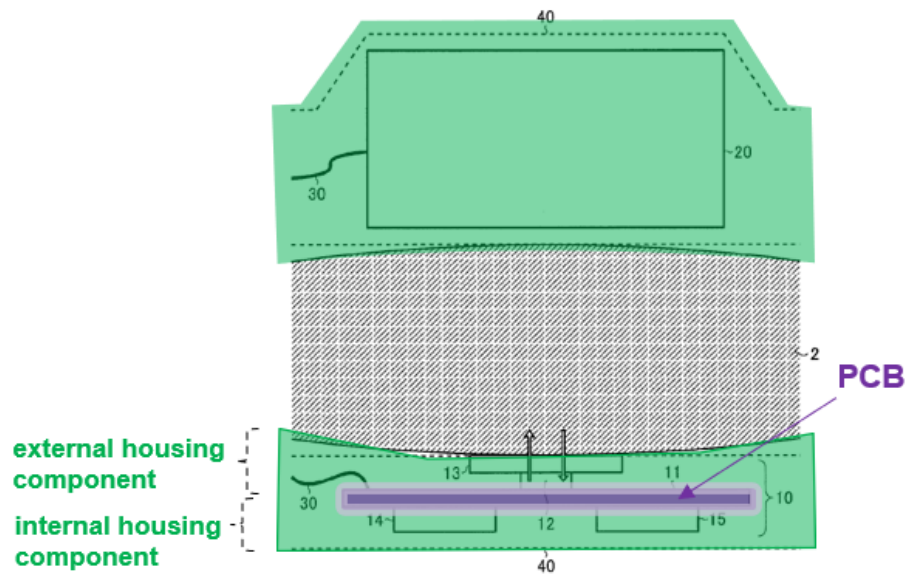
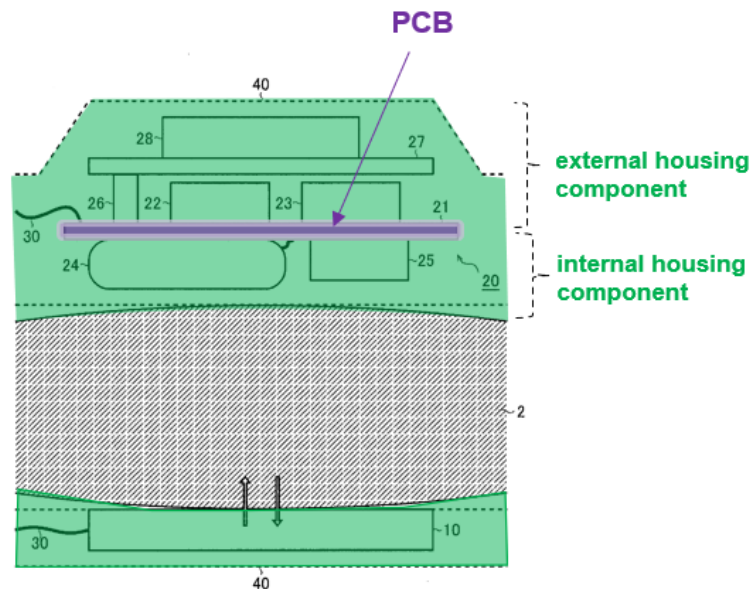


FIG.28



204. Niwa's PCB extends through at least a second portion of the cavity of the finger-worn wearable ring device different from the first portion. A POSITA would have understood that by being disposed between the internal and external

housing components, the PCB necessarily exists within a cavity by being within the finger ring housing 40. *Id.* In view of both the battery and the PCB being arranged inside and covered by the finger ring, the cavity must provide space for both components. *Id.* For example, Figures 27 and 28 (cross-sections) below show how a first portion (light blue) surrounding battery 24 (blue) in second unit 20 is different than a second portion (light purple) surrounding PCB 11 (purple).

FIG.28

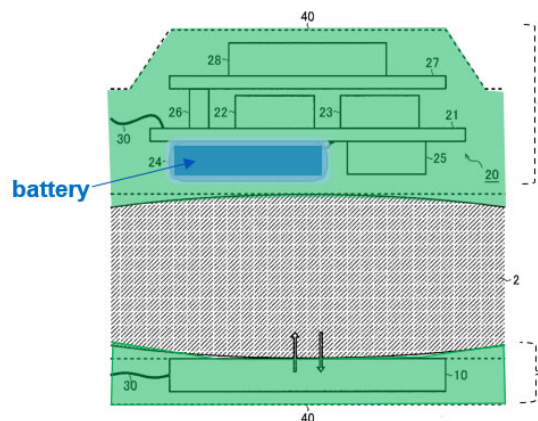
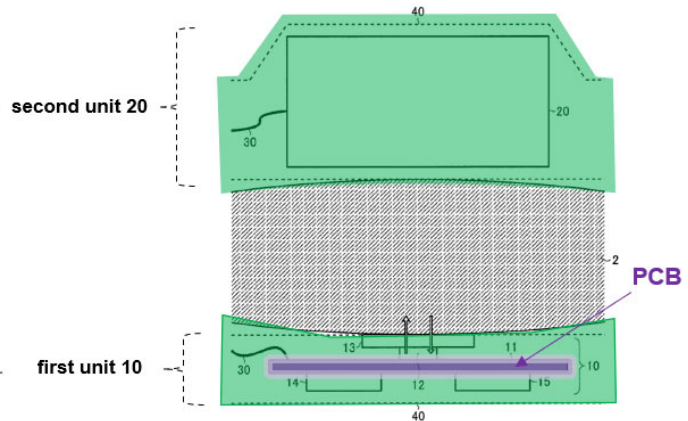


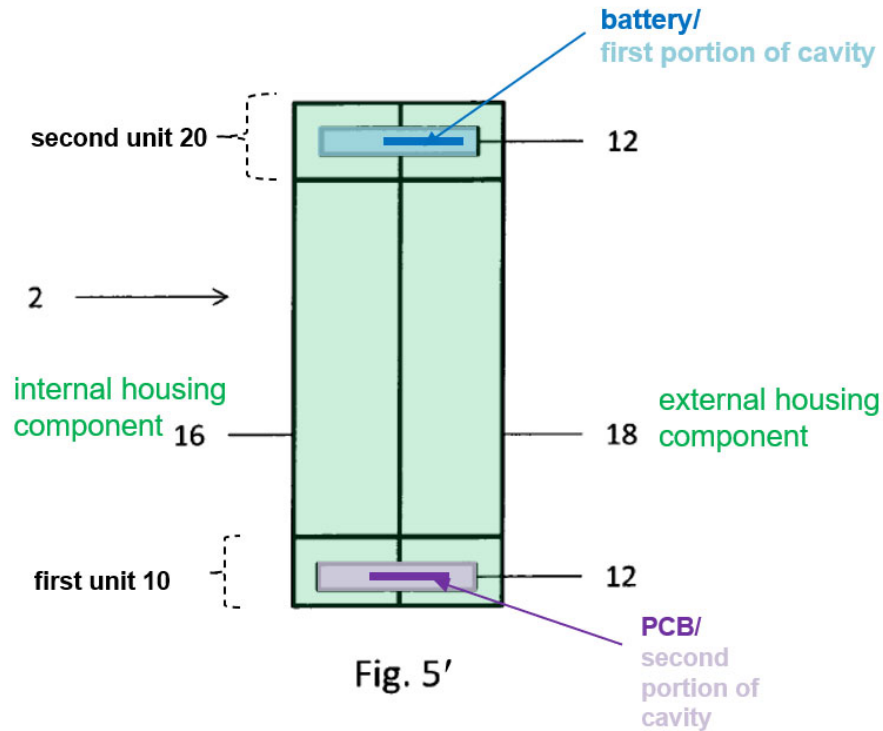
FIG.27



205. Therefore, a POSITA would have understood that Niwa's first portion and second portion correspond with the respective locations of the battery and PCB.

206. Schröder's "finger-ring" combined with Niwa's PCB configuration has the battery and PCB in their respective portions of the cavity that are separate from each other. Modified Figure 5 illustrates Schröder's "finger-ring" with the battery in a first portion of the cavity where second unit 20 would be in Niwa and the PCB and its second portion where a first unit would be in Niwa.

207.



It would have been obvious to use Niwa's PCB configuration in Schröder as to separate a battery and PCB that are in the same ring housing. A POSITA would have been motivated to combine the teachings of Schröder and Niwa and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.B.1. Thus Schröder-Niwa teaches Claim 1.

3. Dependent Claims 2-3 and 13-16

- a. Claim 2: The finger-worn wearable ring device of claim 1, wherein the first portion of the cavity of the finger-worn wearable ring device is non-overlapping with the second portion of the cavity of the finger-worn wearable ring device.**

208. It is my opinion that Schröder-Niwa teaches Claim 2.

209. A POSITA would have found it obvious to design Schröder's first and second portions of the cavity to not overlap for the same reasons explained above in Section VIII.A.2. Moreover, a POSITA would have been motivated to have the first portion of the cavity and the second portion of the cavity not overlap because it was well-known, as taught in Niwa.

210. As shown in Figure 28 (cross-section) below, Niwa's finger ring type housing 40 (green) (disposed upon the wearer's finger 2) includes a battery 24 (blue) in a first portion of the cavity (light blue) in second unit 20. Ex-1005 (Niwa) ¶¶193, 217. Also shown below in Figure 27 (cross-section) is substrate 11 (purple), which extends through a second portion of the cavity (light purple) in first unit 10. *Id.* ¶¶200, 207. A POSITA would have understood a substrate in Niwa to be a PCB. Accordingly, Figures 27 and 28 illustrate a first portion of the cavity (light blue) with the battery (blue) that does not overlap with a second portion of the cavity (light purple) with the PCB (purple). *Id.* As discussed in Section V.B.2, by 2013 it was

well understood that in order to house electronic components within wearable devices, there must be an internal space like a cavity between two housing portions. For example, U.S. Patent No. 6,201,698 to Hunter teaches that “the side walls and the web together create a cavity [] to house the electronic circuit.” Ex-1060, 2:56-57.

FIG.28

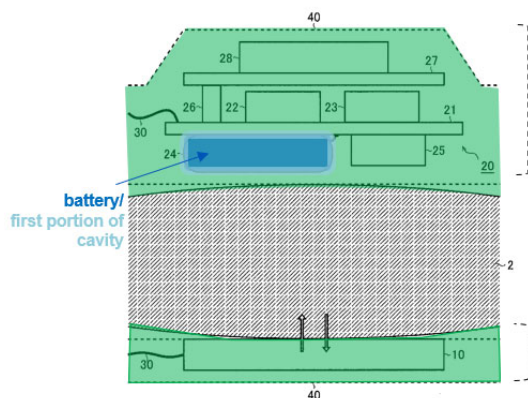
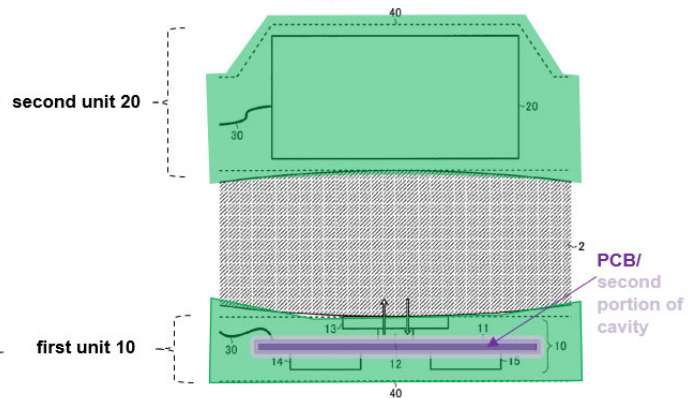


FIG.27



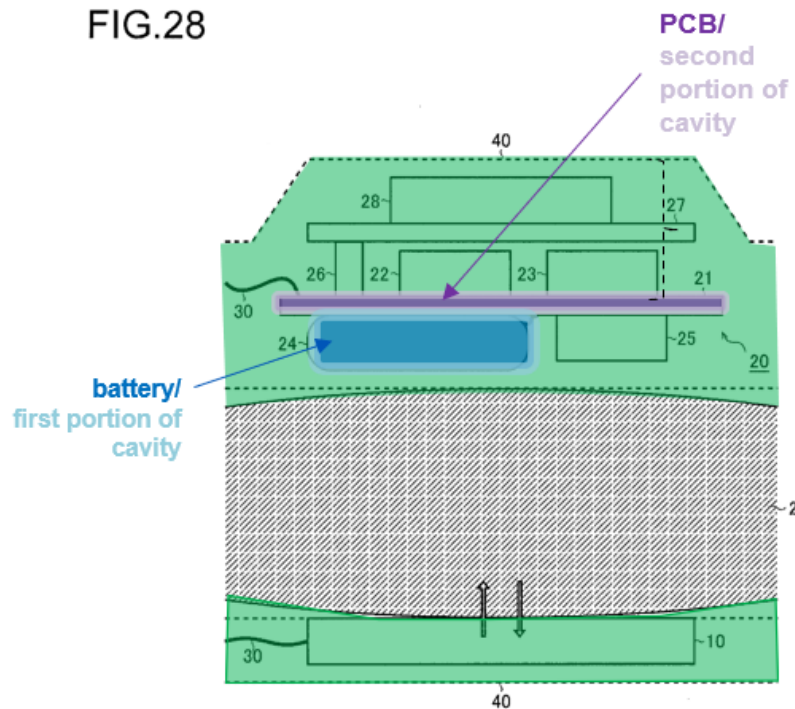
211. In addition to the reasons explained above, a POSITA would have been motivated to prevent overlap, as taught by Niwa, when implementing Schröder’s “finger-ring” because doing so allows for a thinner, more compact finger-worn wearable ring device reduces the volume of the cavity, making the ring more comfortable. For example, Niwa explains that, for the comfort of the ring’s wearer, “it is desirable to restrain the largeness of the first unit 10 and the second unit 20 not to protrude from the third joint of the finger 2.” *Id.* ¶206. Thus, a POSITA would have been motivated to prevent the first and second portions from overlapping as to

minimize the volume of the ring “to not let the examinee have a consciousness for wearing” the ring. A POSITA also would have been motivated to have non-overlapping portions of the cavity in order to save on material costs. With no overlap, there are less components to fit inside the “finger-ring” and thus less components to purchase.

b. Claim 3: The finger-worn wearable ring device of claim 1, wherein the first portion of the cavity of the finger-worn wearable ring device at least partially overlaps with the second portion of the cavity of the finger-worn wearable ring device.

212. It is my opinion that Schröder-Niwa teaches Claim 3.

213. A POSITA would have found it obvious to design Schröder’s first and second portions of the cavity to partially overlap for the same reasons explained above in Section VIII.A.1.e-f. Moreover, a POSITA would have been motivated to have the first portion of the cavity and the second portion of the cavity to partially overlap because it was well-known, as taught in Niwa. For the same reasons explained for the previous claim, Figure 28 illustrates a battery 24 (blue) in a first portion of the cavity (light blue) in second unit 20. *See supra* §VIII.A.2.a. Also shown below in Figure 28 is PCB 11 (purple), which extends through a second portion of the cavity (light purple) in first unit 10. Ex-1005 (Niwa) ¶¶200, 207.



Thus Niwa teaches a first portion of the cavity (light blue) with the battery (blue) that partially overlaps with a second portion of the cavity (light purple) with a PCB (purple). As discussed in Section V.B.2, by 2013 it was well understood that in order to house electronic components within wearable devices, there must be an internal space like a cavity between two housing portions. For example, U.S. Patent No. 6,201,698 to Hunter teaches that “the side walls and the web together create a cavity [] to house the electronic circuit.” Ex-1060, 2:56-57.

214. It would have been obvious to have the cavity portions at least partially overlap. Niwa describes stacking substrates, “according to adoption of the stack layer construction with several substrates, compared to mounting all circuit elements

on one substrate, each area of the first substrate 21 and the second substrate 22 is decreased.” *Id.* ¶219. Niwa also states that “the largeness of the second unit 20 can be restrained not to protrude from the third join of the finger 2” and “a consciousness of the examinee for wearing the plethysmogram sensor 1 can be reduced.” *Id.* In view of Niwa’s teachings, POSITA would have been motivated to partially overlap the first portion of the cavity that has the battery and the second portion of the cavity that has the PCB, as disclosed in Niwa, when implementing Schröder’s “finger-ring” because doing so permits more components to fit inside the limited volume. Thus Schröder-Niwa teaches Claim 3.

- c. **Claim 13: The finger-worn wearable ring device of claim 1, wherein the one or more sensors comprise a first light-emitting component configured to emit light associated with a first wavelength, and a second light-emitting component configured to emit light associated with a second wavelength different from the first wavelength.**

215. It is my opinion that Schröder-Niwa teaches Claim 13.

216. Schröder-Niwa teaches one or more sensors comprising two light-emitting components configured to emit light associated with two different wavelengths. As described above, in Section VIII.A.1.g (element 1[e]), Schröder’s “finger-ring” includes biometric sensors, such as an infrared diode and sensor. Ex-1007, 9:62-10:4. Niwa’s sensors comprise a first light-emitting component

configured to emit light associated with a first wavelength, and a second light-emitting component configured to emit light associated with a second wavelength different from the first wavelength. Niwa's first unit 10 contains a light emitting portion, a light receiving portion, and a processing unit "to acquire information" about the user's plethysmogram. Ex-1005 ¶¶12, 27; *see also id.* ¶¶209-10 ("detection for the emitted light to the finger 2 and a reflected light go back from the finger 2[] via [a] measurement window 13"). Specifically, first unit 10's light emitting portion can include "**LED1 to LED8**" with the "**output wave lengths $\lambda 1$ to $\lambda 8$ [that] are values different from one another.**" *Id.* ¶147. A POSITA would have understood that Niwa's first light-emitting component, e.g., LED1, is associated with a first wavelength $\lambda 1$, and a second light-emitting component, e.g., LED8, associated with a second wavelength $\lambda 8$ that is different than $\lambda 1$.

217. As discussed in Section V.A.6, a POSITA would have also understood that using multiple LEDs emitting light at different wavelengths provide accurate and real-time information to the user about the user's health. Incorporating additional LEDs provides for beneficial redundancy in the device. If one LED fails, loses contact with the skin, or is occluded by a mole, scar, or other skin irregularities, or is above a region of tissue with low levels of vascularization, the remaining LEDs can continue to function. This ensures that the device maintains its accuracy and

reliability even in less-than-ideal conditions. Further, the presence of multiple LEDs creates multiple illumination paths. These multiple paths enable the device to take multiple measurements simultaneously or sequentially, benefitting from measurement averaging, which significantly enhances the signal-to-noise ratio (SNR). A higher signal-to-noise ratio translates to more accurate and reliable readings.

218. A POSITA would have understood that multiple emitters each including multiple LEDs operating at different wavelengths advantageously provide “accurate” “real-time information to the user about the user’s health” by, for example, enabling offset of noise affects. Ex-1039, 4:4-8.

219. Utilizing LEDs that emit light at a range of wavelengths allows the device to be more tolerant to variations in skin color. For example, different skin tones absorb light differently, and by using a broader spectrum of wavelengths, the device can account for these variations, ensuring consistent and accurate readings across diverse populations. A larger number of wavelengths enable the device to perform multiple estimations of the relative absorption between oxygenated and deoxygenated blood or to measure other blood constituents with differing sensitivities to the other wavelengths. Hemoglobin, the molecule responsible for carrying oxygen in the blood, has different absorption characteristics depending on

whether it is oxygenated or deoxygenated. By analyzing light absorption at multiple wavelengths, the device can more accurately determine the ratio of oxygenated to deoxygenated blood, thereby providing a more precise estimate of blood oxygenation levels.

220. A POSITA would have been motivated to combine the teachings of Schröder and Niwa and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.B.1. Thus Schröder-Niwa teaches Claim 13.

d. Claim 14: The finger-worn wearable ring device of claim 13, wherein the first wavelength is associated with visible light, and wherein the second wavelength is associated with infrared light.

221. It is my opinion that Schröder-Niwa teaches Claim 14.

222. Schröder-Niwa's first light emitting component emits visible light and another emits infrared light. Schröder's light emitting diode emits infrared radiation. Ex-1007, 9:62-10:4. Niwa's first light-emitting component emits visible light and the second light-emitting component emits infrared light. Niwa describes that the "output wave lengths" from the LEDs range "from *a visible light region to a near-infrared region.*" Ex-1005 ¶147. A POSITA would have understood that a first wavelength λ_1 from first light-emitting component (LED1) is associated with visible light. A POSITA would have found it obvious to extend the wavelength of Niwa's

LED from “a near-infrared region” to an infrared region for redundancy, to expand the type of information collected, or to use a non-visible light. Ex-1005 ¶147. As I explained in the Technology Background Section (*see* Section V.A.4), to calculate SpO₂, the ratio of the AC to DC components of the PPG signal at two different wavelengths is used, and these wavelengths are typically red and infrared. A POSITA would thus understand that a second wavelength λ_8 from LED8 in Niwa is associated with infrared light.

223. A POSITA would have been motivated to combine the teachings of Schröder and Niwa and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.B.1. Thus Schröder-Niwa teaches Claim 14.

