

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MASIMO CORPORATION,

Petitioner,

v.

APPLE INC.,

Patent Owner.

Case No. *To Be Assigned*

U.S. Patent No. D883,279

DECLARATION OF R. JAMES DUCKWORTH, PH.D.

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

I reserve the right to supplement my opinions in the future to respond to any information, arguments, or positions Apple may raise, taking account of new information as it becomes available to me.

Dated: 3/24/2023



R. James Duckworth, Ph.D

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I, R. James Duckworth, Ph.D, declare and state as follows:

I. INTRODUCTION

1. I have been retained by Knobbe, Martens, Olson & Bear, LLP, counsel for Masimo Corporation (“Masimo”). I am making this declaration at the request of Masimo in connection with Masimo’s petition for *inter partes* review (“IPR”) of the claimed design (the “Challenged Claim”) of U.S. Patent No. D883,279 (the “D’279 Patent”). I understand that this Declaration is being submitted in the above-captioned proceeding as Exhibit 1014.

2. I am being compensated for my work in this matter at my standard hourly rate for expert consulting services. My compensation in no way depends on the outcome of this proceeding. I have no financial interest in any of the parties to these matters.

II. INFORMATION AND MATERIALS CONSIDERED

3. I have been asked to provide technical expert opinions relating to the validity of the Challenged Claim of the D’279 Patent. In conducting the analyses and forming the opinions set forth in this Declaration, I have reviewed and considered the D’279 Patent’s claim, specification, and file history, as well as numerous prior art references and other documents. I have reviewed and considered at least the following materials in preparing this Declaration:

- The D’279 Patent, including its claim, specification, and file history;

- Masimo’s IPR petition regarding the Challenged Claim of the D’279 Patent;
- The references relied upon herein, including, but not limited to, Paulke, Yuen, Fong, Bushnell, Mendelson, Chung;
- The Korean priority application for Chung (Exhibit 1012) and the certified English translation thereof (Exhibit 1013);
- The Declaration of Joel Delman (Exhibit 1003);
- The complaint from the parties’ parallel design patent litigation in Delaware District Court (Exhibit 1005);
- Apple’s public opening post-hearing brief from the parties’ parallel ITC Investigation (Exhibit 1017);
- The public hearing transcript from the parties’ parallel ITC Investigation (Exhibit 1021);
- The redacted opening expert report of Steve Warren, Ph.D. from the parties’ parallel litigation in California District Court (Exhibit 1026);
- Any materials referenced directly or indirectly in my Declaration; and
- The information and materials identified in the following table:

Exhibit No.	Description
1001	U.S. Patent No. D883,279 (“the D’279 Patent”)
1002	File History of U.S. Patent No. D883,279

Exhibit No.	Description
1003	Declaration of Joel Delman
1004	<i>Curriculum Vitae</i> of Joel Delman
1005	<i>Apple Inc. v. Masimo Corporation, et al.</i> , Complaint, No. 1:22-cv-01377 (D. Del.)
1006	PCT Appl. Pub. No. WO 2017/165532 (“Paulke”)
1007	U.S. Pat. Appl. Pub. No. 2019/0196411 (“Yuen”)
1008	U.S. Pat. No. D827,831 (“Fong”)
1009	U.S. Pat. Appl. Pub. No. 2017/0086743 (“Bushnell”)
1010	U.S. Pat. Appl. Pub. No. 2019/0324593 (“Chung”)
1011	U.S. Pat. No. 6,801,799 (“Mendelson”)
1012	Korean Pat. Appl. No. 10-2018-0038206
1013	Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (“Chung-KR-Application”)
1015	<i>Curriculum Vitae</i> of R. James Duckworth, Ph.D.
1016	Scott Jung, “Medgadget Joins the Verily Baseline Project Study, Part 2: The Tech,” archived on October 27, 2017 by the Internet Organization’s “Wayback Machine” at https://web.archive.org/web/20171027221742/https://www.medgadget.com/2017/10/medgadget-joins-verily-baseline-project-study-part-2-tech.html
1017	<i>Masimo Corp. et al. v. Apple Inc.</i> , Apple’s September 14, 2022 Public Second Corrected Post-Hearing Brief, ITC Inv. No 337-TA-1276
1018	“Apple Watch Series 4: Beautifully redesigned with breakthrough communication, fitness and health capabilities,” archived on September 12, 2018 by the Internet Organization’s “Wayback Machine” at