- e. **Claim 15: The finger-worn wearable ring device of claim 13, wherein the first light-emitting component is positioned within the finger-worn wearable ring device at a first radial position, and the second light-emitting component is positioned within the finger-worn wearable ring device at a second radial position different from the first radial position.**

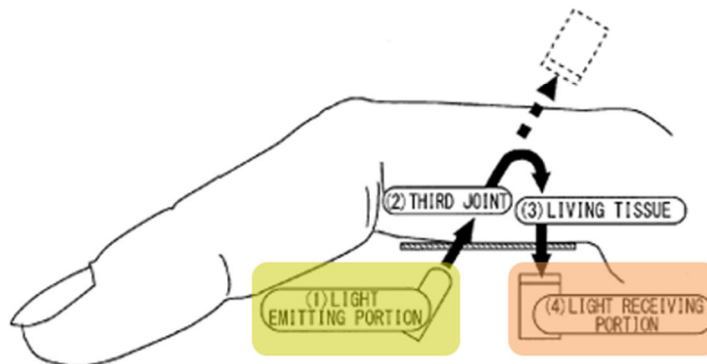
224. Schröder-Niwa teaches Claim 15.

225. Schröder-Niwa’s first light-emitting component is positioned within the finger-worn wearable ring device at a first radial position, and the second light-

emitting component is positioned within the finger-worn wearable ring device at a second radial position different from the first radial position.

226. Niwa teaches a “finger ring” “worn on the third joint of the finger 2.” Ex-1005 ¶191. As discussed in Section V.A.1, photo-plethysmogram sensors were well known and used to measure changes in volume within the body of the user such as monitoring heart rate. As illustrated in Figure 21, Niwa’s photo-plethysmogram has the light emitting portion at the third joint of the user’s finger. Ex-1005 ¶117; *see also id.*, Fig. 1. The finger is pressed against the measurement window of the device and the light which penetrates the living tissue and is emitted out of the living tissue is detected at the light receiving portion. *Id.*

FIG.21



227. Niwa's finger ring has a light emitting portion with eight light emitting components centrally arranged around light receiving portion PD. *See id.* ¶120, Fig. 3. Niwa further teaches two light-emitting components at different radial positions. Niwa describes Figure 3 as the "Layout of the Light Emitting Portion and the Light Receiving Portion" of the first unit's light sensor 12. *Id.* ¶119. Niwa states that "first unit 10 is a unit to measure the plethysmogram mainly, which is contained within the finger ring type housing 40 to be set to the ball side of the finger 2 (i.e., palm side)." *Id.* ¶192. Light sensor 12, which is part of first unit 10, "can be located at the vicinity of the finger 2 as much as possible" to improve measurement accuracy. *Id.* ¶208. A POSITA would have understood that the light sensor (or any PPG sensor) would be placed tangentially or flush against the finger. As I described above in Section V.A.1, PPG sensor uses a light source and light detector (for example, an LED and photodetector respectively) at the skin's surface to take a measurement. *See* Ex-1038 (Castaneda); *see also* Ex-1006 (Yuen), 12:24-42 ("little to no gap between the skin side of the device and the juxtaposed surface of the skin of the user"). For example, Yuen explains that "a more secure physical connection between the user's skin and the optical window ... improves sustained and/or fixed contact between the biometric monitoring device and the user's skin ... which may reduce the amount of stray light measured by the photodetector, decrease motion

between the biometric monitoring device and the user... all of which may increase the quality of the cardiac signal.” Ex-1006 (Yuen), 13:46-62. Thus, a POSITA would have understood that the sensor would benefit from being placed tangentially or flush against the finger.

228. Niwa further describes “a single light receiving portion PD (i.e., a photo diode or a photo transistor) and *eight light emitting portions LED1 to LED8* (i.e., a light emitting diode) *equally spaced from one another and placed on a circumference with a central focus on the light receiving portion PD.*” *Id.*, ¶120. As shown below in Figure 27, the first unit 10 houses the light sensor 12 (annotated), which faces the user’s skin (finger 2). *See id.* ¶¶50, 200.

FIG.27

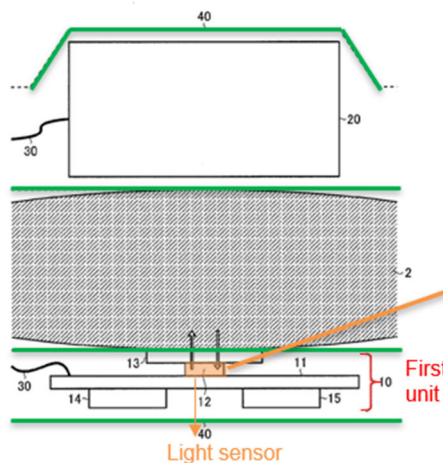
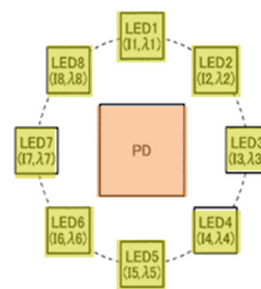
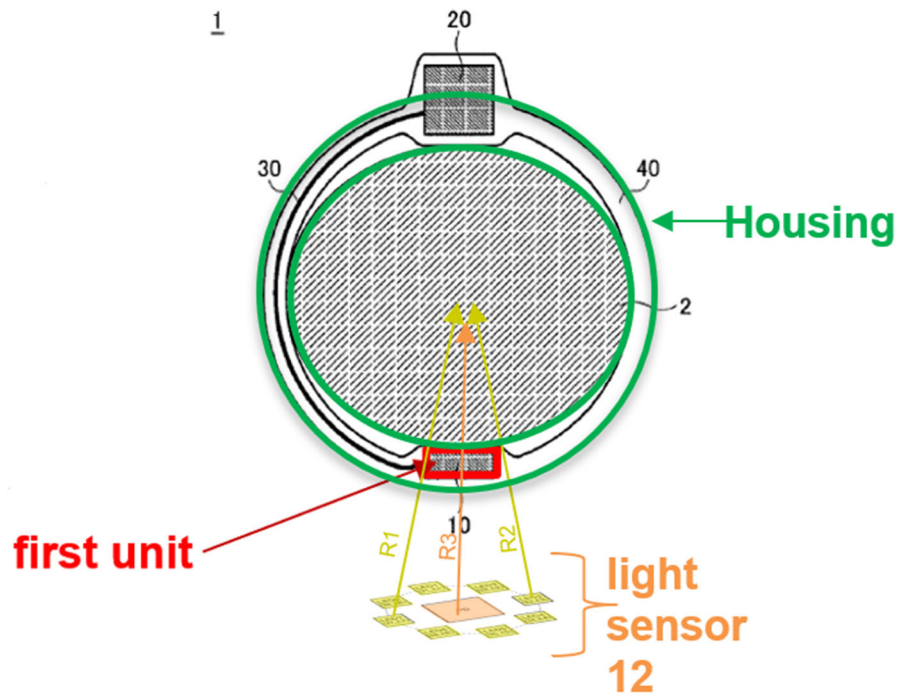


FIG.3



229. A POSITA would have understood that the light emitters (LEDs) are at different radial positions. Modified Figure 22' below superimposes the light emitting components and photodetector of Figure 3 in the light emitting portion of first unit 10's light sensor 12. As shown in modified Figure 22', Niwa's LED7 (yellow) is positioned at a first radial position (R1) and LED3 (yellow) is positioned at a second radial position (R2) within the finger-worn wearable ring device (green).



230. A POSITA would have understood LED7 and LED3 are positioned at different radial positions because the LEDs are located at different circumferential positions pointing along a radius from the center of the finger ring (i.e., the claimed “radial position”), just like in the ’178 Patent. Ex-1001, Figs. 3B, 3C. A POSITA

would have further understood that the LEDs would be at different radial positions because separation between the LEDs is important to enhance the quality of the plethysmogram signal and for redundancy within the device. A POSITA would have also understood that other LEDs in this specific orientation or variations would be in different radial positions. A POSITA would have also understood that having the LEDs in a central circumference and away from the edges of the device, prevents light leakage from visible LEDs and interference from ambient light.

231. If PO argues that the LEDs in Niwa's Figure 3 are oriented in a plane that is parallel to the plane of the ring, then (while this orientation would be illogical because the emitters would emit light into the ambient environment rather than the skin) it would still result in a number of LEDs being at different radial positions relative to the center of the ring.

232. As discussed in Section V.A.7, separation between the LEDs and the light receiving portion is important for signal strength. Placing the LEDs at different radial positions can result in stronger signals that relate to the heart characteristics of the user. For example, U.S. Patent No. 7,468,036 to Rulkov et al. ("Rulkov") recommends a "greenlight LED and a pulsed infrared LED to offset noise affects of ambient light and sunlight." Ex-1039, 6:56-58.

233. A POSITA would have been motivated to combine the teachings of Schröder and Niwa and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.B.1. Thus Schröder-Niwa teaches Claim 15.

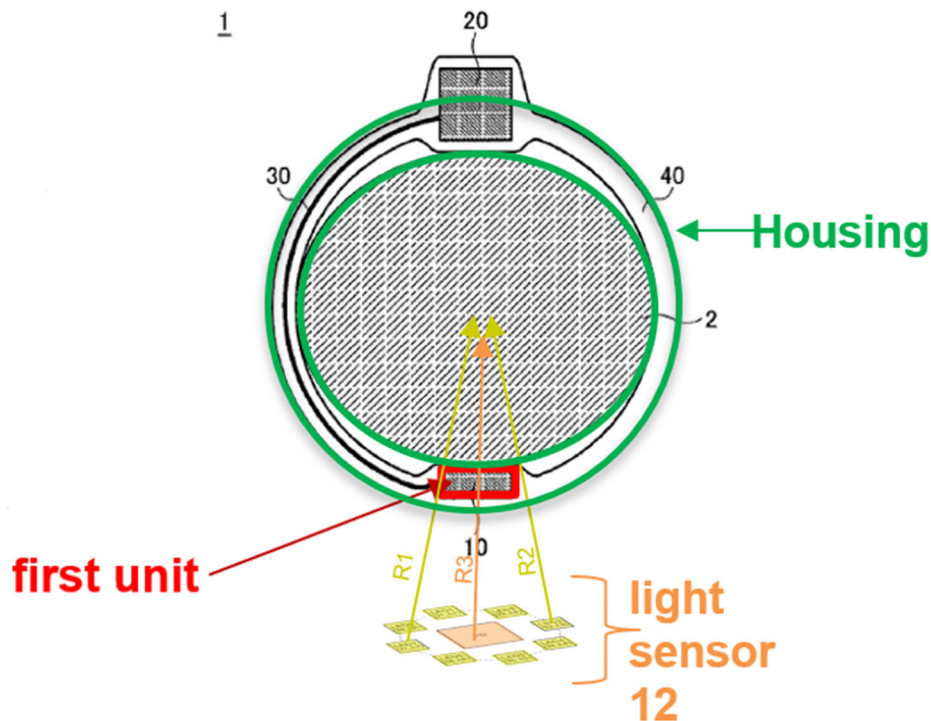
- f. Claim 16: The finger-worn wearable ring device of claim 15, wherein the one or more sensors further comprise a photodetector positioned within the finger-worn wearable ring device at a third radial position that is between the first radial position and the second radial position.**

234. Schröder-Niwa teaches Claim 16.

235. Schröder-Niwa's Schröder-Niwa teaches a photodetector positioned within the finger-worn wearable ring device at a third radial position that is between the first and second radial positions. Schröder teaches a light-emitting component and light-receiving component "arranged e.g., opposite each other such that e.g., a[] finger bone located therebetween has no adverse effect" measuring the user's vein. Ex-1007, 9:62-10:4. Niwa's sensor in its finger ring has a photodetector positioned at a third radial position that is between the first radial position and the second radial position. Niwa discloses "multiple light emitting portions provided at different places [and] at least a single light receiving portion to detect each intensity of lights emitted from each of the multiple light emitting portions." Ex-1005 ¶¶32; *see also id.* ¶¶43, 117, Fig. 1.

236. As shown in modified Figure 22', Niwa's light receiving portion PD (orange) is positioned at a third radial position (R3) that is between the first radial position (R1) of LED7 (yellow) and second radial position (R2) of LED3 (yellow) within the finger-worn wearable ring device (green).

237. As discussed in Section V.A.7, separation between the LEDs and the light receiving portion is important for signal quality. Placing the LEDs at different radial positions can result in beneficial redundancies and for multiple illumination pathways through the tissue and provide for stronger signals that relate to the heart characteristics of the user.



238. A POSITA would further understand that Niwa teaches light-emitter and photodetector configurations with varying radial positions. *See, e.g., id.* ¶¶32, 43, 117, Figs. 1, 14-16. A POSITA would have been motivated to combine the teachings of Schröder and Niwa and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.B.1. Thus Schröder-Niwa teaches Claim 16.

C. Ground 3: Claims 3 and 12 are obvious over Schröder in view of Mestas.

1. A POSITA would have been motivated to combine Schröder with the teachings of Mestas and would have had a reasonable expectation of success.

239. A POSITA would have been motivated to apply the teachings of Mestas to Schröder (“Schröder-Mestas”), and would have had a reasonable expectation of success in doing so because each relates to the same well-known technologies.

240. A POSITA would have been motivated to combine Schröder with Mestas because they are analogous art and teach improvements to the same type of devices. Both Schröder and Mestas are directed to wearable biometric sensing devices having similar structural components, including, for example, inner and outer surfaces, a cavity, and a battery and PCB within the cavity. *See, e.g.,* Ex-1007 (Schröder), 11:46-48 (battery), 12:26-42 (PCB), Figs. 4-10 (structure); Ex-1010 (Mestas) ¶¶150 (cavity, battery), 151 (structure), 154 (cavity), 157 (structure), 164

(PCB), 168 (battery), Figs. 4, 6 (structure). Mestas specifically teaches these portions of the cavity partially overlapping. Ex-1010 (Mestas) ¶177, Figs. 14-16. Schröder's "finger-ring" includes a "recess" (i.e., cavity) within at least one of its components (16, 18) where an electronic part (e.g., chip module 10 and/or inlay 12) is inserted. Ex-1007 (Schröder), 12:10-32, 15:26-28. Schröder further teaches using injection-molding to cover the electronic part and cavity with a resin or plastic to form "a ring-shaped body." *Id.*, 14:38-49. Mestas likewise teaches a cavity that houses electrical components. Ex-1010 (Mestas) ¶151. Mestas further teaches a battery and a PCB arranged in overlapping portions of a cavity. *Id.* ¶¶164, 168, 177. Based on Mestas's teachings, it would have been obvious to have the first portion and second portion of the cavity in Schröder at least partially overlap.

241. Mestas further offers additional design and manufacturing benefits to Schröder's "finger-ring." A POSITA would have been motivated to have the first and second portions of the cavity at least partially overlap as taught by Mestas to reduce the risk of electrical components and the PCB losing mechanical or electrical connection to the other and to allow other parts of the ring to be thinner for the wearer's comfort. *See also* Ex-1007 (Schröder), 3:9-11; Ex-1010 (Mestas) ¶206. Additionally, a POSITA would have been motivated to implement Mestas's curved battery in Schröder's "finger-ring" because having a curved battery would provide

a larger battery that conforms to the circular shape of the ring without stressing the battery or ring housing.

242. A POSITA would have had a reasonable expectation of success in combining Schröder and Mestas. Mestas contemplates different sizing of its generally circular wearable device, stating that its “wearable athletic device may be worn in a variety of locations on a user’s body including a user’s chest (e.g., a chest strap), around a user’s wrist, around a user’s arm, on a user’s head on a user’s ankle or thigh, and the like.” Ex-1010 (Mestas) ¶143. As miniaturization of electronic components improved, a POSITA would have found it trivial to implement Mestas’s teachings into a ring form like that of Schröder’s “finger-ring.” As I described in the Technical Background Section (*see* §V.A), a POSITA would have been motivated to implement a ring-shaped device due to a ring’s “[c]ompactness, stability of signal, motion and other disturbance rejection, durability, data storage and transmission, and low power consumption” and it being “simple to use and comfortable to wear for long periods of time.” Ex-1037, 28 (Asada 2003). A POSITA would have understood that these wearable electronic devices, specifically a ring shape, are restricted by form factors. A POSITA would have understood, therefore, that these references disclose interrelated teachings based on routine technologies that would have been amenable to various well-understood and

predictable combinations to provide smaller and more comfortable wearable computing devices.

2. Dependent Claims 3 and 12

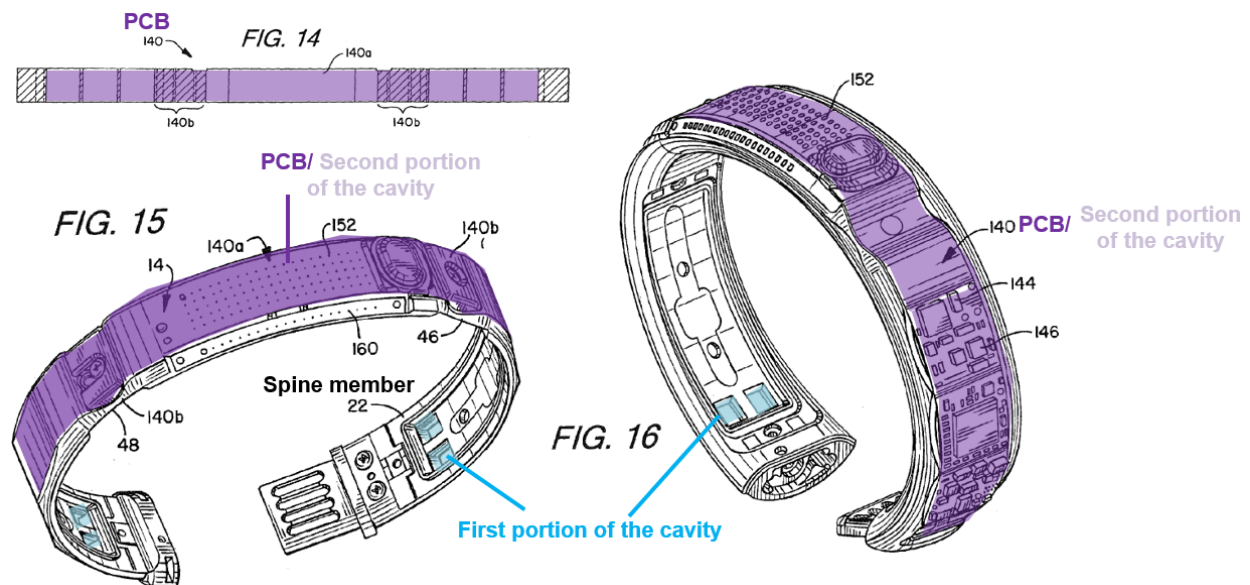
- a. Claim 3: The finger-worn wearable ring device of claim 1, wherein the first portion of the cavity of the finger-worn wearable ring device at least partially overlaps with the second portion of the cavity of the finger-worn wearable ring device.**

243. It is my opinion that Schröder-Mestas teaches Claim 3.

244. A POSITA would have found it obvious to design Schröder's first and second portions of the cavity to partially overlap for the same reasons explained above in Section VIII.A.2.b. Moreover, a POSITA would have been motivated to have the first portion of the cavity and the second portion of the cavity overlap because doing so was well-known, as taught in Mestas. Mestas's wearable computing device has a housing 12 that includes an inner spine member 22 that supports the internal components of the device. Ex-1010 (Mestas) ¶151. A POSITA would have understood that the space inside housing 12 occupied by spine member 22 is the "cavity" of Mestas's device housing.

245. As shown in Figures 14-16 (below), Mestas's wearable electronic device has PCB member 140 (purple) "wrapped around and mounted to the spine member 22" to "follow[] the contours of the spine member 22." *Id.* ¶164. Mestas's

batteries are “positioned in the recessed compartments 50,52 [light blue] wherein the contacts 150 [not labelled] extend through the openings 59 [not labelled] in the compartments 50,52 and engage the PCB member 140 to provide power to the device 10.” *Id.* ¶168. The battery contacts “are biased against mating contacts associated with PCB member 140.” *Id.* ¶177. As discussed in Section V.B.2, by 2013 it was well understood that in order to house electronic components within wearable devices, there must be an internal space like a cavity between two housing portions. For example, U.S. Patent No. 6,201,698 to Hunter teaches that “the side walls and the web together create a cavity [] to house the electronic circuit.” Ex-1060, 2:56-57.



246. Mestas’s wearable electronic device thus has two different portions of the cavity: the portion that the PCB occupies and the portion that the batteries

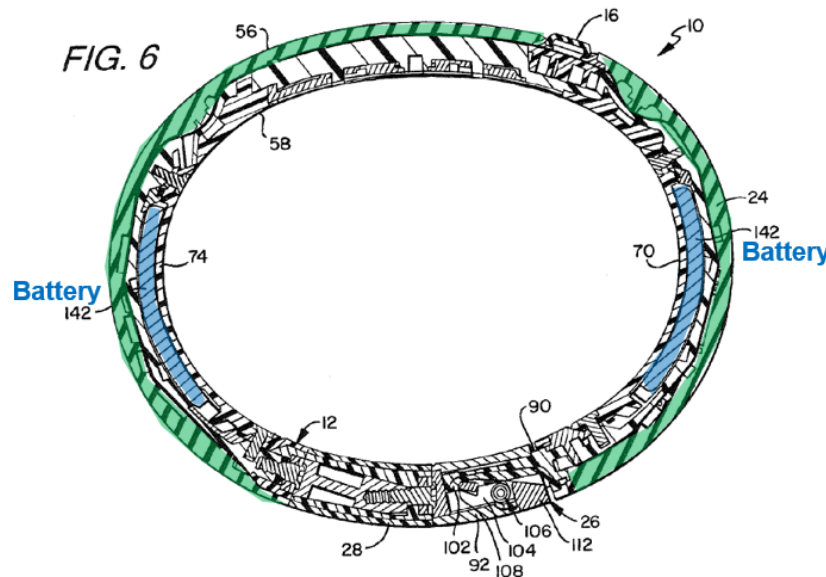
occupy. A POSITA would have understood that a first portion of the cavity overlaps with a second portion of the cavity because the PCB member wraps around the entire length of the spine member (defining the second portion) and the first portion (where the batteries are mounted) is positioned on the interior side of the spine member. A POSITA would have been motivated to combine the teachings of Schröder and Mestas and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.C.1. Thus Schröder-Mestas teaches Claim 3.

b. Claim 12: The finger-worn wearable ring device of claim 1, wherein the battery comprises a curved battery, wherein an arc of the curved battery approximates a corresponding arc of the external housing component.

247. It is my opinion that Schröder-Mestas teaches Claim 12.

248. Schröder-Mestas teaches “the battery compris[ing] a curved battery, wherein an arc of the curved battery approximates a corresponding arc of the external housing component.” Schröder and Mestas each disclose a battery that supplies power to the device. Ex-1007 (Schröder), 11:46-48; Ex-1010 (Mestas) ¶143. As shown in Figure 6 (below), Mestas’s “batteries 142 [blue] have a curvilinear or curved configuration” defining “curved planar surfaces.” Ex-1010 (Mestas) ¶168. Mestas’s outer encasement member 24 has a generally rounded outer surface 56 (green). *Id.* ¶157. A POSITA would have understood that the arc of Mestas’s

“*curved battery*” (blue) “approximates a corresponding arc of the external housing component” (green). It would have been obvious, in view of Mestas, that this shape allows the batteries to be positioned in the curved spine member’s recessed compartments 50, 52 without increasing the thickness of wearable device and to allow for an elongated battery without stressing the battery or the ring housing. *Id.* ¶168 (“[T]he batteries 142 have a curvilinear or curved configuration and are generally rigid members. The batteries 142 define curved planar surface.”).



249. A POSITA would have been motivated to combine the teachings of Schröder and Mestas and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.C.1.

D. Ground 4: Claims 1, 4-11 and 13-16 are obvious over Schröder in view of Yuen.

1. A POSITA would have been motivated to combine Schröder with the teachings of Yuen and would have had a reasonable expectation of success.

250. A POSITA would have been motivated to apply the teachings of Yuen to Schröder (“Schröder-Yuen”), and would have had a reasonable expectation of success in doing so because each relates to the same well-known technologies. A POSITA would have been motivated to combine Schröder with Yuen because they are analogous art and both teach improvements to the same type of devices. Both Schröder and Yuen teach electronic wearable devices. Ex-1007 (Schröder), 3:9-11, 3:61-62; Ex-1006 (Yuen), 12:50-52. Both describe the devices having a processor, battery, and one or more sensors. Ex-1007 (Schröder), 1:45 (processor), 1:50-51 (processor), 9:54-10:11 (sensor), 11:46-48 (battery); Ex-1006 (Yuen), 4:3-6 (processor, sensor), 12:18-61 (sensor), 14:42-46 (battery), 14:60-66 (sensor), 28:40-43 (battery), Figs. 17-25 (processor, sensor).

251. Schröder’s teachings involve methods of capturing information about finger veins, which is crucial for applications such as biometric identification or medical diagnostics. This methodology specifically targets the patterns of veins within the finger.

252. Building on this understanding, a POSITA would have recognized that Yuen's teachings, which discuss the capture of pulse oximetry data, also indirectly involve capturing information about veins. Pulse oximetry is a non-invasive method used to measure the oxygen saturation level of the blood and heart rate through photoplethysmography (PPG), a technique that detects blood volume changes in the microvascular bed of tissue.

253. PPG technology is sensitive to changes in blood volume within tissues, which includes the venous structures targeted by Schröder's vein image.

254. A POSITA would have understood that both Schröder's and Yuen's techniques involve data collection from veins. This understanding would indicate that advances or techniques developed in one application (like pulse oximetry) could potentially inform or enhance methodologies in the other (like vein pattern biometrics), highlighting the interconnectedness of these imaging and sensing technologies in capturing venous information.

255. Yuen further offers additional design and manufacturing benefits to Schröder's "finger-ring." First, Yuen teaches a flexible PCB. Ex-1006 (Yuen), 2:38-39, 12:35-38. In my opinion, a POSITA would have been motivated to implement a flexible PCB for Schröder's inlay because flexible PCBs are

lightweight and save space and are easier to assemble into curved constructions than a rigid planar PCB.

256. Second, Schröder's wireless charging may be improved by Yuen. Schröder teaches a battery that "is preferably charged by means of [a] reader's electromagnetic field." Ex-1007 (Schröder), 11:46-55. Yuen further teaches charging a battery using magnetic properties of its device or docking station. Ex-1006 (Yuen), 14:42-49. Based on Yuen's teachings, it would have been obvious to use a magnetic alignment mechanism within a charger device to orient the finger-ring in Schröder to facilitate wireless charging. A POSITA would have been motivated to implement an alignment mechanism for Schröder's "finger-ring" using Yuen's teachings to make wireless charging easier and more convenient. *See* Thus design incentives and market forces would have motivated a POSITA to combine the teachings of Schröder and Yuen to result in a wearable electronic device with wireless charging when the device is oriented in a charging position.

257. Third, Yuen can improve Schröder's sensor. Both teach a sensor comprising a light-emitting component. Ex-1007 (Schröder), 8:30-53; Ex-1006 (Yuen), 2:29-33, Fig. 5. Yuen further teaches adjusting the operational parameters or measurement periodicity of various sensors based on data related to a user's activity, heart rate, sleep state, and a sensor's power level. Based on Yuen's

teachings, it would have been obvious to modify a sensor's operational parameter or measurement periodicity in the wearable device of Schröder. *See, e.g.*, Ex-1006 (Yuen), 7:19-38 (reducing sampling rate reduces the sensor's power consumption); 17:5-16 (sensor switching to "oversampl[ing]" when the user is active). A POSITA would have understood from Yuen that a higher sampling rate or higher sampling resolution may "enable more accurate adaptive filtering" on the sensor data. *Id.*, 7:1-6. Thus, it would have been obvious to a POSITA to adjust the operational parameters and measurement periodicity of a sensor at least based in part on the information from the sensor.

258. A POSITA also would have been motivated to make these adjustments for reasons of improved accuracy and reduced power consumption. As I described above in Section V.D, by reducing the sampling rate based on user activity (e.g., "rest" or "running"), battery performance can improve in comparison to using the same sampling rate for all activities. Ex-1051, 4-5. On the other hand, increasing the sampling rate during periods maintains or increases accuracy. *See supra* §V.D.

259. In my opinion, it would have been obvious to implement Yuen's teachings to Schröder's sensor. Schröder's teachings involve methods of capturing information about finger veins, which is crucial for applications such as biometric identification or medical diagnostics. This methodology specifically targets the

patterns of veins within the finger. Building on this understanding, a POSITA would have recognized that Yuen's teachings, which discuss the capture of pulse oximetry data, also indirectly involve capturing information about veins. Pulse oximetry is a non-invasive method used to measure the oxygen saturation level of the blood and heart rate through photoplethysmography (PPG), a technique that detects blood volume changes in the microvascular bed of tissue. PPG technology is sensitive to changes in blood volume within tissues, which includes the venous structures targeted by Schröder's vein image. A POSITA would have understood that both Schröder's and Yuen's techniques involve data collection from veins. This understanding would indicate that advances or techniques developed in one application (like pulse oximetry) could potentially inform or enhance methodologies in the other (like vein pattern biometrics), highlighting the interconnectedness of these imaging and sensing technologies in capturing venous information. A POSITA would have been motivated to combine these teachings because incorporating additional sensors and radial positions can enhance redundancy, thereby improving the reliability and accuracy of measurements. However, a POSITA would also recognize the need to carefully balance the increased number of radial positions against the associated costs and the added complexity of materials and manufacturing processes. This balancing act involves evaluating the benefits of

additional redundancy against the practical constraints of production and budget, ensuring that the design remains feasible and cost-effective while achieving the desired level of performance and reliability.

260. It also would have been obvious to a POSITA to apply Yuen's sensor configurations—e.g., the wavelength and positioning parameters—to Schröder's sensor. For example, Yuen's LED switches from infrared to green to “enhance the signal corresponding to cardiac activity.” *Id.*, 10:50-54. Yuen's sensors also “provide, acquire and/or detect information from multiple sides” of its device. *Id.*, 10:1-3. Yuen states, “[t]he use of multiple sensors may also improve the accuracy and/or precision of biometric measurements of the accuracy and/or precision of a single sensor.” *Id.*, 22:48-50. A POSITA would have been motivated to combine these teachings to improve measurement accuracy. As I described above in Section V.B.6, using multiple LEDs for biometric monitoring was known in the art.

261. A POSITA would have had a reasonable expectation of success in combining Schröder and Yuen. A POSITA would have understood that the electronic components of Yuen and Schröder's devices are similar and are interchangeable regardless of whether the devices are in the form of, for example, a toe-band or a “finger-ring.” For example, the '178 Patent acknowledges that a device “can be subjected to [a] magnetic field to produce a current that can charge

the onboard battery in accordance with known electromagnetic principles.” Ex-1001, 30:45-48. Schröder and Yuen teach the same. Ex-1007 (Schröder), 11:50-55 (“The energy storage device is preferably charged by means of the reader’s electromagnetic field.”); Ex-1006 (Yuen), 14:42-46 (“device...may interconnect with a charger using magnetic properties to secure thereto”), 28:41-50 (“the device may use magnets to help the user align the device to the dock or cable...The magnets may also be used as conductive contacts for charging....”). Moreover, a POSITA would have understood that different wearable electronic devices often contain similar components that can be scaled in size and power to achieve interchangeable functionality. This modularity allows for components such as sensors, processors, and batteries to be customized according to the specific needs and constraints of various devices while maintaining their core functions. The ability to scale and interchange these components ensures that designers can adapt and optimize wearable technology for different applications, enhancing both the versatility and practicality of wearable devices in diverse contexts.

2. Independent Claim 1

a. Elements 1[pre]-1[c] and 1[e]

262. As described above, Schröder teaches Elements 1[pre]-1[c] and 1[e].

See supra §VIII.A.1.

- b. Element 1[d]: a printed circuit board disposed between the internal housing component and the external housing component, wherein the printed circuit board extends through at least a second portion of the cavity of the finger-worn wearable ring device different from the first portion**

263. It is my opinion that Schröder teaches Claim 1 for the reasons explained above. *See supra* §VIII.A.1.

264. It is also my opinion that Schröder-Yuen teaches Element 1[d]: “a printed circuit board disposed between the internal housing component and the external housing component, wherein the printed circuit board extends through at least a second portion of the cavity of the finger-worn wearable ring device different from the first portion.”

265. Yuen’s monitoring device has sensors disposed on a “*flexible PCB*.” Ex-1006, 2:38-39, 12:35-38. A POSITA would have understood that the PCB could be applied to Schröder’s inlay, which extends through a second portion of the cavity different from where the first portion.

266. A POSITA would have been motivated to combine the teachings of Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in *supra* §VIII.D.1. Thus Schröder-Yuen teaches Claim 1.

3. **Dependent Claims 4-11 and 13-16**

- a. **Claim 4: The finger-worn wearable ring device of claim 1, further comprising: one or more magnetic components configured to magnetically interact with one or more additional magnetic components of a charger device to orient the finger-worn wearable ring device within a charging position on or within the charger device to facilitate charging of the finger-worn wearable ring device.**

267. It is my opinion that Schröder-Yuen teaches Claim 4.

268. Schröder's "finger-ring" comprises "one or more magnetic components configured to magnetically interact with one or more additional magnetic components of a charger device." Schröder's "finger-ring" is "***charged by means of [a] reader's magnetic field.***" Ex-1007, 11:54-55. A POSITA would have understood that the "finger-ring" and the charger in Schröder have magnetic components to allow for inductive charging. As I described above in the Technology Background Section (*see* §V), inductive coupling relies on magnetic flux coupling between a coil of a primary power transmitter and a coil of a secondary power receiver, which are not physically connected. Ex-1053, 19. The coil on the receiving side picks up the time-varying magnetic field created by the coil on the transmitting side, thus transferring electromagnetic power wirelessly. *Id.*

269. Schröder-Yuen teaches orient[ing] the finger-worn wearable ring device within a charging position on or within the charger device. Yuen teaches

“using magnetic properties to secure” an electronic device to a charger. Ex-1006, 14:42-49. Yuen’s biometric monitoring device uses “*magnets to help the user align the device* to the dock.” *Id.*, 14:42-49. Yuen teaches that the “magnetic field of magnets in the dock or cable and the magnets in the device itself could be strategically *oriented [so] as to force the device to self-align* and provide *a force that holds the device to the dock or cable.*” *Id.*, 28:40-49. A POSITA would have been motivated to implement Yuen’s magnets (that orient the device to the charger) in Schröder’s “finger-ring” to improve wireless charging.

270. A POSITA would have been motivated to combine the teachings of Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.D.1. Thus Schröder-Yuen teaches Claim 4.

- b. Claim 5: The finger-worn wearable ring device of claim 4, further comprising: a charging component configured to wirelessly transfer energy from an additional charging component of the charger device to the battery when the finger-worn wearable ring device is oriented in the charging position.**

271. It is my opinion that Schröder-Yuen teaches Claim 5.

272. Schröder-Yuen teaches a charging component configured to wirelessly transfer energy from a charger device when the finger-worn wearable ring device is oriented in the charging position. Schröder’s “finger-ring” is “charged by means of

[a] reader's magnetic field." Ex-1007, 11:54-55. The battery (energy storage device) is "connected directly to the antenna coil 8 via rectifier circuit" for charging. *Id.*, 11:63-67. A POSITA would have understood that antenna coil 8 is the charging component that is configured to wirelessly transfer energy from the "reader's magnetic field" to the battery. As described above in Section VIII.D.1, a POSITA would have been motivated to implement Yuen's magnetic alignment to orient Schröder's "finger-ring" to improve inductive charging. A POSITA would have understood, in light of Yuen's magnetic alignment, to initiate Schröder's inductive charging based on the orientation of the "finger-ring" based on Yuen's teachings. A POSITA would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.D.1. Thus Schröder-Yuen teaches Claim 5.

- c. Claim 6: The finger-worn wearable ring device of claim 1, further comprising: one or more processors communicatively coupled to the battery and the one or more sensors, wherein the one or more processors are configured to: selectively adjust one or more operational parameters of the one or more sensors based at least in part on the data acquired by the one or more sensors.**

273. It is my opinion that Schröder-Yuen teaches Claim 6.

274. Schröder-Yuen teaches one or more processors communicatively coupled to the battery and the one or more sensors. Schröder and Yuen each disclose a device with a processor, battery, and one or more sensors. *See supra* §VIII.D.1.

Yuen further describes a device having a “sensor processor” that “*process[es] data from physiological, environmental and/or activity sensors*” or an “application processor” that “may be used to store and execute applications that *utilize sensor data acquired* and processed by” a sensor processor, while such an application process may also have sensors directly connected. Ex-1006, 22:60-23:15. A POSITA would find it obvious that one or more processors in the device are coupled to the battery and one or more sensors.

275. It is my opinion that Schröder-Yuen teaches, “one or more processors are configured to: selectively adjust one or more operational parameters of the one or more sensors based at least in part on the data acquired by the one or more sensors.” Yuen describes “*adjust[ing] or modify[ing] the sampling rate and/or resolution mode of the motion sensor(s) during...periods of user activity or motion* (for example, periods where the amount of user motion exceeds a certain threshold).” *Id.*, 6:64-7:1. A POSITA would have understood that whether the user motion exceeds a threshold amount would be based on data acquired by one of the sensors. In my opinion, a POSITA would have been motivated to combine the teachings of Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.D.1. Thus Schröder-Yuen teaches Claim 6.

- d. **Claim 7: The finger-worn wearable ring device of claim 6, wherein the data acquired by the one or more sensors comprises heart rate data associated with a heart rate of the user, wherein the one or more processors are further configured to: selectively adjust a measurement periodicity used by the one or more sensors to acquire the heart rate data based at least in part on the heart rate of the user.**

276. It is my opinion that Schröder-Yuen teaches Claim 7.

277. Schröder-Yuen teaches that data acquired by one or more sensors comprises heart rate data associated with a heart rate of the user. Yuen describes “obtain[ing] *data which is representative of, for example, a user’s heart rate, respiration, heart rate variability, oxygen saturation (SpO2).*” Ex-1006, 10:14-25; *see also id.*, 6:57-7:6, 21:14-45. Yuen explains that “*data indicative of user activity or motion* may be employed *to adjust or modify the sampling rate and/or resolution mode of sensors which acquire heart rate data.*” *Id.*, 6:57-7:6.

278. Schröder-Yuen also teaches that its processors selectively adjust a measurement periodicity used by the one or more sensors to acquire the heart rate data based at least in part on the heart rate of the user. Yuen explains that optical detectors can obtain data representative of “a user’s heart rate,” and that these detectors “may sample, measure and/or detect one or more wavelengths that are also specific and directed to a type of physiological data to be collected and physiological parameter (of the user) to be assessed or determined.” *Id.*, 10:7-28. As I described

above in Section V.D, adjusting operational parameters was well-known. A POSITA would have understood that a user activity or “context” could be determined based on measurements from sensors. *See* Ex-1051 (Au), 4, Fig. 1 (classifying the activity based on measurements from heart rate sensors, respiratory sensor, and accelerometer). A POSITA would have understood that a processor could selectively adjust a measurement period (e.g., sampling rate) of a sensor acquiring heart rate data based at least in part on the user’s heart rate (e.g., motion or user activity). For example, a POSITA would recognize from Yuen’s teachings that whether a user is sedentary can be determined, at least in part, from the user’s heart rate, and that a processor can decrease the sampling rate for the heart rate sensor when the user is sedentary.

279. A POSITA would have been motivated to combine the teachings of Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.D.1.

- e. **Claim 8: The finger-worn wearable ring device of claim 6, wherein the data acquired by the one or more sensors comprises activity data associated with one or more activities engaged in by the user, wherein the one or more processors are further configured to: selectively adjust a measurement periodicity used by the one or more sensors to acquire the activity data based at least in part on the one or more activities engaged in by the user.**

280. It is my opinion that Schröder-Yuen teaches Claim 8.

281. Schröder-Yuen's processor selectively adjust[s] a measurement periodicity used by the one or more sensors to acquire the activity data based at least in part on the one or more activities engaged in by the user. Yuen teaches that "*data indicative of user activity or motion* may be employed *to adjust or modify the sampling rate and/or resolution mode of sensors* which acquire heart rate data." Ex-1006, 6:57-7:6. Yuen also teaches that its device "may *adjust or modify the sampling rate and/or resolution mode of the motion sensor(s)* during such *periods of user activity or motion* (for example, periods where the amount of user motion exceeds a certain threshold)." *Id.*, 6:57-7:6.

282. For the reasons discussed *supra* §VIII.D.2.e, it is my opinion that it would have been obvious that a processor could selectively adjust a measurement period of a sensor acquiring user activity data based at least in part the activity engaged in by the user. A POSITA would have been motivated to combine the

teachings of Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.D.1.

- f. **Claim 9: The finger-worn wearable ring device of claim 6, wherein the data acquired by the one or more sensors is associated with one or more sleep states of the user, wherein the one or more processors are further configured to: selectively adjust a measurement periodicity used by the one or more sensors to acquire the data based at least in part on the one or more sleep states of the user.**

283. It is my opinion that Schröder-Yuen teaches Claim 9.

284. Schröder-Yuen further teaches that the data acquired by the one or more sensors is associated with one or more sleep states of the user. Yuen teaches that a device can determine a user is asleep based on the user's motion. Ex-1006, 7:19-25.

285. Schröder-Yuen also teaches one or more processors further configured to selectively adjust a measurement periodicity used by the one or more sensors to acquire the data based at least in part on the one or more sleep states of the user. Yuen's device "may *adjust and/or reduce the sampling rate of optical heart rate sampling* when the biometric monitoring device determines that the *user is* sedentary or *asleep*." *Id.* As I describe above in Section V.D, adjusting measurement periodicity based on a user's sleep state was well-known. Chen described the "general principle" that turning off some sensors depending on its current state, e.g., "when little or no motion is occurring." Ex-1050 (Chen) ¶33. A

POSITA would have understood to use that general principle here, for example in order to conserve power and extend battery life. It would have been obvious that a processor could selectively adjust a measurement period of a sensor acquiring data associated with one or more sleep states based at least in part on the one or more sleep states of the user. A POSITA would have been motivated to combine the teachings of Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.D.1.