Exhibit No.	Description
	https://web.archive.org/web/20180912191250/https://www.apple.com/newsroom/2018/09/redesigned-apple-watch-series-4-revolutionizes-communication-fitness-and-health/
1019	“Your heart rate. What it means, and where on Apple Watch you’ll find it,” archived on January 23, 2019 by the Internet Organization’s “Wayback Machine” at https://web.archive.org/web/20190123031906/https://support.apple.com/en-us/HT204666
1020	“Apple Watch Series 4 – Health,” archived on September 20, 2018 by the Internet Organization’s “Wayback Machine” at https://web.archive.org/web/20180920103403/https://www.apple.com/apple-watch-series-4/health/
1021	<i>Masimo Corp. et al. v. Apple Inc.</i> , June 6-10, 2022 Public Hearing Transcript, ITC Inv. No 337-TA-1276
1022	“Charge Apple Watch,” https://support.apple.com/guide/watch/charge-apple-watch-apd2b717523a/watchos (last visited Mar. 6, 2023)
1023	“Apple Watch Magnetic Charging Cable (1 m),” https://www.apple.com/shop/product/MX2E2AM/A/apple-watch-magnetic-charging-cable-1m (last visited Mar. 6, 2023)
1024	U.S. Pat. No. 10,610,157 (“’157 patent”)
1025	U.S. Pat. No. 10,627,783 (“’783 patent”)
1026	<i>Apple Inc. v. Masimo. Corp., et al.</i> , Excerpts of Redacted Sept. 23, 2022 Opening Expert Report of Steve Warren, Ph.D., No. 1:22-cv-01377 (D. Del.)
1027	“Apple Watch Series 4 Teardown,” https://www.ifixit.com/Teardown/Apple+Watch+Series+4+Teardown/113044 (last visited Mar. 6, 2023)
1028	U.S. Pat. Appl. Pub. No. 2017/0325744

Exhibit No.	Description
1029	K192415 510(k) Summary for Verily Study Watch, https://www.accessdata.fda.gov/cdrh_docs/pdf19/K192415.pdf (last visited Mar. 6, 2023)
1030	U.S. Pat. No. 10,912,501 (“the ’501 patent”)
1031	Y. Mendelson et al., “Measurement Site and Photodetector Size Considerations in Optimizing Power Consumption of a Wearable Reflectance Pulse Oximeter,” Proceedings of the 25th IEEE Conference (2003)
1032	U.S. Pat. No. D753,510
1033	U.S. Pat. No. D782,537
1034	U.S. Pat. No. D735,131 (“the ’131 patent”)
1035	Chinese Design Reg. No. 303285726
1036	König et al., <i>Reflectance Pulse Oximetry – Principles and Obstetric Application in the Zurich System</i> , 1998 (“König”)
1037	Yitzhak Mendelson, <i>Invasive and Noninvasive Blood Gas Monitoring</i> , 1991 (“Mendelson-1991”)
1038	<i>Masimo Corp. et al. v. Apple Inc.</i> , Public Excerpts of Apple’s June 6, 2022 Opening Presentation, ITC Inv. No 337-TA-1276
1039	U.S. Pat. No. D816,524
1040	<i>Masimo Corp. et al. v. Apple Inc.</i> , Excerpts of Public Final Initial Determination on Violation of Section 337, ITC Inv. No 337-TA-1276
1041	U.S. Pat. No. 10,912,502 (“the ’501 patent”)
1042	U.S. Pat. No. 10,945,648 (“the ’648 patent”)
1043	N. Meziane et al., Dry Electrodes for Cardiography, Physiological Measurement 34 (2013) (“Meziane”)

Exhibit No.	Description
1044	U.S. Pat. No. 6,265,789 (“Honda”)
1045	<i>Apple Inc. v. Masimo Corporation, et al.</i> , Masimo’s (Public) Opposition to Apple’s Motion for an Expedited Trial, No. 1:22-cv-01377 (D. Del.)
1046	<i>Apple Inc. v. Masimo Corporation, et al.</i> , Public Excerpt of January 30, 2023 Declaration of James Malackowski in Support of Apple Inc.’s Motion for an Expedited Trial, No. 1:22-cv-01377 (D. Del.)
1047	U.S. Pat. No. 6,091,530 (“Duckworth”)
1048	U.S. Pat. No. 6,075,755 (“Zarchan”)
1049	Y. Mendelson, “A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring,” Proceedings of the 28th IEEE (2006)
1050	Y. Mendelson, “Wearable Wireless Pulse Oximetry for Physiological Monitoring,” PPL Workshop (2008)

4. In preparing this Declaration, I have considered my own knowledge and experience, including my work in the fields of electrical engineering and wearable sensor development; my experience teaching within those subjects; my experience working with others involved in those fields; and the materials identified herein. I understand my analyses and opinions, including my review of any materials cited herein, should be made from the perspective of one of ordinary skill in the art related to the D’279 Patent at the relevant time (i.e., a “POSITA”). I understand the relevant time is June 27, 2018. Accordingly, my analyses and opinions are made from that relevant perspective. My testimony herein refers to the

knowledge of a POSITA as of June 27, 2018, unless indicated otherwise. I discuss the level of ordinary skill in the relevant art further in Section VI of this Declaration, below.