- g. Claims 10/11: The finger-worn wearable ring device of claim 1, further comprising: one or more processors communicatively coupled to the battery [and]/[and] the one or more sensors, wherein the one or more processors are configured to: selectively adjust one or more operational parameters of [the]/[she] one or more sensors based at least in part on a power level of the battery, a power usage of the one or more sensors, or both.**

286. It is my opinion that Schröder-Yuen teaches Claims 10.

287. As described above, Schröder-Yuen teaches one or more processors communicatively coupled to the battery and the one or more sensors. *See supra* §VIII.D.5.

288. Schröder-Yuen's processors "selectively adjust one or more operational parameters of the one or more sensors based at least in part on a power level of the battery, a power usage of the one or more sensors, or both." Yuen

describes that a “monitoring device (or selected portions thereof) may implement or be placed in a lower power mode of operation—for example, *the optical heart rate sensor and/or circuitry may be placed in an off or disabled state or a lower power or sleep mode.*” Ex-1006, 9:15-24. Yuen further describes that “[u]pon such a determination, the device may *reduce its power consumption*—for example, *‘disable’ or adjust the operating conditions of the stress and/or heart rate detection sensors and/or circuitry* (for example, reduce duty cycle of or disable the light source(s) and/or detector(s), and/or disable or attenuate associated circuitry or portions thereof).” *Id.*, 9:30-35. A POSITA would have understood that Schröder-Yuen can adjust the operating conditions of heart rate sensors based on the device being placed in a lower power mode of operation.

289. A POSITA would have been motivated to combine the teachings of Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.D.1.

290. It is my understanding that Claim 11, as written, is indefinite. *See infra* §VIII.H.1. If Claim 11 is to read to be like Claim 10, then Schröder-Yuen teaches Claim 11 for the same reasons it teaches Claim 10.

- h. Claim 13: The finger-worn wearable ring device of claim 1, wherein the one or more sensors comprise a first light-emitting component configured to emit light associated with a first wavelength, and a second light-emitting component configured to emit light associated with a second wavelength different from the first wavelength.**

291. It is my opinion that Schröder-Yuen teaches Claim 13.

292. Schröder-Yuen teaches one or more sensors comprising two light-emitting components configured to emit light associated with two different wavelengths. As described above, in Section VIII.A.1.g (element 1[e]), Schröder's "finger-ring" includes biometric sensors, such as an infrared diode and sensor. Ex-1007 (Schröder), 9:62-10:4. Yuen further describes a sensor with "*a light source emitting light having a wavelength in the red spectrum,*" which corresponds to the claimed "first light-emitting component associated with a first wave length"; and "*a light source emitting light having a wavelength in the infrared spectrum,*" which corresponds to the claimed "second light-emitting component associated with a second wavelength different than the first wavelength." Ex-1006 (Yuen), 10:34-42.

293. A POSITA would have been motivated to combine the teachings of Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.D.1.

- i. Claim 14: The finger-worn wearable ring device of claim 13, wherein the first wavelength is associated with visible light, and wherein the second wavelength is associated with infrared light.**

294. It is my opinion that Schröder-Yuen teaches Claim 14.

295. Schröder-Yuen's first light emitting component emits visible light and another emits infrared light. As discussed above, Schröder's light emitting diode emits infrared radiation. Ex-1007 (Schröder), 9:62-10:4. Yuen's sensor has "a light source emitting light having *a wavelength in the red spectrum*," which corresponds to the "first wavelength associated with visible light," and "a light source emitting light having *a wavelength in the infrared spectrum*," which corresponds to the claimed "second wavelength...associated with infrared light." Ex-1006 (Yuen), 10:34-42.

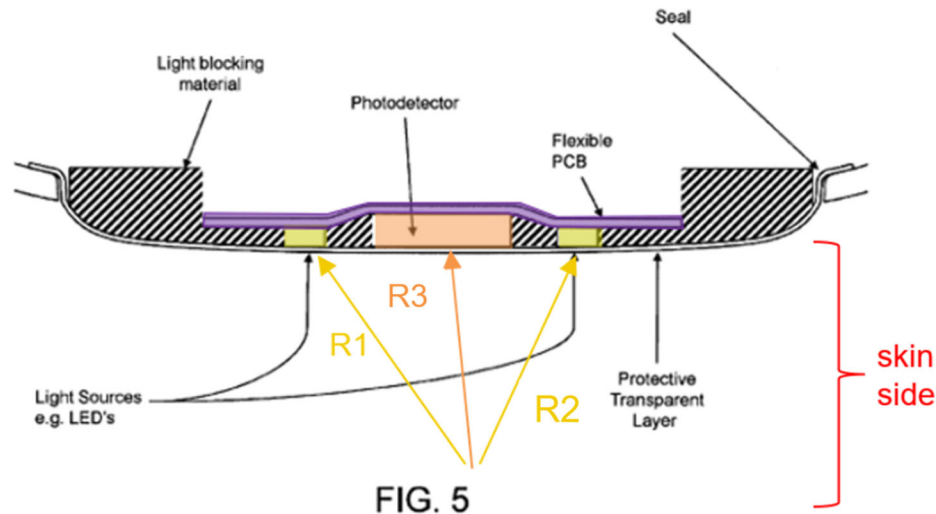
296. In my opinion, a POSITA would have been motivated to combine the teachings of Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.D.1.

- a. Claim 15: The finger-worn wearable ring device of claim 13, wherein the first light-emitting component is positioned within the finger-worn wearable ring device at a first radial position, and the second light-emitting component is positioned within the finger-worn wearable ring device at a second radial position different from the first radial position.**

297. It is my opinion that Schröder-Yuen discloses Claim 15.

298. Schröder-Yuen's first light-emitting component is positioned within the finger-worn wearable ring device at a first radial position, and the second light-emitting component is positioned within the finger-worn wearable ring device at a second radial position different from the first radial position. As shown below in Figure 5, Yuen's "light sources and photodetector are placed on a flexible PCB." Ex-1006, 2:38-39. Yuen explains that the light emitters are also disposed on a "flexible or pliable substrate which facilitates the skin side of the device to conform...to the shape of the user's body part." *Id.*, 12:25-30. Yuen describes that this allows the inner surface of the device to adapt to the shape of the user's appendage so that there is "little to no gap between the skin side of the device and the juxtaposed surface of the skin of the user." *Id.*, 12:24-42. A POSITA would have understood that Yuen's light's sources can be shaped to facilitate skin contact with the user's finger, such as the Yuen-Schröder's finger-ring. Therefore, the light sources disposed on the flexible PCB are also conformed to contact the user's finger by Schröder-Yuen's finger-ring in the same way as the light emitters contact the user's skin in Figure 5. A POSITA would have understood that Yuen's light emitters in the Schröder-Yuen's finger-ring device are at different radial positions, R1 and R2, because the LEDs are at different circumferential positions pointing along a radius from the center of the finger-ring. A POSITA would have also understood

that Yuen's light sources in Yuen's device can be integrated into Schröder's finger-ring device because a "toe band" is structurally equivalent to a "finger-ring." *Id.*, 24:35-37.



299. In addition, Yuen describes "*a plurality of photodetectors and photoemitters [(yellow)] placed along the circumference of the interior* of the band," *id.*, 19:8-10, at different radial positions because the band circular to be worn on the user's arm, wrist, leg and/or ankle, *id.*, 12:50-52.

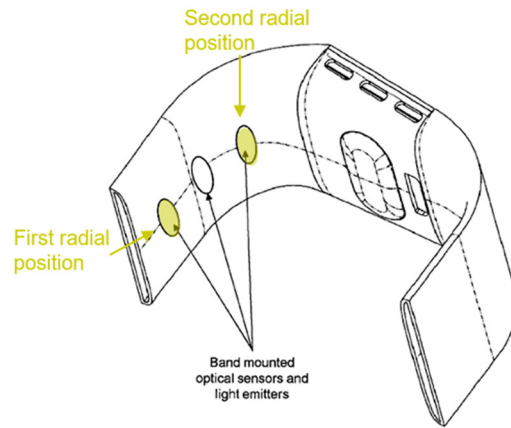


FIG. 11

300. In my opinion, a POSITA viewing Figure 11 would have understood the first LED and the second LED to be at a radial position because the LEDs are at a direction pointing along a radius from the center of an object. A POSITA would have understood that two of the shaded portions of Figure 11 correspond to a first light-emitting component at a first radial position and a second light-emitting component positioned at a second (different) radial position on the user's arm, wrist, leg and/or ankle. *Id.*, 12:50-52. A POSITA would have been motivated to combine the teachings of Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in §VIII.D.1.

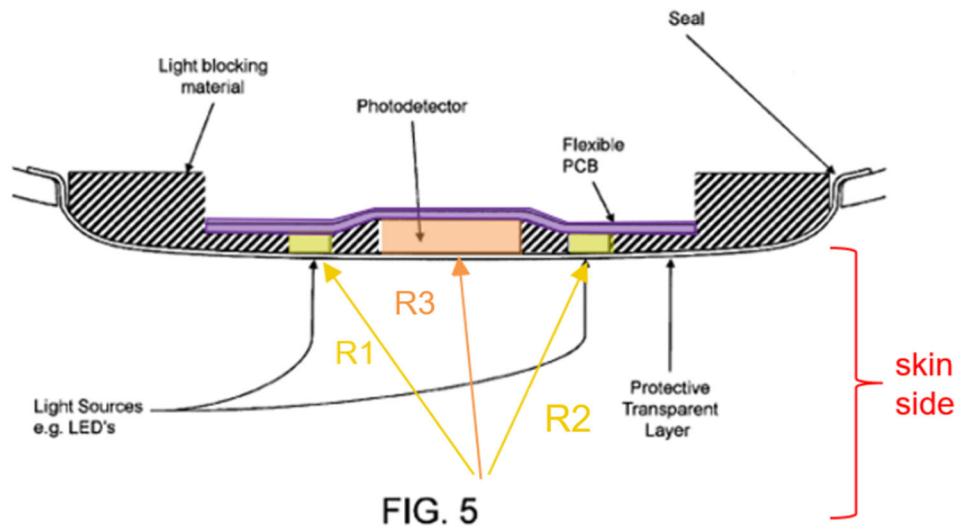
- b. Claim 16: The finger-worn wearable ring device of claim 15, wherein the one or more sensors further comprise a photodetector positioned within the finger-worn wearable ring device at a third radial position that is between the first radial position and the second radial position.**

301. It is my opinion that Schröder-Yuen teaches Claim 16.

302. Schröder-Yuen further teaches a photodetector positioned within the finger-worn wearable ring device at a third radial position that is between the first and second radial positions. Schröder's infrared diode and sensor integrated into the finger-ring are "arranged e.g., opposite each other such that e.g., a[] finger bone located therebetween has no adverse effect" measuring the user's vein. Ex-1007 (Schröder), 9:62-10:4. Thus, Schröder's light receiver is located at a different radial position than the light emitting-component's radial position.

303. Moreover, Yuen teaches photodetector in a third radial position. The LEDs, photodetectors, and other electronics may be provided on the PCB. Ex-1006 (Yuen), 2:38-39. The LEDs/photodetector are further positioned "on a flexible or pliable substrate," such as a flexible PCB, which allows the inner surface of the device to adapt to the shape of the user's appendage (for example, arm, wrist, ankle or leg) that the device is secured to so that there is "little to no gap between the skin side of the device and the juxtaposed surface of the skin of the user." *Id.*, 12:24-42 *see id.*, 2:28-39. Yuen's Figure 5 is "a configuration" that has "the components...positioned on the skin side of the device of the device to conform...to the shape of the user's body part." *Id.*, 12:18-35. A POSITA would have understood, as shown in Figure 5 (below), that first and second light emitting components (yellow) are at two different radial positions (R1 and R2) and a

photodetector (orange) is positioned at a third radial position (R3). *Id.*, 12:50-52. A POSITA also would have understood that the third radial position (R3) is between the first and second (R1 and R2) because the band circular to be worn on the user's arm, wrist, leg and/or ankle. A POSITA also would have understood that Yuen's photodetector in the Schröder-Yuen's finger-ring device is between the different radial positions (R1 and R2) because the photodetector sits between the LEDs that are at different circumferential positions pointing along a radius from the center of the finger-ring.



304. Yuen further describes a portable biometric monitoring device “having a band and optical sensors and light emitters disposed therein.” *Id.*, 3:27-29. “[T]here may be a plurality of photodetectors and photoemitters placed along the circumference of the interior of the band.” *Id.*, 19:7-10. Yuen states that “[o]ptical

components of differing heights may be mounted to different “fingers” of flexible substrate and pressed or secured to the housing surface such that the optical components are flush to the housing surface.” *Id.*, 12:42-45. A POSITA would have understood Figure 11 (below) to teach a first and second light emitting components (yellow) at two different radial positions and a photodetector (orange) positioned at a third radial position between the first and second radial positions because the band circular to be worn on the user’s arm, wrist, leg and/or ankle. *Id.*, 12:50-52.

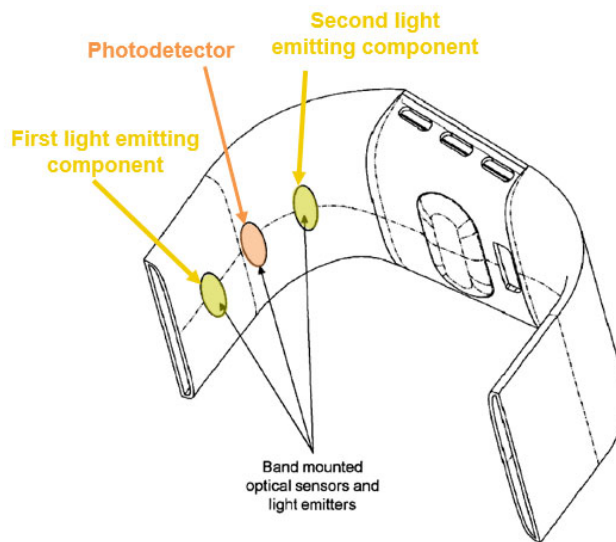


FIG. 11

305. In my opinion, it would have been obvious for to implement the radial positioning of either Figure 5 or Figure 11 in Schröder’s “finger-ring.” A POSITA would have been motivated to combine the teachings of Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in §VIII.D.1.

E. Grounds 5/6: Claims 1-3 and 13-18 are obvious over Niwa Alone/Over Niwa in view of Schröder.

1. A POSITA would have been motivated to combine Niwa with the teachings of Schröder and would have had a reasonable expectation of success.

306. A POSITA would have been motivated to apply the teachings of Schröder to Niwa (“Niwa-Schröder”), and would have had a reasonable expectation of success in doing so because each relates to the same well-known technologies.

307. A POSITA would have been motivated to combine Niwa with Schröder because they are analogous art and teach improvements to the same type of devices. *See* §VIII.B.1 (Ground 2). Both Niwa and Schröder are directed to wearable biometric sensing devices having similar structural components including, for example, inner and outer housing components, a cavity, and electronic components (e.g., battery and PCB) within the cavity. *See, e.g.*, Ex-1005 (Niwa) ¶¶67-68 (circuits and substrate), 194-95 (FPC [Flexible Printed Circuits], i.e., a PCB), 213 (battery), Figs. 22, 26-29 (showing device’s structure); Ex-1007 (Schröder), 11:46-48 (battery), 12:26-42 (PCB), Figs. 4-10 (showing device’s structure). Niwa teaches a ring-shaped device with a cavity that houses electrical components. Ex-1005 ¶¶201, 205. Schröder’s “finger-ring” likewise has a cavity within its components (16, 18) where an electronic part (e.g., chip module 10 and/or inlay 12) is inserted. Ex-1007, 12:10-32, 15:26-28. Schröder also describes various “finger-ring”

constructions “consisting of ring-shaped components 16, 18 of the finger-ring 2 and of an inlay 12.” *Id.*, 12:43-47, Figs. 6-10. Schröder explains that the finger-ring’s “components 16, 18...are interconnected...e.g., by plugging, gluing, screwing, crimping, etc...so that the connection between the components 16, 18 can be undone again” to add or replace the parts inside the finger-ring. *Id.*, 12:20-26. As I described in the Technical Background Section (*see* §V.B.2), it was well known that electronic components may be arranged in a structural cavity. For example, U.S. Patent Application Publication No. 2012/0218184 to Wissmar (Ex-1013), teaches electronic components “located in a cavity within the electronic finger ring.” Ex-1013 ¶28.

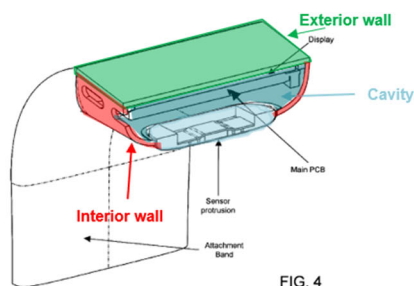


FIG. 4

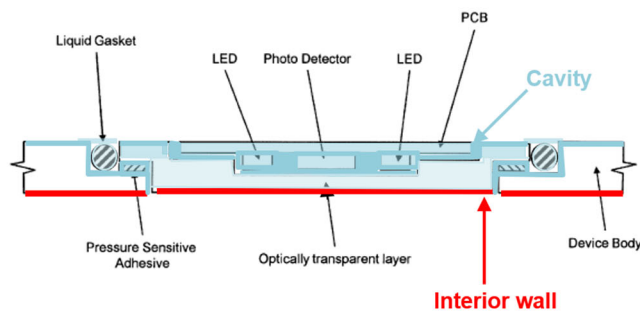


FIG. 7

308. Similarly, Schröder’s finger ring consists of “two ring halves 16 and 18” with a recess so that “inlay 12 is inserted.” Ex-1007, 12:7-9; *see also id.*, 8:56-57 (inlay 12 “arranged” in the interior). Like Yuen, Schröder’s finger ring consist of a cavity within the structural elements.

309. A POSITA would have been motivated to implement Schröder's teachings in Niwa's ring because doing it would then be easier to replace defective parts. *Id.* In addition, a POSITA would have been motivated because Schröder's rigid cavities would improve Niwa's cavity by prolonging the internal components' lifetimes. Moreover, a POSITA would have motivated to combine the design of Niwa's finger ring construction with Schröder's finger-ring structure because a POSITA would have found it beneficial to have multiple components that are "simple, fast and inexpensive to manufacture." Ex-1007, 12:15-17. Thus, design and manufacturing incentives and market forces would have motivated a POSITA to apply Schröder's teachings to Niwa.

310. A POSITA would have had a reasonable expectation of success in combining Schröder and Niwa. As I describe above in Sections V.A-C, a POSITA would have understood that these wearable electronic devices, specifically a ring shape, are restricted by form factors. A POSITA would have understood, therefore, that these references disclose interrelated teachings based on routine technologies that would have been amenable to various well-understood and predictable combinations to provide smaller and more comfortable wearable devices.

2. Independent Claim 1

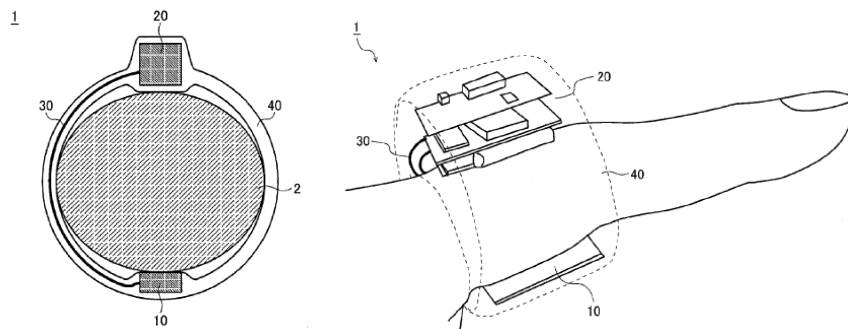
- a. Element 1[pre]: A finger-worn wearable ring device, comprising:**

311. **Grounds 5/6:** It is my opinion that Niwa teaches the preamble, to the extent it is limiting.

312. As shown below in Figures 21 and 26, Niwa discloses a finger-worn wearable ring device such as a “plethysmogram sensor” in a “*a finger ring construction*” to be worn on a third joint of a finger.” Ex-1005 ¶¶28-29.

FIG.22

FIG.26



- b. Element 1[a]: an external housing component defining an outer circumferential surface of the finger-worn wearable ring device;**

313. **Ground 5:** It is my opinion that Niwa teaches Element 1[a].

314. Niwa’s finger ring has an external housing component that defines an outer circumferential surface. Niwa’s “finger ring type housing 40” formed as a circle, Ex-1005 ¶204, has a first unit “located at the ball side of the finger” and a

“second unit...located at the back side of the finger when the finger ring type housing is worn,” *id.* ¶¶29, 193. As shown in Figure 22 and 26 below, the outside of the finger ring housing 40 that is exposed to the environment is the “external housing component” (green) of Niwa’s finger ring 40. Because the finger ring is a circle, the outer portion of the housing defines the outer portion of the circumferential surface of the ring.

FIG.22

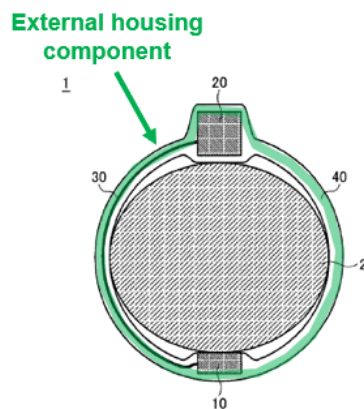
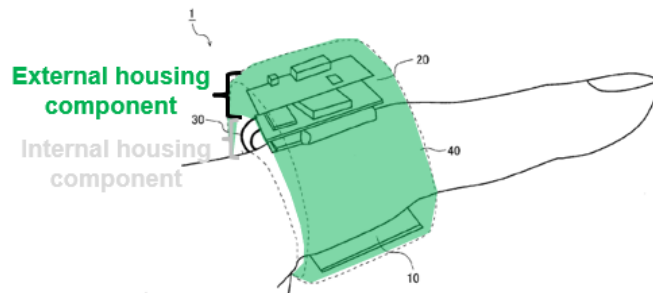


FIG.26



315. As I described in Section V.B-C, 28.30, ring-shaped electronics with external housing components were known. *See* Ex-1032, Fig. 1 (Rhee inner and outer ring design). Housing is not limited to two separate components that are bounded together and then later could be separated again. A POSITA would have understood that the external portion of the Niwa’s ring defines an outer circumferential surface of the ring.

316. **Ground 6:** It is my opinion that Niwa-Schröder teaches Element 1[a]. A POSITA would have understood that the external portion of the ring defines an outer circumferential surface of the ring, as taught in Schröder. As described above in Section VIII.A.1.b, Schröder’s “finger-ring” consists of “two ring halves 16 and 18” with a recess so that “inlay 12 is inserted.” Ex-1007, 12:7-9. As shown below in Figure 4, ring half 18 is the claimed external housing component (green) that defines an outer circumferential surface of the finger-worn wearable ring device because it is the side of Schröder’s “finger-ring” that is exposed to the outside environment and provides an enclosing structure to inlay 12.

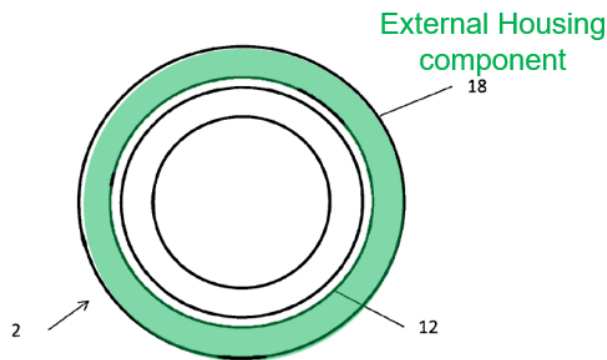


Fig. 4

317. A POSITA would have been motivated to combine the teachings of Niwa and Schröder to have an explicit external housing component in Niwa’s ring and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section XIII.E.1.

- c. Element 1[b(i)]: an internal housing component defining an inner circumferential surface of the finger-worn wearable ring device, the internal housing component coupled with the external housing component,**

318. **Ground 5:** It is my opinion that Niwa teaches Element 1[b(i)].

319. Niwa's finger ring has an internal housing component defining the inner circumferential surface of the ring and is coupled with the external housing component. As shown in annotated Figures 22 and 26, Niwa's "finger ring type housing 40" has an inner portion (green) that surrounds "the ball side of the finger 2 (i.e., palm side) when the finger ring type housing 40 is worn" for the plethysmogram measurement. Ex-1005 ¶192, Figs. 22, 26. The inner portion (green) is coupled with the outer portion to form Niwa's circular finger ring type housing 40.

FIG.22

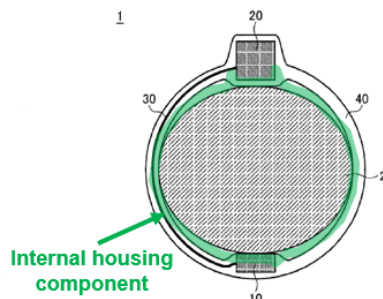
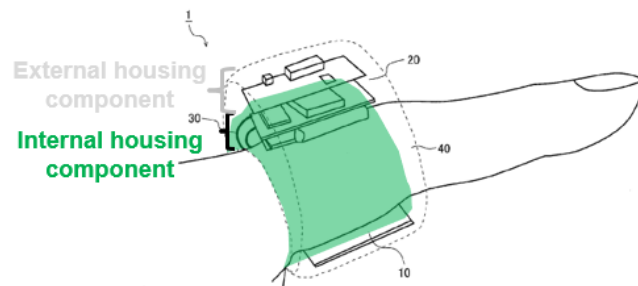


FIG.26



320. In my opinion, a POSITA would have understood that the internal housing component with the external housing component together form the housing for a unified device. This understanding includes recognizing various assembly

techniques that might be used, whether the components are integrated through direct physical contact—which simplifies the design and enhances structural integrity—or through the use of an intermediary structure—that might add functionality or facilitate assembly. The choice in the formation would depend on the specific design requirements, including considerations for durability, maintenance, and performance optimization.

321. **Ground 6:** It is my opinion that Niwa-Schröder teaches Element 1[b]. A POSITA would have understood that the inner circumferential surface of the finger ring is defined by an internal housing component which couples with the external housing component, as taught in Schröder. As described above in Section VIII.A.1.c, Schröder’s “finger-ring” consists of “two ring halves 16 and 18” with a recess so that “inlay 12 is inserted.” Ex-1007, 12:7-9. As shown in Figure 4 below, ring half 16 (green) is the internal housing component defining an inner circumferential surface of the finger-worn wearable ring device because it is the inside ring that contacts the user’s skin when the user is wearing the “finger-ring.”

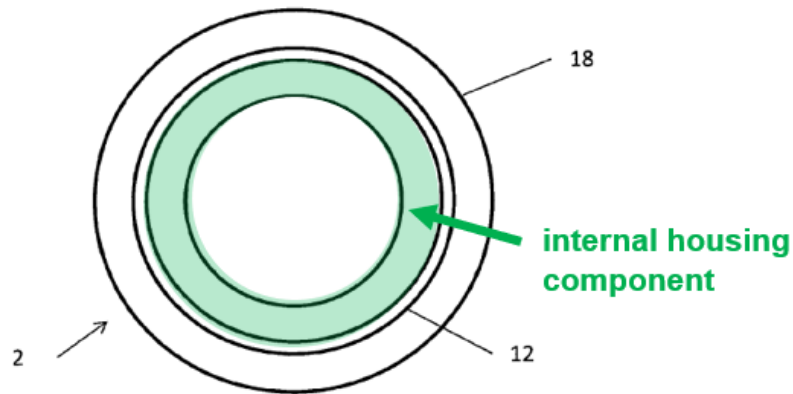


Fig. 4

322. Schröder's internal housing component is coupled with the external housing component to form the "finger-ring." As shown below in Figure 5, Schröder's inner ring half 16 and outer ring half 18 "are interconnected by a suitable technology, e.g., by plugging, gluing, screwing, crimping, etc." Ex-1007, 12:20-22. Schröder's internal housing component is thus coupled with the external housing component, as illustrated by the abutting components 16 and 18 forming the "finger-ring" in Figure 5.

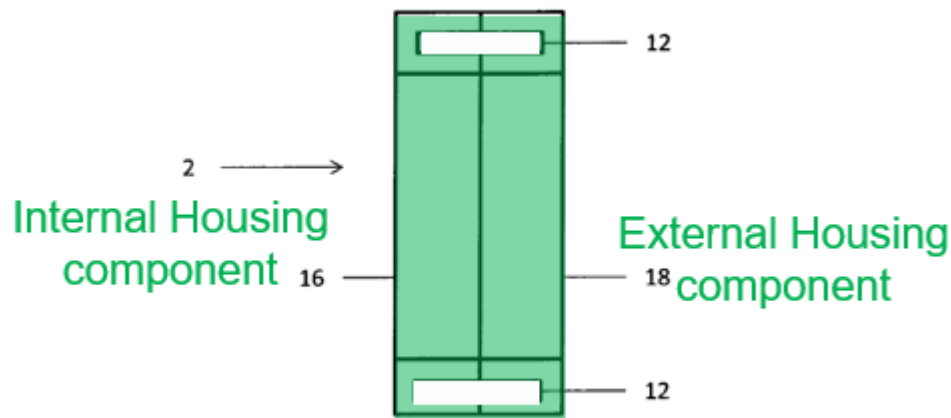


Fig. 5

323. A POSITA would have been motivated to combine the teachings of Niwa and Schröder to have an explicit internal housing component that defines a interior wall in Niwa's ring and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section XIII.E.1.

- d. **Element 1[b(ii)]: wherein at least a portion of the inner circumferential surface of the internal housing component is configured to contact a tissue of a user when the finger-worn wearable ring device is being worn by the user;**

324. **Ground 5:** It is my opinion that Niwa teaches Element 1[b(ii)].

325. As discussed in the previous element, Niwa's inner portion surrounds the ball side of the wearer's finger when worn. Ex-1005 ¶192, Figs. 22, 26. Thus Niwa teaches that the inner circumferential surface of the internal housing component is configured to contact a user's tissue when the ring is worn.

326. **Ground 6:** It is my opinion that Niwa-Schröder teaches Element 1[b(ii)]. A POSITA would have understood that Niwa-Schröder's internal housing component contacts the user's tissue when Niwa-Schröder's "finger ring" is worn. *See* Section VIII.A.1.d. Specifically, Schröder's "finger-ring 2 is worn by a user e.g., permanently on the finger." Ex-1007, 3:61-62; *see id.*, 7:38-39 ("a user wears the external secure unit...directly on his body"), 10:52-56 ("continually worn on the body, e.g., on the finger").

- e. **Element 1[c]: a battery positioned within a cavity formed between the internal housing component and the external housing component, wherein the battery comprises a shape and size configured to fit within the cavity between the outer circumferential surface of the external housing component and the inner circumferential surface of the internal housing component, wherein the battery extends through at least a first portion of the cavity of the finger-worn wearable ring device;**

327. **Ground 5:** It is my opinion that Niwa teaches Element 1[c].

328. Niwa's finger ring has a battery configured to fit between the internal and external housing components in a cavity that is between the outer circumferential surface of the external housing component and the inner circumferential surface of the internal housing component. Niwa's finger ring 40 includes second unit 20 which "supplies" power to the first unit. Ex-1005 ¶¶62, 193, 213. As shown in Figure 28, the second unit 20 includes battery 24 which "is a

power supply source required to drive the plethysmogram sensor.” *Id.* ¶217. Niwa explains that the second unit is covered by the finger ring housing and encompasses the thickness of battery 24 (i.e., 2mm to 5mm). *Id.* ¶201. As shown in Figures 22 and 26, a POSITA would have understood that Niwa’s battery 24 is disposed in a “cavity” formed between the outer circumferential surface of the external housing component and the inner circumferential surface of the internal housing component because the second unit (including the battery) is covered by the ring housing 40 (green, made of the external side and internal side that touches the user’s finger).

FIG.22

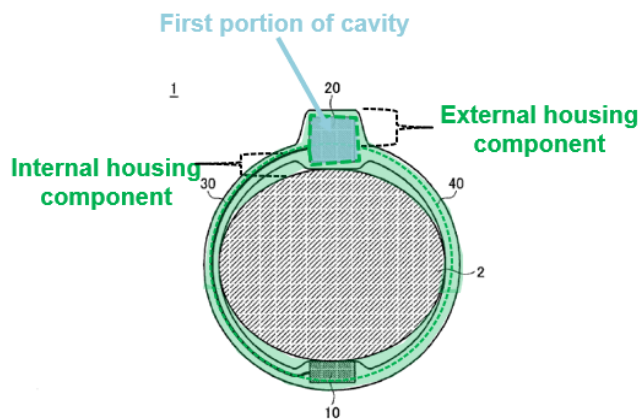
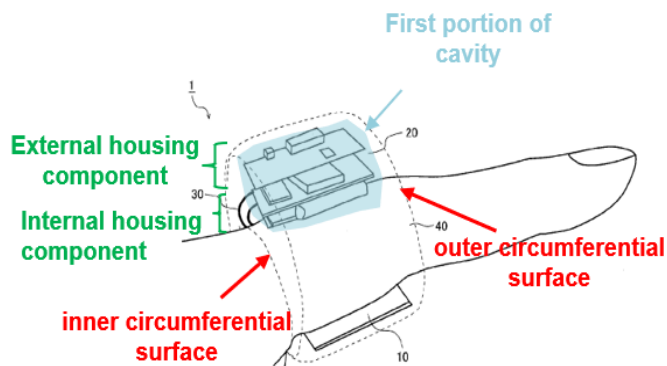


FIG.26



329. It is my opinion that a POSITA would have understood that placing the battery between the internal and external housing components means that the battery is positioned to extend through at least a first portion of the cavity. This portioning is intentional, as the cavity is designed to accommodate not only the battery but also other components and parts, effectively utilizing the available space within the device's framework. Apportioned placement is crucial for maintaining the structural integrity of the assembly. Furthermore, this arrangement facilitates efficient connections from the battery in the first portion to other components situated in different portions of the device. Such connectivity is essential for optimal power management and enhances the overall functionality of the device. Additionally, this configuration improves accessibility for maintenance or replacement of the battery and other components, thereby extending the device's operational life and ease of service.

330. As I explained in the Technology Background Section (*see* Section V), by 2013, the formation of cavities, whether by single-structure formation or multi-structure assembly techniques, was known to be essential for integrating electronic components, cabling, batteries, PCBs, and assemblies into the interiors and exteriors of mechanical surfaces, structures, and frames. This was known to be crucial in the manufacturing of electromechanical devices ranging from cars and computer

interface devices to phones, toys, watches, electronic medical devices, and other modern battery or wall-power operated devices. Manufacturing and assembly approaches were known to vary based on tooling sizes, costs, and complexities.

331. As discussed in Section V.B.2, by 2013 it was well understood that in order to house electronic components within wearable devices, there must be an internal space like a cavity between two housing portions. For example, U.S. Patent No. 6,201,698 to Hunter teaches that “the side walls and the web together create a cavity [] to house the electronic circuit.” Ex-1060, 2:56-57. Moreover, U.S. Patent No. 6,745,061 to Hicks teaches that “[i]ncluded within the assembly 350 are upper and lower flexible members 304 and 300, respectively,” which are “thermally bound to one another sandwiching a leadframe 308 between their inside surfaces.” Ex-1025, 6:48-54 (Hicks). “This leadframe 308 contains active components (i.e., LEDs and a photodetector) for use in oximetry measurements.” Ex-1025, 6:48-54 (Hicks).

332. I also explained in Section V.C that not all cavities are premolded. A conformal cavity may be formed by way of encapsulation. *See, e.g.*, Ex-1055 (Ardebili), 3 (“[p]otting involved positioning the electrical circuit in a container and pouring the liquid encapsulant into the cavity.”). Ardebili also discusses encapsulating electronics within a cavity. *See id.*, 4 (“The encapsulant, typically a thermosetting polymer, is cured in the cavity to form the final electronic package.”).

An epoxy adhesive may be poured and set over the components, and a cavity is formed around the components.

333. A POSITA would have understood that by placing the battery between the inner and outer housing components, the battery necessarily is of a size and shape to fit inside the ring and power the components of Niwa's ring. In order to fit inside Niwa's ring, the battery must be configured in size and shape to fit within the cavity. Otherwise, Niwa's ring either has (1) a battery that sticks out or is exposed to the environment or (2) a wired connection to power its components, which is contrary to the intent of having a portable, wearable device.

334. **Ground 6:** Niwa-Schröder teaches Element 1[c]. A POSITA would have understood that Niwa's cavity would be in between the external and internal housing components, as taught in Schröder. *See* Section VIII.A.1.e.

- f. **Element 1[d]: a printed circuit board disposed between the internal housing component and the external housing component, wherein the printed circuit board extends through at least a second portion of the cavity of the finger-worn wearable ring device different from the first portion; and**

335. **Ground 5:** It is my opinion that Niwa teaches Element 1[d].

336. Niwa's finger ring has a substrate disposed between the internal housing component and the external housing component. Niwa describes components and circuits that are "mounted" onto the surface or back side of the

“substrate.” *See, e.g.*, Ex-1005 (Niwa) ¶¶68, 69, 213. Niwa also describes an “electrical connection...established between the surface and back side of the...substrate...by means of the through hole and the via hole.” *Id.* ¶214. Thus a POSITA would have understood Niwa’s substrate to be a PCB.

337. As shown in Figures 27 and 28 (cross-sections) below, Niwa utilizes substrates in first unit 10 and second unit 20, all of which exist within finger ring type housing 40. Ex-1005 ¶¶194-95, 207. A POSITA would have understood that the claimed PCB corresponds to a substrate in Niwa because its substrate is a PCB disposed between the internal and external housing components which electrically connects components and circuits.

FIG.27

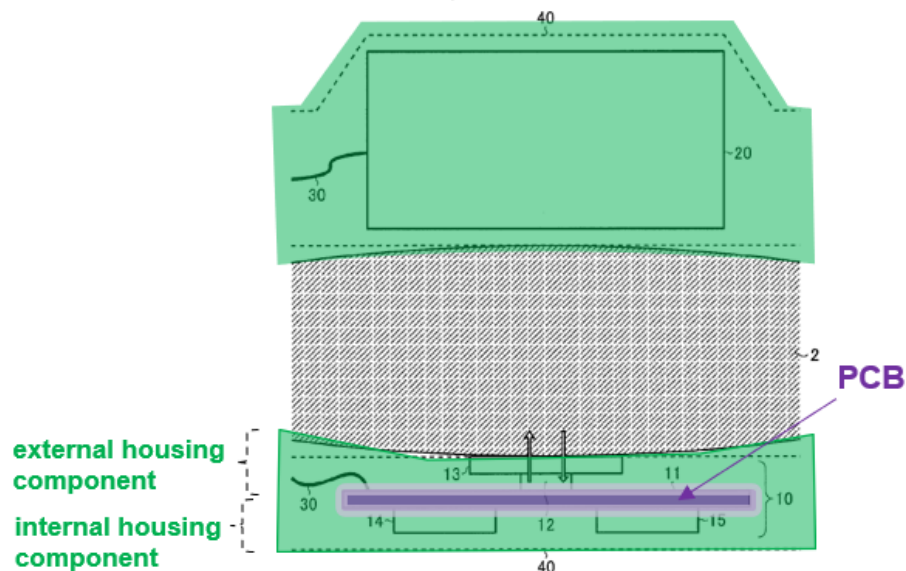
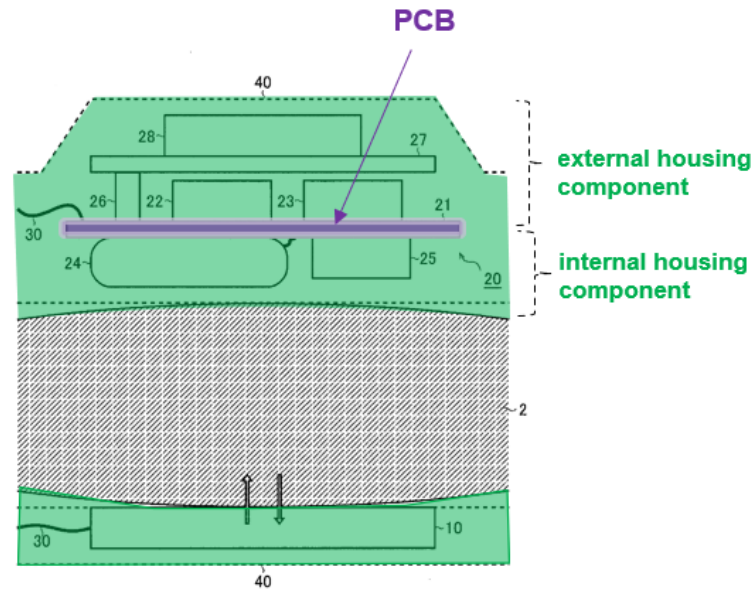


FIG.28



338. Niwa's PCB extends through at least a second portion of the cavity of the finger-worn wearable ring device different from the first portion. As I described above in Section V.B.2, electronic components were housed within the cavity of rings' structure. *See* Ex-1013 (Wissmar) ¶28 (listing "printed circuit board 9" within a ring structure). A POSITA would have understood that by being disposed between the internal and external housing components, the PCB necessarily exists within a cavity by being within the finger ring housing 40. *Id.* In view of both the battery and the PCB being arranged inside and covered by the finger ring, the cavity must provide space for both components. *Id.* For example, Figures 27 and 28 (cross-sections) below show how a first portion (light blue) surrounding battery 24 (blue)

in second unit 20 is different than a second portion (light purple) surrounding PCB 11 (purple).