5. Any figures appearing in this Declaration were prepared with the assistance of counsel and reflect my understanding of the D'279 Patent and the materials discussed herein. Coloring and colored annotations to figures in my Declaration have been added unless I have indicated otherwise.

III. EXPERIENCE AND QUALIFICATIONS

6. My academic and professional background is in electrical and computer engineering. I obtained a Bachelor of Engineering degree in Electrical and Electronic Engineering from the University of Bradford and a Ph.D. Degree in Electrical and Electronic Engineering from the University of Nottingham. My Ph.D. thesis work concerned increasing the speed of data processing using multiple processing elements to complete computations in parallel and triggering computations based on the availability of data. After completing my Ph.D., I was a lecturer in the university's Computer Science Department for two years.

7. For more than 40 years, I have studied, designed, and worked in these fields. My experience includes over 35 years of teaching and research, including in the fields of pulse oximetry and other physiological monitoring technologies, low

powered wireless sensor design, embedded system design, wearable technology, and indoor location tracking for first responders, among others.

8. I have been a professor of electrical and computer engineering at Worcester Polytechnic Institute (“WPI”) for over 35 years. I joined WPI in January 1987 as an Assistant Professor of Electrical Engineering and was an Associate Professor of Electrical and Computer Engineering from July 1991 to June 2021. Presently, I am a Professor Emeritus of Electrical and Computer Engineering at WPI.

9. More recently, my research work has centered on Precision Personnel Location (PPL) for first responders. This project started as a result of a tragic incident in Worcester in 1999, when six firefighters lost their lives in a warehouse fire. The overall goal of the PPL project is to protect the lives of emergency responders and to enhance their ability to accomplish their missions through research and development of systems for personnel location and tracking, movements, physiological and environment status monitoring, and command and control. The PPL project brought together diverse technical capabilities from other centers and laboratories at WPI to address important problems for emergency responders, the most critical of which is precise location and path tracking for each person in a building.

10. For over 30 years, I developed and taught courses at WPI relevant to wearable health sensors and devices like the one claimed by the D’279 Patent (i.e.,

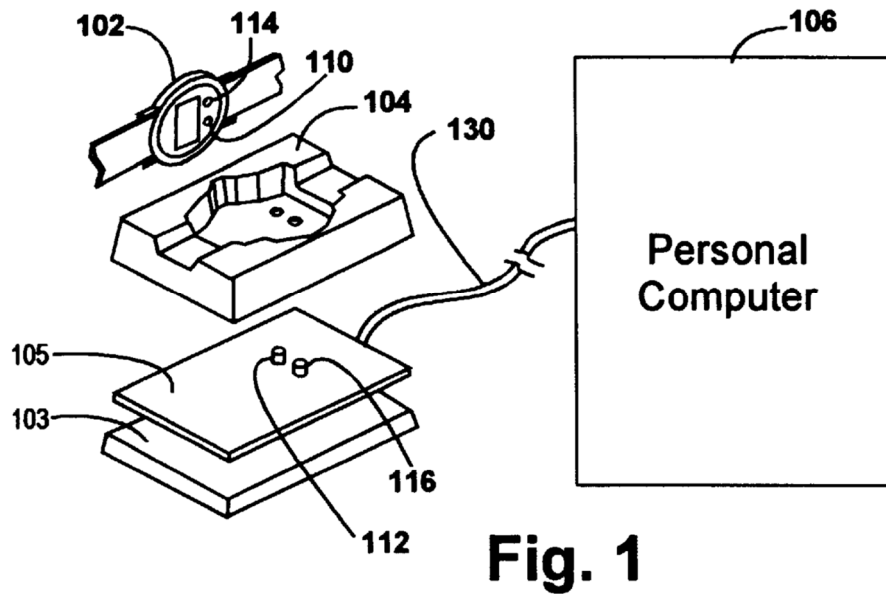
Apple Watch Series 4). The classes I developed and taught included associated laboratory exercises and projects, which I also developed. As reflected in my curriculum vitae (Exhibit 1015), I developed and taught at least the following relevant courses: (1) Microprocessor System Design; (2) Modeling and synthesis of digital system using Verilog and VHDL; (3) VHDL for Modeling and Synthesis; (4) Computer System Design; (5) Multi-processor and Distributed Systems; (6) Advanced Computer System Design; and (7) Advanced Digital System Design with FPGAs. All of these courses pertain to the sensor technology underlying the device (Apple Watch Series 4) depicted in the D'279 Patent. For example, the “Advanced Digital System Design with FPGAs” course required students to interface peripheral sensors such as a light sensor with an analog-to-digital converter to read information from the sensors and a digital-to-analog converter to convert sensed data into waveforms for processing.