FIG.28

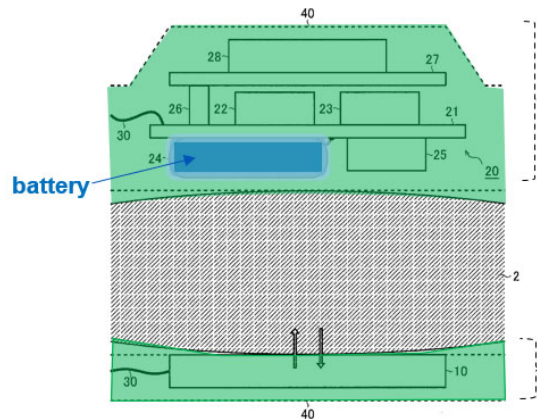
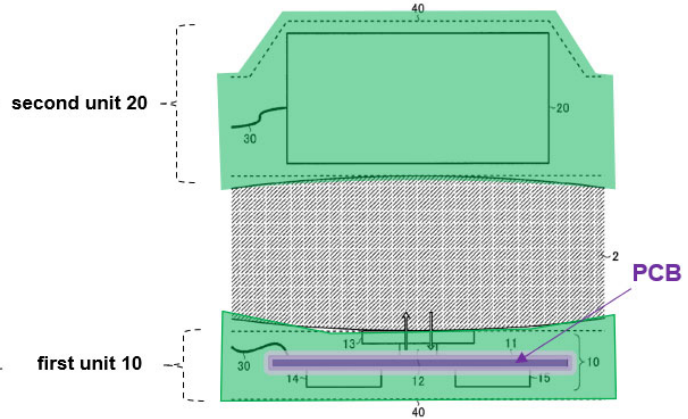


FIG.27



Therefore, a POSITA would have understood that Niwa's first portion and second portion correspond with the respective locations of the battery and PCB. It would have been obvious to use Niwa's PCB configuration in Schröder as to separate a battery and PCB that are in the same ring housing. A POSITA would have been motivated to combine the teachings of Schröder and Niwa and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section VIII.B.1. Thus Niwa teaches Claim 1.

339. **Ground 6:** It is my opinion that Niwa-Schröder teaches Element 1[d].

340. Niwa teaches a PCB. *See supra* §VIII.B.2.b. A POSITA would have understood that Niwa's PCB would be second portion of the cavity would be

between the external and internal housing components, as taught in Schröder for the same reasons as explained in Section VIII.A.1.f..

- g. Element 1[e]: one or more sensors electrically coupled with the printed circuit board and the battery and configured to acquire data from the user through the internal housing component.**

341. **Ground 5:** It is my opinion that Niwa teaches Element 1[e].

342. Niwa's finger ring has one or more sensors electrically coupled with the PCB and the battery. Specifically, Niwa's finger ring has a first unit "to measure the plethysmogram." Ex-1005 ¶192. Niwa's second unit has battery 24 to "supply" power to the first unit by cable 30 which "connect[s] the first unit and the second unit electrically." *Id.* ¶62. Niwa further teaches substrates and circuits in the first and second units. *See, e.g., id.* ¶¶67-69 ("the first unit comprises an amplifier circuit...the first unit comprises a processing circuit...the first unit comprises a substrate to the surface of which the light sensor is to be mounted...the amplifier circuit and the processing circuit are to be mounted to the backside of the substrate"), 77 ("Moreover, with respect to the plethysmogram sensor according to the construction 6-3 to 6-17, wherein the second unit comprises multiple substrates stacked vertically via a connector"), 200 ("In addition, with respect to the thickness of the first unit 10, including a substrate 11..., an amplifier circuit 14, and a processing circuit 15...and the thickness of the finger ring type housing 40 which

covers the first unit 10 are included”), 200 (“the thickness of a first substrate 21 and a power source circuit 22...the thickness of a second substrate 27 and a wireless communication circuit 28..., furthermore the thickness of the finger ring type housing 40 covering the second unit 20 are included”), Figs. 27-29. Thus, Niwa teaches a sensor electrically coupled with the PCB and the battery.

343. Niwa’s first unit is a sensor configured to acquire data from the user through the internal housing component. Niwa’s first unit 10 contains a light emitting portion, a light receiving portion, and a processing unit “to acquire information about the plethysmogram of the measured person based on a measured value provided from the light receiving portion.” *Id.* ¶¶12, 27. Specifically, first unit 10 has “light sensor 12,” comprised of “both the light emitting portion and the light receiving portion are provided at same side against the finger 2,” that “performs the measurement of the plethysmogram (i.e., *detection for the emitted light to the finger 2 and a reflected light go back from the finger 2*) via [a] measurement window 13.” *Id.* ¶¶209-10. A POSITA would have understood that Niwa’s sensor acquires data from the user through window 13 that faces the finger, i.e., through the internal housing component. *See supra* §V.C.

344. **Ground 6**: It is my opinion Niwa-Schröder teaches Element 1[e]. A POSITA would have understood that Niwa’s sensors would acquire data from the

user through the internal housing component, as taught in Schröder for the same reasons as explained in Section VIII.A.1.g.

3. Dependent Claims 2-3 and 13-18

- a. Claim 2: The finger-worn wearable ring device of claim 1, wherein the first portion of the cavity of the finger-worn wearable ring device is non-overlapping with the second portion of the cavity of the finger-worn wearable ring device.**

345. **Grounds 5/6:** It is my opinion that Niwa teaches Claim 2.

346. Niwa teaches the first portion of the cavity not overlapping with the second portion for the reasons discussed in Section VIII.B.2.a (Ground 2).

- b. Claim 3: The finger-worn wearable ring device of claim 1, wherein the first portion of the cavity of the finger-worn wearable ring device at least partially overlaps with the second portion of the cavity of the finger-worn wearable ring device.**

347. **Grounds 5/6:** It is my opinion that Niwa teaches Claim 3.

348. As described in Section VIII.E.1, Niwa teaches Claim 1. Niwa further teaches the first portion of the cavity at least partially overlapping with the second portion for the reasons discussed in Section VIII.B.2.b (Ground 2).

- c. **Claim 13: The finger-worn wearable ring device of claim 1, wherein the one or more sensors comprise a first light-emitting component configured to emit light associated with a first wavelength, and a second light-emitting component configured to emit light associated with a second wavelength different from the first wavelength.**

349. **Grounds 5/6:** It is my opinion that Niwa/Niwa-Schroeder teaches Claim 13 for the reasons explained in Section VIII.B.3.c.

350. Niwa's sensors comprise a first light-emitting component configured to emit light associated with a first wavelength, and a second light-emitting component configured to emit light associated with a second wavelength different from the first wavelength. As described above, Niwa's first unit 10 contains a light emitting portion, a light receiving portion, and a processing unit "to acquire information" about the user's plethysmogram. Ex-1005 ¶¶12, 27; *see also id.* ¶¶209-10 ("detection for the emitted light to the finger 2 and a reflected light go back from the finger 2) via [a] measurement window 13"); *supra* §V.C. Specifically, first unit 10's light emitting portion can include "***LED1 to LED8***" with the "***output wave lengths $\lambda 1$ to $\lambda 8$ [that] are values different from one another.***" *Id.* ¶147. A POSITA would have understood that Niwa's first light-emitting component, e.g., LED1, is associated with a first wavelength $\lambda 1$, and a second light-emitting component, e.g., LED8, associated with a second wavelength $\lambda 8$ that is different than $\lambda 1$.

- d. **Claim 14: The finger-worn wearable ring device of claim 13, wherein the first wavelength is associated with visible light, and wherein the second wavelength is associated with infrared light.**

351. **Grounds 5/6:** It is my opinion that Niwa/Niwa-Schroeder teaches Claim 14 for the reasons explained in Section VIII.B.3.d.

352. Niwa's first light-emitting component emits visible light and the second light-emitting component emits infrared light. Niwa describes that the "output wavelengths" from the LEDs range "from *a visible light region to a near-infrared region.*" Ex-1005 ¶147. A POSITA would have understood that a first wavelength λ_1 from first light-emitting component (LED1) is associated with visible light. *See supra* §XIII.E.3. A POSITA would have found it obvious to extend the wavelength of Niwa's LED from "a near-infrared region" to an infrared region for redundancy, to expand the type of information collected, or to use a non-visible light. *Id.* ¶147. A POSITA would thus have understood that a second wavelength λ_8 from LED8 in Niwa is associated with infrared light.

- e. **Claim 15: The finger-worn wearable ring device of claim 13, wherein the first light-emitting component is positioned within the finger-worn wearable ring device at a first radial position, and the second light-emitting component is positioned within the finger-worn wearable ring device at a second radial position different from the first radial position.**

353. **Grounds 5/6:** It is my opinion that Niwa/Niwa-Schroeder teaches Claim 15 for the reasons explained in Section VIII.B.3.e.

354. Niwa teaches a “finger ring” “worn on the third joint of the finger 2.” Ex-1005 ¶191. Niwa’s finger ring has a light emitting portion with eight light emitting components centrally arranged around light receiving portion PD. *See id.* ¶120, Fig. 3. Niwa further teaches two light-emitting components at different radial positions. Niwa’s “light emitting portion and the light receiving portion are provided at same side against the fingertip.” *Id.* ¶120. Niwa describes Figure 3 as the “Layout of the Light Emitting Portion and the Light Receiving Portion” of the first unit’s light sensor 12. *Id.* Niwa further describes “a single light receiving portion PD (i.e., a photo diode or a photo transistor) and *eight light emitting portions LED1 to LED8* (i.e., a light emitting diode) *equally spaced from one another and placed on a circumference with a central focus on the light receiving portion PD.*” *Id.* As shown below in Figure 27, the first unit 10 houses the light sensor 12 (annotated), which faces the user’s skin (finger 2). *See id.* ¶¶50, 200.

FIG.27

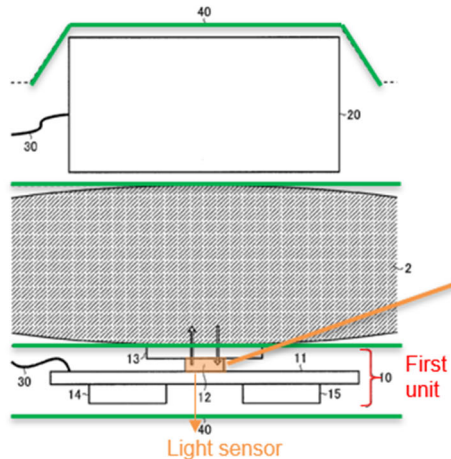
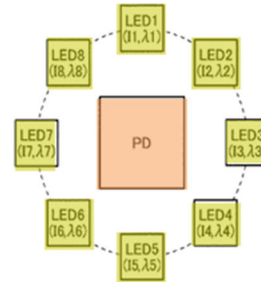
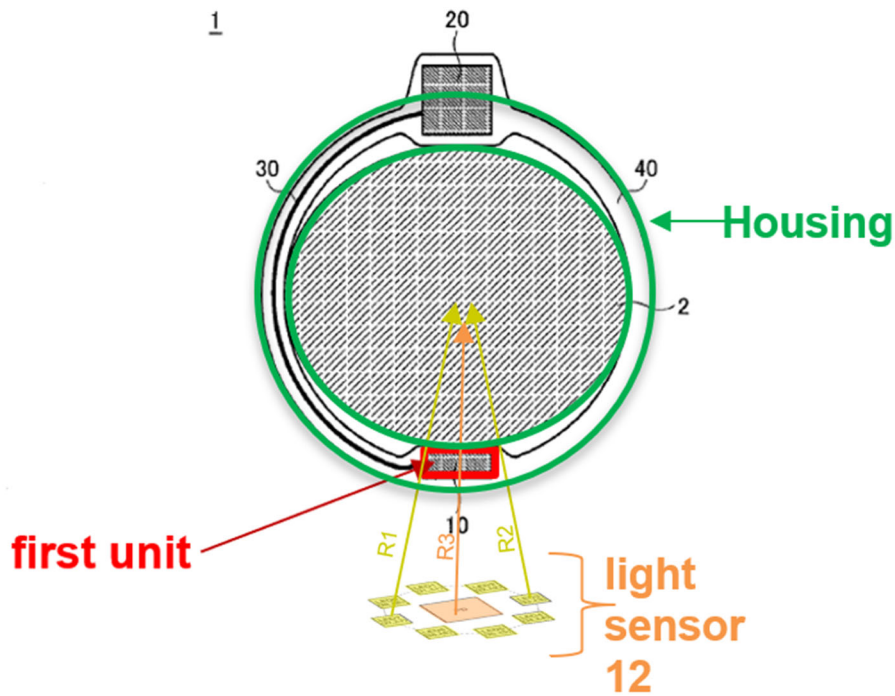


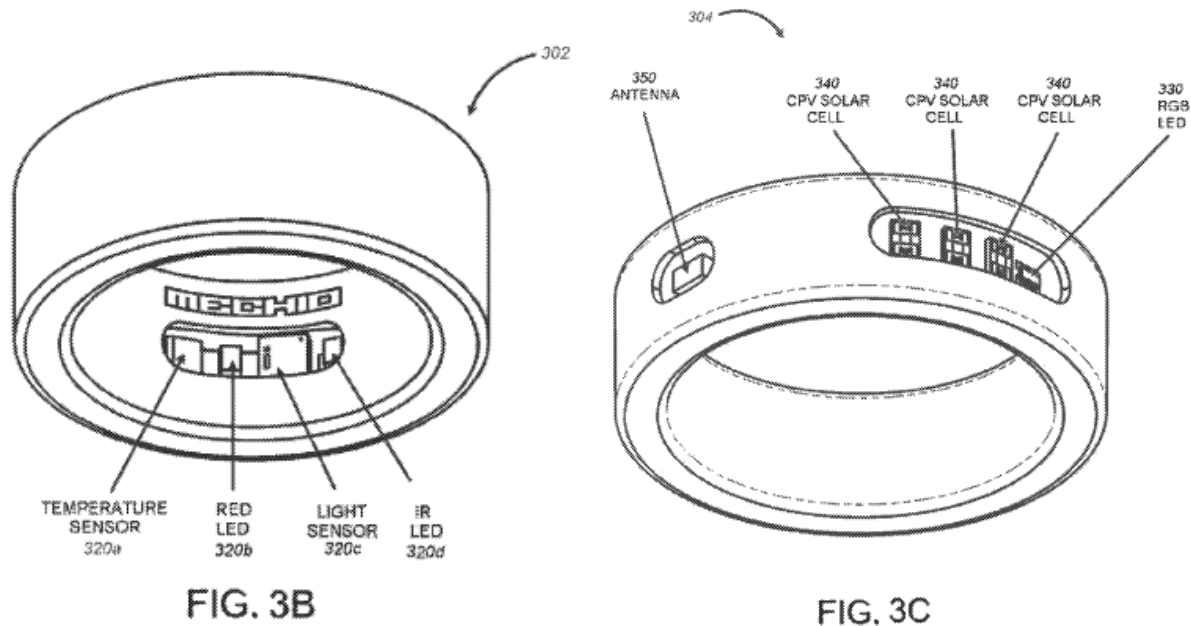
FIG.3



355. A POSITA would have understood that the light emitters (LEDs) are at different radial positions. Modified Figure 22' below superimposes the light emitting components and photodetector of Figure 3 in the light emitting portion of first unit 10's light sensor 12. As shown in modified Figure 22', Niwa's LED7 (yellow) is positioned at a first radial position (R1) and LED3 (yellow) is positioned at a second radial position (R2) within the finger-worn wearable ring device (green).



356. A POSITA would have understood LED7 and LED3 are positioned at different radial positions because the LEDs are located at different circumferential positions pointing along a radius from the center of the finger ring (i.e., the claimed “radial position”), just like the ’178 Patent. Ex-1001, Figs. 3B, 3C.



- f. **Claim 16:** The finger-worn wearable ring device of claim 15, wherein the one or more sensors further comprise a photodetector positioned within the finger-worn wearable ring device at a third radial position that is between the first radial position and the second radial position.

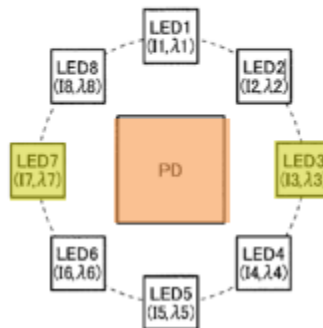
357. **Grounds 5/6:** It is my opinion that Niwa/Niwa-Schroeder teaches Claim 16 for the reasons explained in Section VIII.B.3.f.

358. Niwa's finger ring has a photodetector positioned at a third radial position that is between the first radial position and the second radial position. Niwa discloses "*a light receiving portion to detect an intensity of the lights* emitted from the light emitting portion and penetrates the living body of a measured person." Ex-1005 ¶¶43, 117, Fig. 1. As described in the previous section, a POSITA would have

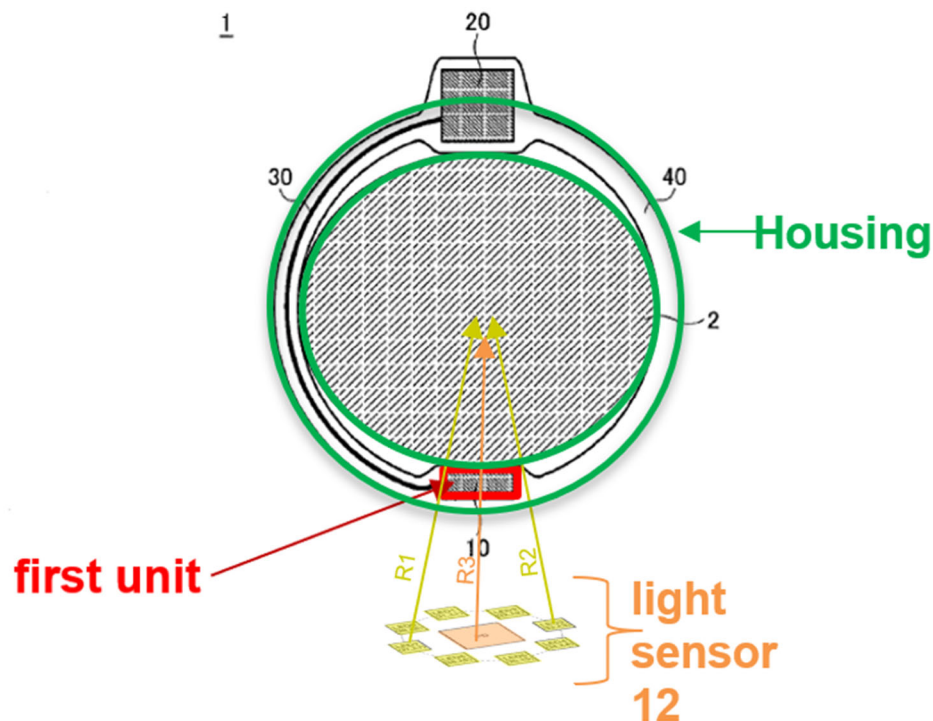
understood Niwa's Figure 3 teaches light emitting portions at different radial positions. *See supra* §XIII.E.2.e (Claim 15).

359. In my opinion, a POSITA would have also understood Figure 3 to show light receiving portion PD (orange) positioned at a third radial position between the first radial position of LED7 (yellow) and a second radial position of LED3 (yellow). *See* Ex-1005 ¶64.

FIG.3



360. As shown in modified Figure 22' (with Figure 3 superimposed on first unit 10), Niwa's light receiving portion PD (orange) is positioned at a third radial position (R3) that is between the first radial position (R1) of LED7 (yellow) and second radial position (R2) of LED3 (yellow) within the finger-worn wearable ring device (green).



Id., Fig. 22'. In my opinion, a POSITA would further have understood that Niwa teaches light-emitter and photodetector configurations with varying radial positions. *See, e.g., id.* ¶¶32, 43, 117, Figs. 1, 14-16. A POSITA would have been motivated to try different configurations for a wider range of measurements. For example, Figure 14 of Niwa shows a sensor layout with the light emitting portion LED and the light receiving portion PD “provided at different places.” *Id.* ¶164. Figure 14’s elliptical “construction makes it possible to shorten the measurement time for the plethysmogram.” *Id.*

- g. **Claim 17: The finger-worn wearable ring device of claim 1, wherein the external housing component and the internal housing component define the cavity configured to at least partially surround the battery, and the printed circuit board, wherein one of the external housing component or the internal housing component comprises: a first side wall and a second side wall that extend between the internal housing component and the external housing component, wherein the cavity is defined at least in part by the outer circumferential surface, the inner circumferential surface, the first side wall, and the second side wall.**

361. **Grounds 5/6:** It is my opinion that Niwa/Niwa-Schröder teaches Claim 17.