11. In the course of my work at WPI, I have advised hundreds of engineering students in B.S. and M.S. programs and advised or co-advised approximately ten Ph.D. students that have completed Ph.D. degrees.

12. Additionally, I have authored or co-authored dozens of technical papers in refereed journals and conference proceedings and given many conference presentations in the fields I have taught, researched, and worked.

13. Aside from my work at WPI, I have years of experience working with portable, battery-powered electronic devices and sensors. During leave in approximately 2000 from WPI, I was the Vice President of Engineering for Adaptive Instruments. At Adaptive Instruments, I was responsible for designing and manufacturing a line of wireless industrial sensors for use in industrial process control. As a consultant, I helped program a small, battery-powered device used to count the number of times an inhaler had been used. Also as a consultant, I helped design and program a wrist-worn device that reminded the user throughout the day of the medications that needed to be taken. My work on the wrist-worn device led to the patent I obtained on a “Low Power Infrared Communication System,” U.S. Patent No. 6,091,530, a copy of which is included as Exhibit 1047. This wearable electronic device had some similar functionality to the consumer product underlying the design claimed in the D’279 Patent (i.e., Apple Watch Series 4). The wearable electronic device in my ’530 patent was worn like a watch, provided watch functionality on a display, was battery powered, contained a microcontroller to calculate and display messages, employed an optical data communication system, and incorporated buttons for user control. Exhibit 1047, Abstract, col. 2:7-17. The system included a cradle shaped complimentary to the watch for data communication: “The cradle housing 104 is preferably shaped configured to receive and align the case of the watch 102 so that, when the watch 102 is placed in the

shaped nest provided by 104, the watch IR emitter 110 is thereby aligned in close proximity with the cradle IR detector 112.” *Id.*, 4:38-42. This device from my ’530 patent is shown below.



Id., Fig. 1.

14. My technical work also contributed to features in the same device shown in U.S. Patent 6,075,755, which is titled “Medical Reminder System and Messaging Watch,” and a copy of which is included as Exhibit 1048. As in my ’530 patent above, the device from the ’755 patent incorporated a display with watch functionality (LCD display 110), was battery powered, contained a microcontroller to calculate and display medication reminder messages, employed an optical data communication system (infrared emitter and detector 116), and incorporated buttons (120, 122, 124, 126) for user control. Exhibit 1048, 6:28–65. Figures 1 and 4 from the ’755 patent are shown below.