(1) The finger-worn wearable ring device of claim 1, wherein the external housing component and the internal housing component define the cavity configured to at least partially surround the battery, and the printed circuit board

362. **Grounds 5/6:** It is my opinion that there is ambiguity as to what “the cavity configured to at least partially surround the battery, and the printed circuit board” is referencing. *See infra* §VIII.H.2. To the extent that this recited limitation is to be interpreted to mean the same cavity as claim 1—“a cavity formed between the internal housing component and the external housing component, wherein the battery comprises a shape and size configured to fit within the cavity between the outer circumferential surface of the external housing component and the inner

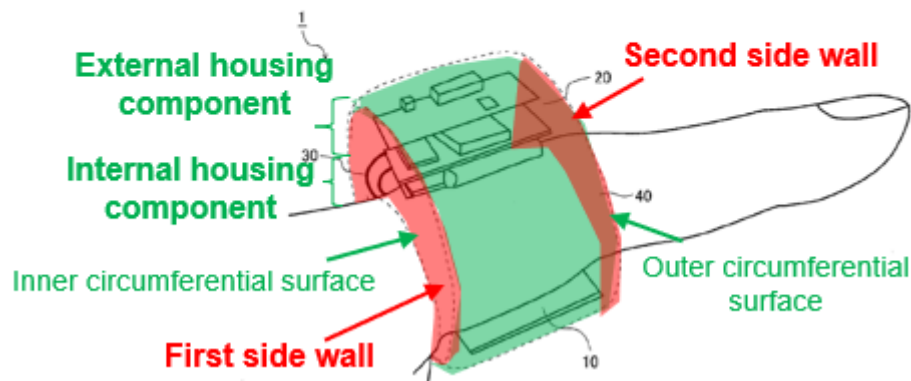
circumferential surface of the internal housing component,” then Niwa/Niwa-Schröder teaches Claim 17’s cavity limitation as described in Section VIII.E.1.e (element 1[c]). Niwa’s external and internal housings define a cavity that surround the battery and PCB. Niwa’s “finger ring type housing 40” contains the first unit 10, second unit 20, and the cable 30. Ex-1005 ¶194. As discussed above in Section VIII.E.1.e-f (elements 1[c]-[d])), Niwa/Niwa-Schröder’s battery 24 and PCB 30 are in different portions of the cavity of finger ring housing 40.

(2) Wherein one of the external housing component or the internal housing component comprises: a first side wall and a second side wall that extend between the internal housing component and the external housing component

363. **Ground 5:** Niwa’s finger ring has a first side wall and a second side wall that extend between the internal housing component and the external housing component and further define the cavity. Niwa explains the thickness of the finger ring type housing 40 “covers” the first unit and the second unit. Ex-1005 ¶¶200-201. As shown in annotated Figure 26 below, side walls (red) extend between the internal and external housing components (green) and correspond to the claimed side walls because they are the material that connects the external and internal housing components at a thickness that covers the first and second units inside the ring. It would have been obvious to implement side walls that extend between the internal

and external housing components because a POSITA would want to create space to fit more components or allow for better thermal management inside the finger ring. By extending the space vertically, in implementing the side walls, a POSITA would have been motivated to keep a ring shape for the wearer's comfort without taking more surface area of the finger or expanding the width of the ring.

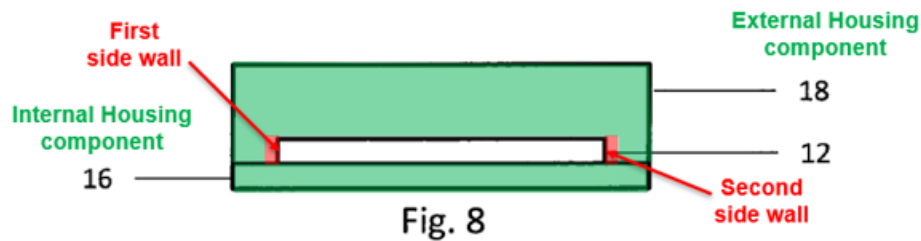
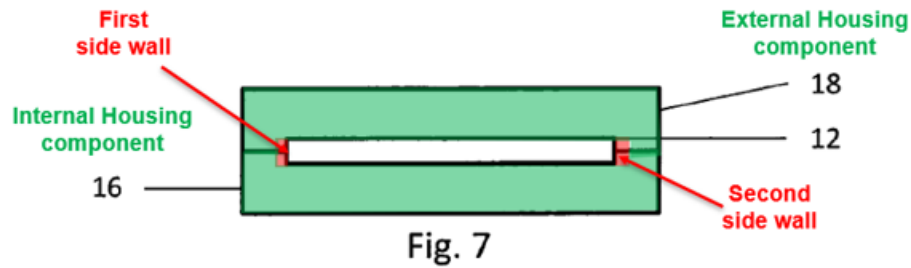
FIG.26



364. As discussed in Section V.B.1 and V.B.2, wearable devices having an interior and exterior component was well-known. For example, U.S. Patent No. 6,699,199 to Asada teaches that “one or more photo diodes 2 and one or more light-emitting diodes (LEDs) 4 are imbedded in a ring 10.” Ex-1034, 2:59-61 (Asada ’199). Moreover, U.S. Patent No. 6,745,061 to Hicks teaches that “[i]ncluded within the assembly 350 are upper and lower flexible members 304 and 300, respectively,” which are “thermally bound to one another sandwiching a leadframe 308 between

their inside surfaces.” Ex-1025, 6:48-54. “This leadframe 308 contains active components (i.e., LEDs and a photodetector) for use in oximetry measurements.” *Id.*, 6:48-54. Similarly, Schröder teaches having multiple components. Schröder’s ring has two halves 16 and 18 that are manufactured by casting, milling, or embossing and are “interconnected by a suitable technology, e.g., by plugging, gluing, screwing, crimping, etc.” Ex-1007, 12:10-22. Schröder provides various designs for the shape of the ring halves, such as a U-shape with inlay 12 being arranged between the components 16 and 18. *Id.*, 12:45-55.

365. **Ground 6**: A POSITA would have understood that Schröder teaches this claim element for the same reasons as described above in Ground 1 (Section VIII.A.1). As shown in the annotated Figures 7 and 8 below, a POSITA would have understood that both housing components thus a first side wall and a second side wall extend between the internal housing component and the external housing component because both components are U-shaped. *See* Ex-1007, Figs. 7, 8. A POSITA would have been motivated to implement side walls in the Niwa-Schröder’s ring because, as I explained in Section VIII.E.1, doing so improves the longevity of the internal components and makes it easier to replace parts.



(3) Wherein the cavity is defined at least in part by the outer circumferential surface, the inner circumferential surface, the first side wall, and the second side wall

366. **Ground 5:** Niwa's cavity is defined by the outer circumferential surface, the inner circumferential surface, the first side wall, and the second side wall. Niwa describes these surfaces allow the finger ring to be "water-proof" so that it is "possible to measure the plethysmogram without breaking down even if it is soaked to water (e.g., rain) or sweat." Ex-1005 ¶205. A POSITA would have understood that all the components in Niwa exist within a cavity inside the finger ring type housing 40, which is comprised of the outer circumferential surface and inner circumferential surface because the finger ring housing 40 "covers" and "water-proofs" the components so that the finger ring may continue to measure the plethysmogram. A POSITA would have found it obvious to partially define the

cavity with a first and second side wall because a POSITA would have been motivated to arrange the components in a way that reduces the wearer's consciousness of the ring. *Id.* ¶206. One arrangement would include positioning the components in a stacking manner—making make the ring taller but still comfortable to wear—rather than evenly increasing the ring's circumference and becoming less comfortable to wear. Moreover, a POSITA would have been motivated to include first and second side walls to strengthen the cavity's structure and extend the components' longevity.

367. **Ground 6:** A POSITA would have understood that Schröder teaches this claim element for the same reasons as described above in Ground 1 (Section VIII.A.1).

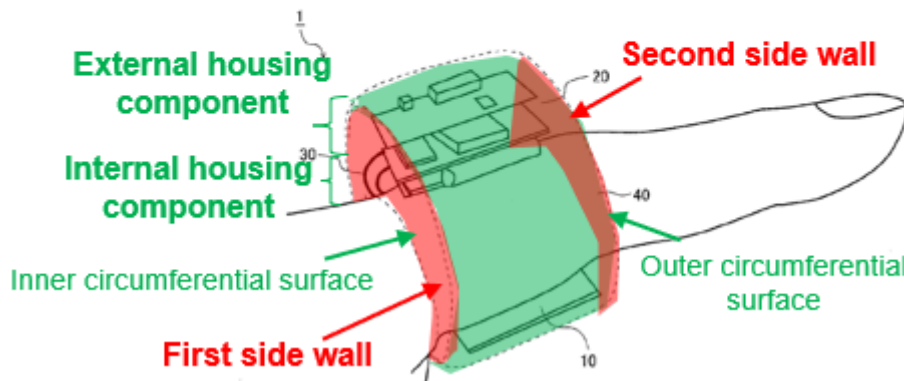
- h. Claim 18: The finger-worn wearable ring device of claim 17, wherein the first side wall, the second side wall, or both, are substantially perpendicular to the inner circumferential surface, the outer circumferential surface, or both.**

368. **Ground 5:** It is my opinion that Niwa teaches Claim 18.

369. Niwa teaches the first side wall, the second side wall, or both, are substantially perpendicular to the inner circumferential surface, the outer circumferential surface, or both. Annotated Figure 26 shows that the side walls (red) are substantially perpendicular to the inner circumferential surface or outer

circumferential surface (green) in order to “cover” and “water-proof” the components so that the finger ring may continue to measure the plethysmogram. Ex-1005 ¶205. For the reasons explained in Section VIII.E.2.g, a POSITA would have found been motivated to implement side walls that are substantially perpendicular to the inner or outer circumferential surface. *Id.* A POSITA would have found it obvious for the side walls in Niwa’s finger ring to be perpendicular to the interior and exterior wall in order to extend the longevity of the device and cover the components as plethysmogram sensors are “shared by many persons (e.g., when used as rental at sports gym).” Ex-1005 ¶205.

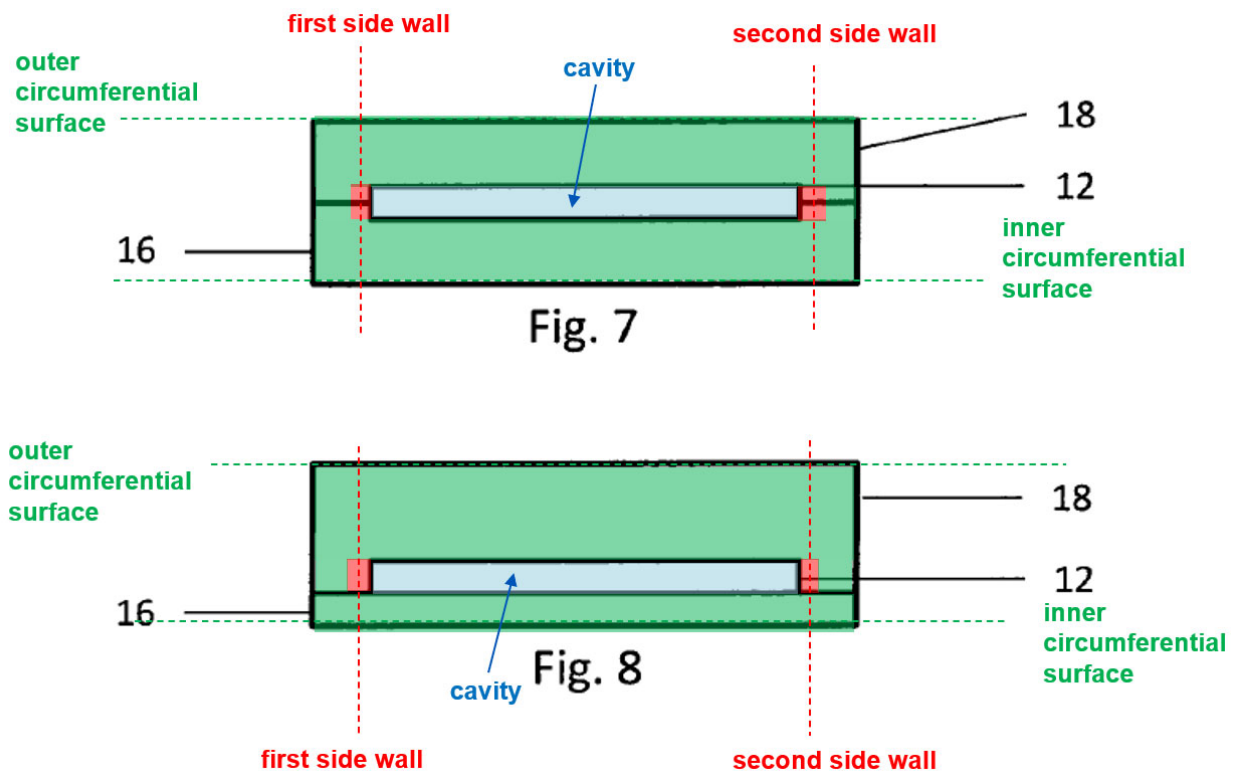
FIG.26



370. **Ground 6:** It is my opinion that Niwa-Schröder teaches Claim 18.

371. A POSITA would have understood that Schröder teaches this claim for the same reasons as described above in Ground 1 (Section VIII.A.2.d). A POSITA

would have understood that Niwa's ring combined with Schröder's cavity would have side walls substantially perpendicular to the inner and outer circumferential surfaces. Annotated Figures 7 and 8 below illustrate how Schröder's side walls (red) are substantially perpendicular to the inner and outer circumferential surfaces, i.e., outside surfaces of the internal and external housing components (green).



372. A POSITA would have found been motivated to implement side walls that are substantially perpendicular to the inner and/or outer circumferential surface for the reasons explained in Section VIII.E.1. Thus Niwa-Schröder teaches Claim 18.

F. Grounds 7/8: Claim 12 is obvious over Niwa/Niwa-Schröder in view of Mestas.

1. A POSITA would have been motivated to combine Niwa/Niwa-Schröder in view of Mestas and would have had a reasonable expectation of success.

373. A POSITA would have been motivated to apply the teachings of Mestas to Niwa/Niwa-Schröder (“Niwa-Mestas”/“Niwa-Schröder-Mestas”), and would have had a reasonable expectation of success in doing so because each relates to the same well-known technologies.

374. A POSITA would have been motivated to combine Niwa/Niwa-Schröder with Mestas because they are analogous art and teach improvements to the same type of devices. Each are directed to wearable electronic devices. Ex-1005 (Niwa) ¶28; Ex-1007 (Schröder) 2:60-65; Ex-1010 (Mestas) ¶143. Each also describe collecting health-related information. Ex-1005 (Niwa) ¶11; Ex-1007 (Schröder), 9:62-10:4; Ex-1010 (Mestas) ¶148. Niwa discloses an electronic plethysmogram—or heart or blood monitoring—device that may be worn “without restricting the behavior of the examinee.” Ex-1005 (Niwa) ¶11. Niwa discloses that the device may be in a “finger ring construction.” *Id.* ¶61, Cl. 16. Schröder also teaches a “finger-ring” consisting of “two ring halves 16 and 18” with a recess so that “inlay 12 is inserted.” Ex-1007 (Schröder), 12:7-9. Mestas also discloses an electronic health monitoring device that may be “worn in a variety of locations on a

user's body." Ex-1010 (Mestas) ¶143. Therefore, the three references teach analogous wearable devices.

375. Niwa teaches a cavity that houses electrical components. Ex-1005 (Niwa) ¶¶201, 205. Niwa further teaches a battery and a PCB arranged in non-overlapping portions of a cavity. *Id.*, Fig. 28. Schröder also teaches a cavity with electrical component like a battery and PCB. Ex-1007 (Schröder), 12:7-9, 8:56-60 (inlay and chip module 10 are inserted into a recess). Mestas similarly teaches a device with structural components, including, for example, inner and outer surfaces, a cavity, and a battery and PCB within the cavity. *See, e.g.*, Ex-1010 (Mestas) ¶¶150 (cavity, battery), 151 (structure), 154 (cavity), 157 (structure), 164 (PCB), 168 (battery), Figs. 4, 6 (structure).

376. Mestas further offers additional design and manufacturing benefits to Niwa's/Niwa-Schröder's ring. Mestas specifically discloses batteries having a "curved configuration." *Id.* ¶168. A POSITA would have been motivated to implement Mestas's curved battery in Niwa/Niwa-Schröder's ring because Niwa/Niwa-Schröder and Mestas relate to wearable electronic devices and doing so would provide a more compact structure with the battery conforming to the circular shape of the ring thereby reducing the risk of stress of the circular shape. As Niwa explains, because it is "desirable to restrain the largeness of...the second unit 20 not

to protrude from...the finger,” a POSITA would have been motivated to give the battery in Niwa/Niwa-Schröder a “curved configuration” like in Mestas. Ex-1005 (Niwa) ¶206.

377. A POSITA would have had a reasonable expectation of success in combining Niwa/Niwa-Schröder and Mestas. A POSITA would have understood that different electronic health monitoring devices contain interchangeable components. A POSITA would have understood, therefore, that these references disclose interrelated teachings based on routine technologies that would have been amenable to various well-understood and predictable combinations to provide smaller, more comfortable, and more structurally sound wearable devices.

2. Dependent Claim 12

- a. Claim 12: The finger-worn wearable ring device of claim 1, wherein the battery comprises a curved battery, wherein an arc of the curved battery approximates a corresponding arc of the external housing component.**

378. **Grounds 7/8:** It is my opinion that Niwa-Mestas/Niwa-Schröder-Mestas teaches Claim 12.

379. As described above in Section VIII.C.2.b (Ground 3), Mestas teaches that the battery can be “curvilinear or curved.” Ex-1010 ¶168. A POSITA would have been motivated to combine the teachings of Niwa/Niwa-Schröder and Mestas

and would have had a reasonable expectation of success in doing so for the same reasons discussed in Sections VIII.F.1 and VIII.C.1.

G. Grounds 9/10: Claims 4-11 are obvious over Niwa/Niwa-Schröder in view of Yuen.

1. A POSITA would have been motivated to combine Niwa/Niwa-Schröder with the teachings of Yuen and would have had a reasonable expectation of success.

380. A POSITA would have been motivated to apply the teachings of Yuen to Niwa/Niwa-Schröder, and would have had a reasonable expectation of success in doing so because each relates to the same well-known technologies. A POSITA would have been motivated to combine Niwa-Schröder for the same reasons as described in Section VIII.E.1.

381. A POSITA would have been motivated to combine Niwa with Yuen because they are analogous art and teach improvements to the same type of devices. Niwa and Yuen are both directed to wearable electronic health monitoring devices. Ex-1005 (Niwa) ¶¶11, 28; Ex-1006 (Yuen), 12:50-52. Niwa teaches charging a battery using “a non-contact method as an electromagnetic induction method, an electric field connection method, or an electric field resonance method.” Ex-1005 (Niwa) ¶218. Schröder’s “finger-ring” is “charged by means of [a] reader’s electromagnetic field.” Ex-1007 (Schröder), 11:54-55. Yuen further teaches charging a battery or transferring data via magnetic properties of the portable

biometric device or docking station. For example, Yuen states its device “includes a rechargeable energy source (for example, rechargeable battery) [that] may *interconnect with a charger using magnetic properties to secure thereto.*” Ex-1006 (Yuen), 14:42-46. Yuen goes on to state its device “may also *engage a dock or dock station using such magnetic properties* to facilitate data transfer.” *Id.*, 14:46-49. Based on Yuen’s teachings, it would have been obvious to use the magnetic properties of a charger device to orient the ring in Niwa to facilitate charging or wireless energy transfer.

382. Yuen further offers additional design and manufacturing benefits to Niwa’s ring device. A POSITA would have been motivated to implement orienting Niwa’s ring using Yuen because “battery swapping...is not required” and the “utility of the plethysmogram sensor 1 can be enhanced” by not requiring wired charging because a device will last longer and is more convenient for users. *See* Ex-1005 (Niwa) ¶218. The ’178 Patent acknowledges that a device “can be subjected to [a] magnetic field to produce a current that can charge the onboard battery in accordance with known electromagnetic principles.” Ex-1001, 30:45-48. Niwa and Yuen teach the same. Ex-1005 (Niwa) ¶218 (“a non-contact method as an electromagnetic induction method, an electric field connection method, or an electric field resonance method can be used”); Ex-1006 (Yuen), 14:42-46 (“the portable biometric

monitoring device (where it includes a rechargeable energy source (for example, rechargeable battery) may interconnect with a charger using magnetic properties to secure thereto”), 28:41-50 (“the device may use magnets to help the user align the device to the dock or cable. The magnetic field of magnets in the dock or cable and the magnets in the device itself could be strategically oriented to as to force the device to self-align and provide a force that holds the device to the dock or cable. The magnets may also be used as conductive contacts for charging or data transmission”). Thus design and manufacturing incentives and market forces would have motivated a POSITA to combine the teachings of Niwa and Yuen to result in a wearable ring device with wireless charging when the device is oriented in a charging position.