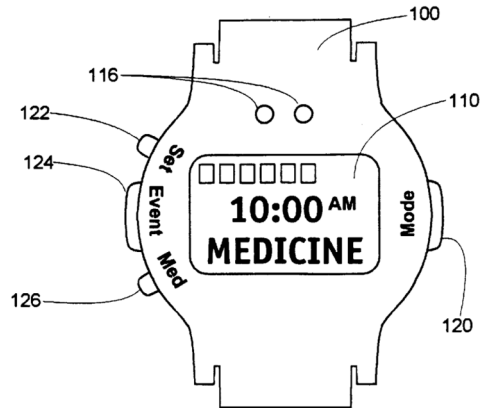


Fig. 1

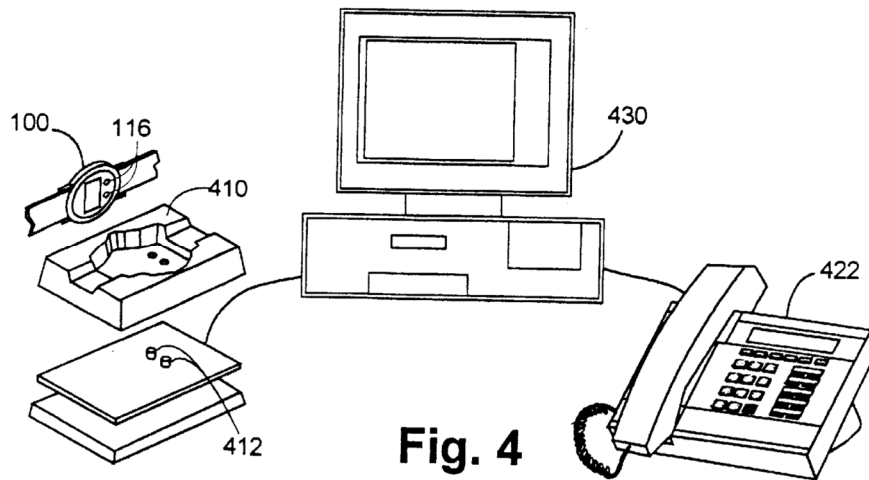
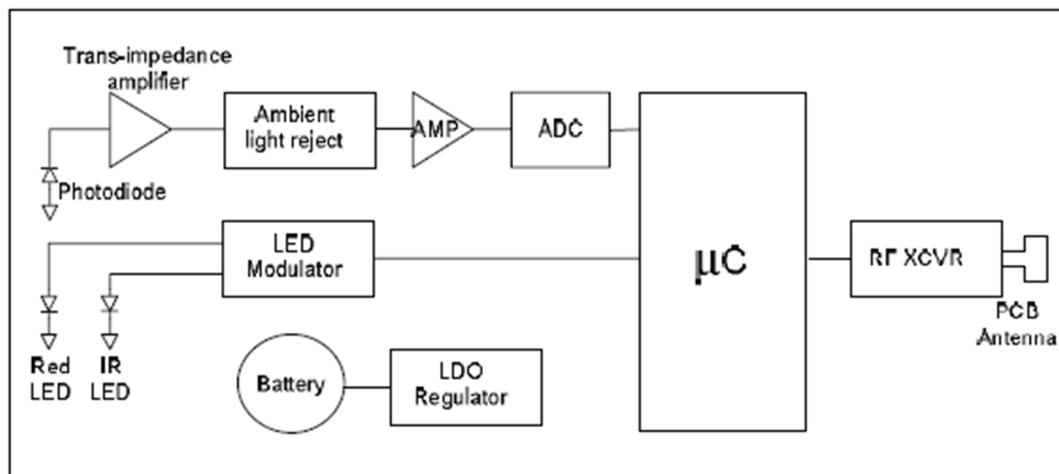
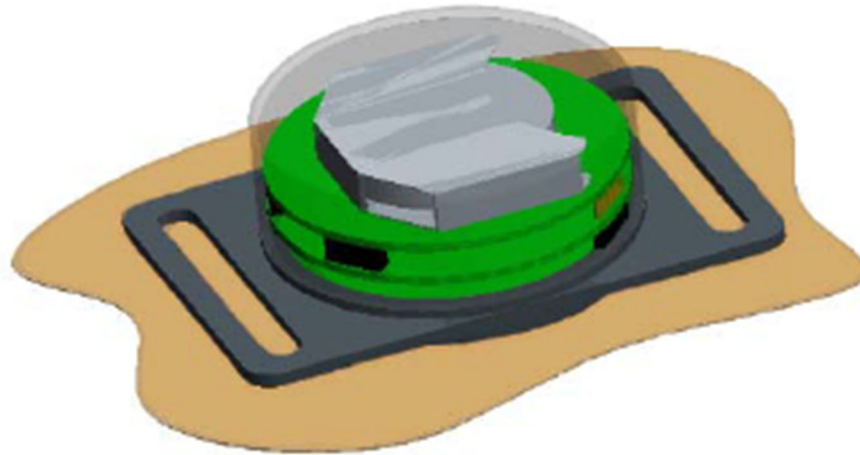


Fig. 4

Id., Figs. 1, 4.

15. From 2005 through 2008, I worked extensively with my colleague at WPI, Professor Yitzhak Mendelson, Ph.D. (the inventor of the Mendelson patent (Exhibit 1011) discussed in Section IX), to research, publish papers about, design, and make, wearable pulse oximetry devices. One publication stemming from this work is titled “A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring,” a copy of which is included as Exhibit 1049. As stated in that publication, our wearable pulse oximeter measured arterial oxygen saturation (SpO_2)

and utilized the principle of photoplethysmography: “Pulse oximetry also relies on the detection of photoplethysmographic (PPG) signals produced by variations in the quantity of arterial blood that is associated with periodic contractions and relaxations of the heart.” Exhibit 1049, 1. As shown below, our pulse oximeter incorporated a photodiode, a red LED, and an infrared LED.



Id., 2.

16. Subsequently, in July 2007, Professor Mendelson and I formed a company together called Advanced Body Sensing to design, develop, and build a

new, wireless, battery powered, forehead-mounted reflectance pulse oximetry device. To meet these design goals, we had to develop a completely new device, as our prior work concerned prototype devices that required an external power supply and additional instrumentation to operate. Together, Professor Mendelson and I developed, along with a small team of engineers, a new housing, optical sensor, and associated electronics, including the design and programming of microprocessor and wireless transmission components. Our design and development process led us to the final forehead-mounted pulse oximetry device shown below.



Exhibit 1050, 24 (annotated).

17. Our device included an optical biosensor with two LED's and a photodetector, as highlighted above. Over the course of 2007 and 2008, Advanced Body Sensing received over \$1,000,000 to develop and build the above pulse oximetry devices for the United States Air Force. The device above was designed to be “integrated into a headband or a helmet” (Exhibit 1049, 2), such as for army

use, but the basic principle allows measurements on various skin surfaces of the body. On August 4, 2008, Professor Mendelson presented on our Advanced Body Sensing work, including the above device, at an annual international technology conference held at WPI called the PPL Workshop. A copy of his presentation, titled “Wearable Wireless Pulse Oximetry for Physiological Monitoring,” is included as Exhibit 1050.

18. In addition to the patents discussed above, I am a named co-inventor on various other patents, including:

- a. U.S. Patent No. 7,292,189, issued in 2007, titled “Methods and Apparatus for High Resolution Positioning”;
- b. U.S. Patent No. 9,476,963, issued in 2016, titled “Search and Rescue Method and System”;
- c. U.S. Patent No. 9,658,309, issued in 2017, titled “Precision Location Method and System”; and
- d. U.S. Patent No. 9,846,042, issued in 2017, titled “Gyroscope Assisted Scalable Visual Simultaneous Localization and Mapping.”

19. Above, I have provided a brief summary of my education and experience that I believe is most relevant to the analyses and opinions I have expressed in this Declaration. A copy of my curriculum vitae, which describes in

further detail my qualifications, responsibilities, employment history, honors, awards, professional associations, presentations, publications, and patents is included as Exhibit 1015.

IV. SUMMARY OF OPINIONS

20. I have conducted analyses leading to the opinions expressed in this Declaration. To summarize those opinions, it is my conclusion, from a technical point of view, that:

- The convex protrusion claimed by the D'279 Patent is a primarily functional design element;
- The arrangement of arc-shaped portions claimed by the D'279 Patent is a primarily functional design element;
- The arrangement of rectangles claimed by the D'279 Patent is a primarily functional design element;
- The concentric circles claimed by the D'279 Patent are a primarily functional design element;
- The overall circular shape of the Apple Watch sensor claimed by the D'279 Patent is a primarily functional design element;
- The Chung-KR-Application (Exhibit 1013) enables the full scope of the claims of Chung (Exhibit 1010) and provides written description support to reasonably convey to a POSITA that Chung's inventors

possessed the subject matter claimed in Chung by the time the Chung-KR-Application was filed on April 2, 2018;

- The PPG sensor in FIG. 7 of Mendelson and the PPG sensor in FIG. 7 of Chung would both be a suitable PPG sensor to use with the devices disclosed in Paulke, Yuen, and Fong;
- By June 2018, a POSITA would have been motivated to use Mendelson's FIG. 7 PPG sensor as the PPG sensor of Paulke, Yuen, and Fong to increase the signal-to-noise ratio, and thus the accuracy, of the sensor;
- By June 2018, a POSITA would have been motivated to extend the ends of the arc-shaped electrodes of Paulke, Yuen, and Fong to be closer together to maximize the surface area of the arc-shaped electrodes that contacts the user's skin;
- By June 2018, a POSITA would have been motivated to shape the arc-shaped electrodes of Paulke, Yuen, and Fong to avoid overlapping the wireless charging coil of the device and/or the wireless charging coil of prior art wireless chargers;
- By June 2018, a POSITA would have been motivated to combine Bushnell's convex housing component with the devices of Paulke, Yuen, and Fong to improve the signal strength of the device's PPG

sensor;

- By June 2018, a POSITA would have been motivated to combine Bushnell's convex housing component with the devices of Paulke, Yuen, and Fong to improve the contact or coupling between the device's PPG sensor and the user's skin and thereby achieve more accurate measurements; and
- By June 2018, a POSITA would have been motivated to use the Fresnel lens of Chung's FIG. 7 PPG sensor over the LEDs of the PPG sensor used with Paulke, Yuen, and Fong (i.e., Mendelson's FIG. 7 PPG sensor) to collimate light and thereby improve the optical sensing efficiency of the PPG sensor.