383. Moreover, Yuen improves Niwa’s sensor. *See* Ex-1005 (Niwa) ¶¶12, 27; *supra* §XIII.E.1.g (Element 1[e]). Yuen teaches adjusting the operational parameters or measurement periodicity of various sensors based on data related to a user’s activity, heart rate, sleep state, and a sensor’s power level. Based on Yuen’s teachings, it would have been obvious to modify a sensor’s operational parameter or measurement periodicity in the wearable device of Niwa. Ex-1006 (Yuen), 7:1-8. Yuen further teaches adjusting the operational parameters or measurement periodicity of various sensors based on data related to a user’s activity, heart rate,

sleep state, and a sensor's power level. Based on Yuen's teachings, it would have been obvious to modify a sensor's operational parameter or measurement periodicity in the wearable device of Schröder. *See, e.g., id.*, 7:19-8:38 (explaining that reducing sampling rate reduces the sensor's power consumption); 17:5-16 (explaining a sensor could switch to "oversampl[ing]" when the user is active). A POSITA would have understood from Yuen that a higher sampling rate or higher sampling resolution may "enable more accurate adaptive filtering" on the sensor data. *Id.*, 7:1-6. Thus, it would have been obvious to a POSITA to adjust the operational parameters and measurement periodicity of a sensor at least based in part on the information from the sensor.

384. A POSITA would have been motivated to adjust the operational parameters or measurement periodicity of a sensor based on data related to that sensor for redundancy, improved accuracy, and reduced power consumption. A POSITA also would have been motivated to make these adjustments for reasons of improved accuracy and reduced power consumption. As I described above in Section V.D, by reducing the sampling rate based on user activity (e.g., "rest" or "running"), battery performance can improve in comparison to using the same sampling rate for all activities. Ex-1051, 4-5. On the other hand, increasing the sampling rate during periods maintains or increases accuracy. *See supra* §V.D.

385. A POSITA would have had a reasonable expectation of success in combining Niwa and Yuen. A POSITA would have understood that different electronic health monitoring devices contain interchangeable components. A POSITA would have understood, therefore, that these references disclose interrelated teachings based on routine technologies that would have been amenable to various well-understood and predictable combinations to provide smaller and more comfortable wearable devices.

2. Dependent Claims 4-11

- a. **Claim 4: The finger-worn wearable ring device of claim 1, further comprising: one or more magnetic components configured to magnetically interact with one or more additional magnetic components of a charger device to orient the finger-worn wearable ring device within a charging position on or within the charger device to facilitate charging of the finger-worn wearable ring device.**

386. **Grounds 9/10:** It is my opinion that Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 4.

387. As I explained in the Technical Background Section (*see* §V.B.5), wireless inductive charging was well known in the art of wearable electronic devices. *See, e.g.*, Ex-1007 (Schröder), 11:54-55 (“charg[ing] by means of [a] reader’s electromagnetic field”). Niwa teaches that its ring device comprises one or more magnetic components configured to magnetically interact with one or more

additional magnetic components of a charger device. Specifically, Niwa's charging circuit receives power by a non-contact method. Ex-1005 (Niwa) ¶74. Niwa explains its non-contact charging method as "an electromagnetic induction method, an electric field connection method, or an electric field resonance method." *Id.* ¶218. Yuen's biometric monitoring device uses "*magnets to help the user align* the device to the dock." *Id.* Yuen further states that the "magnetic field of magnets in the dock or cable and the magnets in the device itself *could be strategically oriented* [so] as to force the device to *self-align* and provide a force that holds the device to the dock or cable." *Id.*, 28:40-49. With that understanding, a POSITA would have understood that Niwa's electromagnetic induction method could use magnetic components to orient the finger ring in a charging position as described by Yuen to facilitate the contactless charging.

388. Moreover, a POSITA would have found it obvious, as explicitly disclosed by Yuen's magnetic orientation as explained above in Section VIII.D.2.a-b.

389. As I mentioned above in Section V.B.5, the benefits of wireless charging of wearable electronics was well-known. A POSITA would have been motivated to implement Yuen's magnets to orient Niwa/Niwa-Schröder's finger ring with its charger in order charge without contact easier. Implementing wireless

charging, especially orienting a device to facilitate the wireless charging also reduces the risk of hardware malfunction from physical overuse. For example, wired charging often involves a physical contact and wires. Each of these external components or connectors introduces a potential point of failure, including mechanical failure or leaks when exposed to fluids. On the other hand, wireless charging eliminates these risks. A POSITA would have been motivated to combine the teachings of Niwa/Niwa-Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Sections VIII.G.1 and VIII.C.1. Thus Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 4.

- b. Claim 5: The finger-worn wearable ring device of claim 4, further comprising: a charging component configured to wirelessly transfer energy from an additional charging component of the charger device to the battery when the finger-worn wearable ring device is oriented in the charging position.**

390. **Grounds 9/10:** It is my opinion that Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 5.

391. Niwa-Yuen/Niwa-Schröder-Yuen teaches a charging component configured to wirelessly transfer energy from an additional charging component of the charger device. Specifically, Niwa's finger ring has a "charging circuit 25" that charges the battery 24 with an outside power source supply. Ex-1005 ¶218; *see also id.* ¶221. As described in the previous section, Yuen uses magnets to orient the

finger ring to the charger for inductive charging. A POSITA would have been motivated to implement Yuen's magnetic alignment to orient Niwa/Niwa-Schröder's finger ring in the charging position to facilitate inductive charging and would have had a reasonable expectation of success in doing so for the same reasons discussed in Sections VIII.G.1 and VIII.C.1. Thus Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 5.

- c. **Claim 6: The finger-worn wearable ring device of claim 1, further comprising: one or more processors communicatively coupled to the battery and the one or more sensors, wherein the one or more processors are configured to: selectively adjust one or more operational parameters of the one or more sensors based at least in part on the data acquired by the one or more sensors.**

392. **Grounds 9/10:** It is my opinion that Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 6.

393. Niwa/Niwa-Schröder teaches one or more processors communicatively coupled to the battery and the one or more sensors. Niwa discloses a “central processing unit” that controls the light emitting and receiving components and a “processing circuit” that “controls entire operation of the plethysmogram sensor.” Ex-1005 ¶¶120, 177, 212. “The processing circuit 15...acquires various information about the plethysmogram (i.e., the fluctuation of the plethysmogram, the heart rate, the fluctuation of the heart rate, and the acceleration plethysmogram).” *Id.* ¶212.

Niwa also states that light sensor 12 can be “located at the vicinity of the processing circuit 15” to enhance the plethysmogram’s accuracy. *Id.* Annotated Figures 27 and 28 of Niwa illustrate a processing circuit (brown) communicatively coupled to a battery (blue) and a sensor (orange) by a cable 30 and substrates 11, 21 (pink).

FIG.28

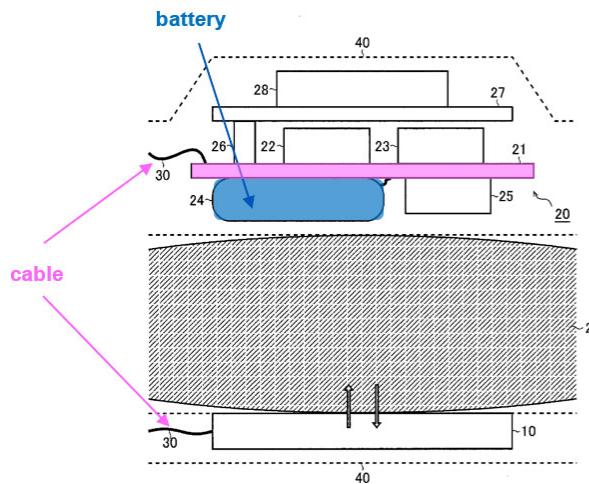
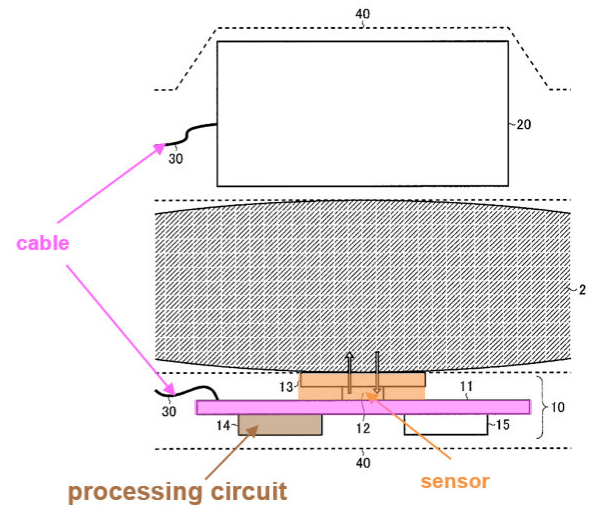


FIG.27



394. Yuen describes a “PPG [photoplethysmography] *sensor having a light source, light detector*, ADC, *processor*, DAC/GPIOs, and light source intensity and on/off control.” Ex-1006, 4:3-6, Figs. 17, 25. Yuen discloses that its device “may include one or more processors,” such as a “sensor processor” that “process[es] data from physiological, environmental and/or activity sensors” or an “application processor” that “may be used to store and execute applications that utilize sensor

data acquired and processed by” a sensor processor, while such an application process may also have sensors directly connected. *Id.*, 22:60-23:15.

395. For the reasons in Section VIII.D.3.c (Ground 4), Yuen further teaches one or more processors are configured to: selectively adjust one or more operational parameters of the one or more sensors based at least in part on the data acquired by the one or more sensors. As I described in Section V.D, adjusting a sensor’s operational parameters was well-known. It would have been obvious to apply the teachings of Yuen to selectively adjust the operational parameters of a sensor based at least in part on the data acquired by a sensor. A POSITA would understand that measurements (data) from Niwa’s light sensor is used at least in part by the processor to selectively adjust the operational parameters.

396. A POSITA would have been motivated to combine the teachings of Niwa/Niwa-Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Sections XIII.G.1 and VIII.C.1. Thus Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 6.

- d. Claim 7: The finger-worn wearable ring device of claim 6, wherein the data acquired by the one or more sensors comprises heart rate data associated with a heart rate of the user, wherein the one or more processors are further configured to: selectively adjust a measurement periodicity used by the one or more sensors to acquire the heart rate data based at least in part on the heart rate of the user.**

397. **Grounds 9/10:** It is my opinion that Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 7.

398. Niwa-Yuen/Niwa-Schröder-Yuen teach data acquired by one or more sensors comprises heart rate data associated with a heart rate of the user. Specifically, Niwa's processing circuit controls the plethysmogram sensor 1 which "acquires" various information such as the "the heart rate, the fluctuation of the heart rate, and the acceleration plethysmogram." Ex-1005 ¶212. Yuen further teaches processors configured to selectively adjust a measurement periodicity used by the one or more sensors to acquire the heart rate data based at least in part on the heart rate of the user. Ex-1006, 6:57-7:6, 10:7-28, 21:14-45; *see* §VIII.D.3.d (Ground 4). As I described above in Section V.A, wearable electronics were well known. Many of these devices measure heart rate or monitor health information by way of PPG sensors. *See generally* Ex-1038; Ex-1039. A POSITA would have been motivated to implement Yuen's teaching of adjusting measurement periodicity based on the user's heart rate to Niwa/Niwa-Schröder's ring device with a reasonable expectation

of success for the same reasons discussed in Sections VIII.G.1 and VIII.C.1. Thus Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 7.

- e. **Claim 8: The finger-worn wearable ring device of claim 6, wherein the data acquired by the one or more sensors comprises activity data associated with one or more activities engaged in by the user, wherein the one or more processors are further configured to: selectively adjust a measurement periodicity used by the one or more sensors to acquire the activity data based at least in part on the one or more activities engaged in by the user.**

399. **Grounds 9/10:** It is my opinion that Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 8.

400. Niwa-Yuen/Niwa-Schröder-Yuen's acquired data comprises activity data. As I described above in Section V.D, adjusting measurement periodicity based on user activity was well-known. User activity or "context" could be determined based on measurements from sensors. *See* Ex-1051 (Au), 4, Fig. 1 (classifying the activity based on measurements from heart rate sensors, respiratory sensor, and accelerometer). A POSITA would have also known to "increase a sampling rate of the one or more sensors in response to the...sensor detecting motion." Ex-1050 (Chen) ¶22. Increased sampling provide for more measurements and enables measurement averaging which reduces the effect of motion noise in PPG estimation. Based on analysis of Niwa's plethysmogram's measured fluctuations, the user's

“athletic ability or tension” can be learned. Ex-1005 ¶118. Moreover, Yuen teaches acquiring a user’s activity data and selectively adjusting a measurement periodicity based on the activity data for the same reasons discussed in Section VIII.D.3.e (Ground 4). Again, Yuen teaches that “*data indicative of user activity or motion* may be employed *to adjust or modify the sampling rate and/or resolution mode of sensors* which acquire heart rate data.” Ex-1006, 6:57-7:6. Yuen also teaches that its device “may *adjust or modify the sampling rate and/or resolution mode of the motion sensor(s)* during such *periods of user activity or motion* (for example, periods where the amount of user motion exceeds a certain threshold).” *Id.*, 6:57-7:6.

401. A POSITA would have been motivated to implement Yuen’s adjusting a measurement periodicity of a sensor based on the user’s activity as applied to the processor in Niwa/Niwa-Schröder with a reasonable expectation of success, for the same reasons discussed in Sections VIII.G.1 and VIII.C.1. Thus Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 8.

- f. **Claim 9: The finger-worn wearable ring device of claim 6, wherein the data acquired by the one or more sensors is associated with one or more sleep states of the user, wherein the one or more processors are further configured to: selectively adjust a measurement periodicity used by the one or more sensors to acquire the data based at least in part on the one or more sleep states of the user.**

402. **Grounds 9/10:** It is my opinion that Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 9.

403. Niwa-Yuen/Niwa-Schröder-Yuen teaches the data acquired by the one or more sensors is associated with one or more sleep states of the user. As I describe above in Section V.D, adjusting measurement periodicity based on a user's sleep state was well-known. Chen described the "general principle" that turning off some sensors depending on its current state, e.g., "when little or no motion is occurring." Ex-1050 (Chen) ¶33. A POSITA would have understood to use that general principle here, for example in order to conserve battery usage. Based on analysis of Niwa's plethysmogram's measured fluctuations, the user's "fatigue level" and "pleasant sleep level" can be learned. Ex-1005 ¶118; Ex-1006, 7:19-25, 7:61-65. Moreover, Yuen teaches acquiring a user's sleep states and selectively adjusting a measurement periodicity based on the sleep states for the same reasons discussed in Section VIII.D.3.f (Ground 4). A POSITA would have understood that Yuen's selectively adjusting a measurement periodicity (e.g., sampling rate) of a sensor

based at least in part on the user's sleep state could be applied to the processor in Niwa.

404. A POSITA would have been motivated to combine the teachings of Niwa/Niwa-Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Sections VIII.G.1 and VIII.C.1. Thus Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 9.

- g. Claims 10/11: The finger-worn wearable ring device of claim 1, further comprising: one or more processors communicatively coupled to the battery [and]/[anil] the one or more sensors, wherein the one or more processors are configured to: selectively adjust one or more operational parameters of [the]/[she] one or more sensors based at least in part on a power level of the battery, a power usage of the one or more sensors, or both.**

405. **Grounds 9/10:** It is my opinion that Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 10.

406. Niwa-Yuen/Niwa-Schröder-Yuen teaches one or more processors communicatively coupled to the battery and the one or more sensors. *See supra* §VIII.G.2.c.

407. For the reasons in Section VIII.D.2.g, Yuen teaches one or more processors further configured to selectively adjust one or more operational parameters of the one or more sensors based at least in part on a power level of the

battery, a power usage of the one or more sensors, or both. A POSITA would have understood that Yuen's selectively adjustment of operational parameters of the sensor(s) based at least in part on the power level or usage of the battery and/or sensor could be applied to Niwa/Niwa-Schröder's device.

408. A POSITA would have been motivated to combine the teachings of Niwa/Niwa-Schröder and Yuen and would have had a reasonable expectation of success in doing so for the same reasons discussed in Sections VIII.G.1 and VIII.D.1. It is my understanding that Claim 11, as written, is indefinite. *See infra* §VIII.H.2. If Claim 11 is to read to be like Claim 10, then Niwa-Yuen/Niwa-Schröder-Yuen teaches Claim 11 for the same reasons it teaches Claim 10.

H. Ground 11: Claims 11 and 17-18 are invalid for not complying with 35 U.S.C. §112.

409. As explained to me by counsel, I understand that a claim is invalid if it violates 35 U.S.C. § 112. In my opinion, Claim 11 is invalid for failing to comply with §112(b) while Claims 17 and 18 are invalid for failing to comply with §112(d).

1. Claim 11 is indefinite under §112(b).

410. As explained to me by counsel, a claim is invalid for indefiniteness when read in light of the specification delineating the patent, and the prosecution history, it fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention. In my opinion, Claim 11's recited limitation "one or more

processors communicatively coupled to the battery and the one or more sensors” fails to inform with reasonable certainty what component the “one or more processors” are “communicatively coupled.” And, in my opinion, Claim 11’s recited limitation “one or more processors ... selectively adjust one or more operational parameters of *she* one or more sensors” fails to inform with reasonable certainty what operational parameters the processor(s) selectively adjust.

411. It is my understanding that a claim can be rendered indefinite if the claim language that fails to inform, with reasonable certainty, those skilled in the art about the scope of the claim. First, it is my opinion that the recited limitation “one or more processors communicatively coupled to the battery and the one or more sensors” fails to inform with reasonable certainty because the term “and” is meaningless in the context of the claim limitation. Here, a POSITA would not have understood what component the processor(s) are to be coupled with. It is further my understanding that if the recited limitation was intended to state “and,” instead of “and,” that the recited limitation would then be identical to Claim 10’s limitation. Second, it is my opinion that the recited limitation “one or more processors ... selectively adjust one or more operational parameters of *she* one or more sensors” does not inform with reasonable certainty because the term “*she*” is meaningless in the context of the claim limitation. “*She*” is a common pronoun that, when read in

the recited limitation, prevents a POSITA from understanding what is being claimed with reasonable certainty. It is further my understanding that if the recited limitation was intended to state “the,” instead of “she,” that the recited limitation would then be identical to Claim 10’s limitation.

412. As explained to me by counsel, duplicative claiming is prohibited by the Patent Office. It is my understanding that a patent may contain multiple claims if the claims are not substantially identical. In my opinion, if the terms “anil” and “she” in Claim 11 are merely typographical errors and corrected to “and” and “the” respectively, a POSITA would understand Claim 11 to be identical to Claim 10. Claim 11 adds nothing to what is already claimed in Claim 10.

413. For at least these reasons, Claim 11 is invalid for indefiniteness.

2. Claims 17-18 are invalid under §112(d).

414. In my opinion, Claim 17’s recited limitation “the cavity configured to at least partially surround the battery” renders the claim ambiguous. It is my understanding that a dependent claim shall reference a claim previously set forth and then specify a further limitation of the subject matter claimed. It is further my understanding that a dependent claim is to be construed to incorporate by reference all the limitations of the claim to which it refers.

415. Claim 1 recites “a battery positioned within a cavity formed between the internal housing component and the external housing component, wherein the battery comprises a shape and size configured to fit within the cavity between the outer circumferential surface of the external housing component and the inner circumferential surface of the internal housing component.” Ex-1001, Claim 1. Based on my review, a POSITA would have understood Claim 1 to require a battery to be completely encompassed by the cavity because the battery is “positioned within” the cavity.

416. Based on my review, Claim 17 is ambiguous as to what cavity it is referencing. In reviewing the plain language of Claim 17, a POSITA would have understood Claim 17 to depend on Claim 1. *See id.*, Claim 17 (“The finger-worn wearable ring device of claim 1....”). A POSITA reviewing Claim 17 would also have understood that its recited language “the cavity configured to at least partially surround the battery” suggests a cavity that partially surrounds the battery—which is broader in scope than the claimed cavity of Claim 1. In my opinion, it would not be clear that “the cavity” of Claim 17 is referencing the same cavity of Claim 1 or defines another cavity.

417. For at least these reasons, it is my opinion that recited limitation “the cavity configured to at least partially surround the battery, as recited in Claim 17 and carried through Claim 18, is invalid for failing to comply with § 112(d).

IX. CONCLUSION

418. For the reasons given above, Claims 1-18 of the '178 Patent are unpatentable.

419. In signing this declaration, I understand that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

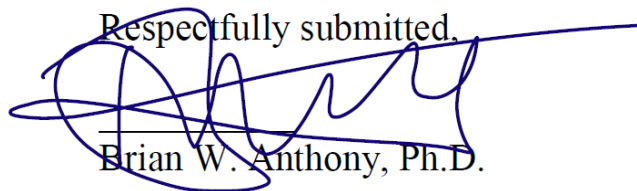
420. I reserve the right to supplement my opinions in the future to respond to any arguments that the Patent Owner raises and to take into account new information as it becomes available to me.

421. I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

U.S. Patent No. 11,868,178
Declaration of Brian W. Anthony, Ph.D.

Dated: May 31, 2024

Respectfully submitted,

A handwritten signature in blue ink, consisting of a large, stylized 'B' followed by several loops and a long horizontal stroke extending to the right. The signature is written over the printed name 'Brian W. Anthony, Ph.D.'.

Brian W. Anthony, Ph.D.