21. Below, I provide the complete analyses supporting my opinions.

V. THE D'279 PATENT

A. Overview of the D'279 Patent

22. The D'279 Patent is titled "Electronic Device" and claims "[t]he ornamental design for an electronic device, as shown and described" in the solid lines of its nine figures. Exhibit 1001. As shown in the following colorized images, the D'279 Patent claims the design of a circular protrusion on the back surface of the electronic device, wherein the protrusion's outermost surface is a convex surface

(red) and the protrusion includes two arc-shaped portions (gray) surrounding a circular array of rectangles (blue) that surround concentric circles (orange).

D'279 Patent Figures and Descriptions

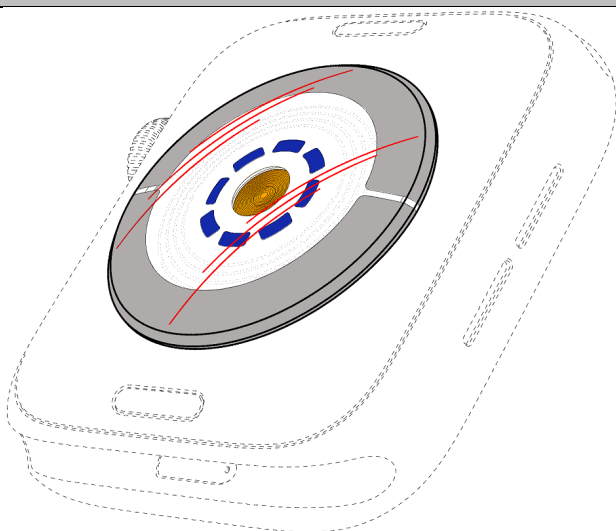


FIG. 2

“FIG. 2 is a bottom rear perspective view [of an electronic device showing the claimed design].”

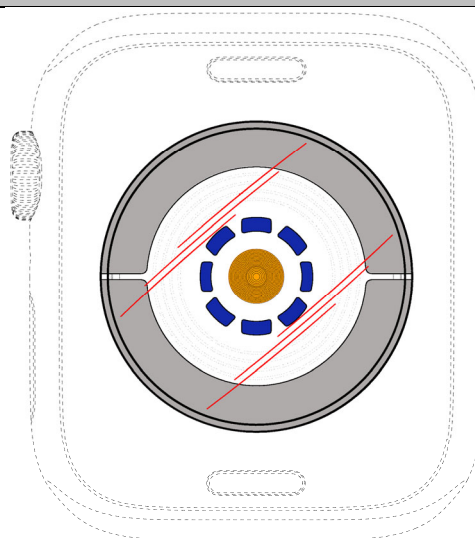


FIG. 4

“FIG. 4 is a rear view thereof.”

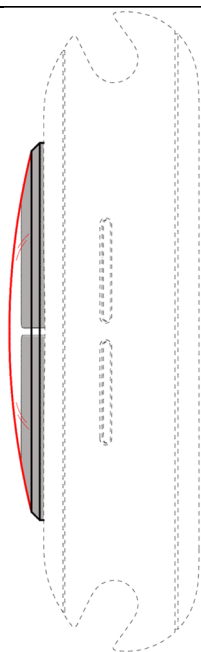


FIG. 5

“FIG. 5 is a left side view thereof.”

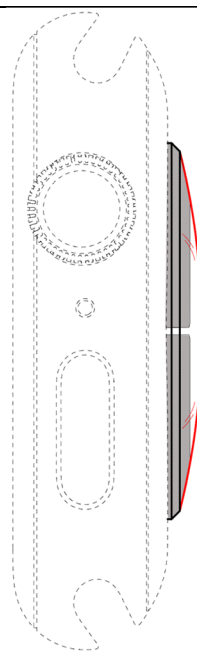
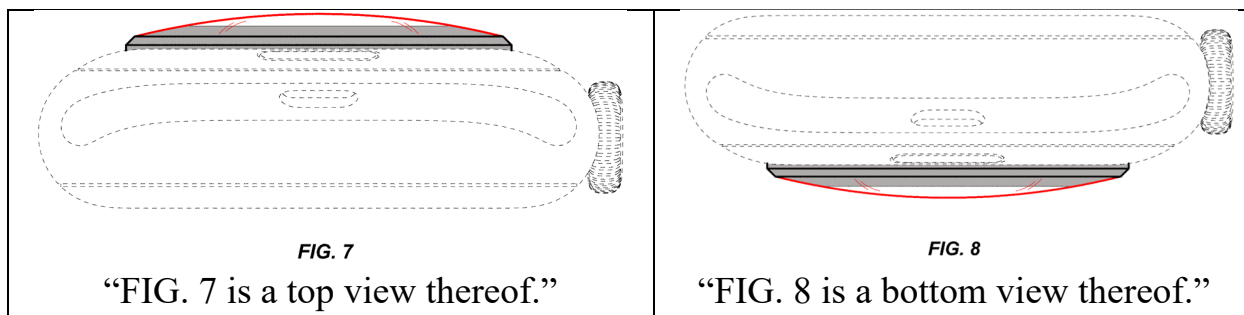


FIG. 6

“FIG. 6 is a right side view thereof.”



I have not included FIGS. 1, 3, or 9 of the D’279 Patent, which show views of the “front” of the electronic device, in the above table because nothing on the front the device is claimed. Exhibit 1001, FIGS. 1, 3, 9, Description.

23. As explained below in Section VIII, the D’279 Patent claims the convex protrusion (including the arc-shaped electrodes, circular array of eight photodiodes, and central Fresnel lens) of the Apple Watch Series 4, which was released in September 2018, a few months after the purported June 2018 filing date of the D’279 Patent. The claimed photodiodes and Fresnel lens are part of the “optical heart sensor” inside the Apple Watch Series 4, which “uses what is known as photoplethysmography,” or PPG, to measure a user’s heart rate. Exhibit 1019, 2-3. By 2018, PPG sensors were a well-known technology used in wearable devices to measure health parameters like heart rate, as explained below.

B. Photoplethysmography (PPG) Sensors

24. PPG sensors are noninvasive devices for measuring health parameters of the user. PPG sensors commonly include LEDs to emit light at two wavelengths, often red and infrared, into the tissue. Exhibit 1011, 1:15-40. Red and infrared

wavelengths are chosen because deoxyhemoglobin absorbs more light (i.e., has a higher optical extinction coefficient) than oxyhemoglobin in the red region of the spectrum, whereas oxyhemoglobin absorbs more light than deoxyhemoglobin in the infrared region of the spectrum. *Id.*; *see id.*, FIG. 1.

25. The emitted red and infrared light enters the user's tissue, where some of the light is absorbed by the blood or other tissue, and some is not absorbed. The light that is not absorbed either passes through the tissue to a light detector (e.g., a photodiode) on the opposite side of the tissue from where the light entered (i.e., a "transmittance" PPG sensor configuration) or is reflected back to a light detector on the same side of the tissue from where the light entered (i.e., a "reflectance" PPG sensor configuration). *Id.*, 2:8-27. The light detector outputs what is known as a photoplethysmography (PPG) signal for each wavelength of received light—one PPG signal for red light, one PPG signal for infrared light. *Id.*, 1:42-2:7. The amount of blood in the user's arteries changes as the heart beats (systole) and relaxes (diastole). The beating of the heart permits each PPG signal to be separated into (1) a pulsatile (or "AC") signal component that is caused by arterial blood and (2) a non-pulsatile (or "DC") signal component that is primarily caused by bloodless tissue and residual blood when the heart is in diastole (i.e., venous blood). *Id.* The device applies algorithms to the obtained AC and DC signal components to determine parameters, such as the user's heart rate or oxygen saturation. *Id.*; Exhibit 1007 ¶41

(“The PPG sensor 118 may associate changes in light intensity with small variations in blood perfusion, and as a result, heart beats.”).

26. I understand the level of skill in the art at the relevant time very well, as I developed and taught courses involving sensor design throughout that time and from my extensive work with my colleague at WPI, Professor Yitzhak Mendelson, Ph.D., the inventor of the Mendelson patent discussed herein (Exhibit 1011), to research, publish papers about, design, and make, wearable PPG sensor devices (specifically, pulse oximetry devices).

VI. LEVEL OF ORDINARY SKILL IN THE RELEVANT ART

27. I understand that the level of ordinary skill in the art for the D’279 Patent is determined as of June 27, 2018, which is the earliest purported filing date of the patent.

28. The field of art relevant to the D’279 Patent is noninvasive wearable devices, like Apple Watch, which measure health parameters (e.g., heart rate, electrical impulses, ECG, etc.). A person of ordinary skill in the art relating to the technical subject matter underlying the D’279 Patent would have had at least a Bachelor or Master of Science degree in electrical or biomedical engineering, or a comparable engineering discipline, in combination with at least two years of related work experience involving wearable physiological sensors. To design and develop wearable physiological sensor designs like the sensor claimed in the D’279 Patent,

a POSITA would have worked closely with a designer of ordinary skill in the art (a “DOSA”), such as an industrial designer or product designer, with a POSITA contributing from a technical perspective and a DOSA contributing from an industrial design perspective. I understand that Joel Delman is an experienced industrial designer that qualifies as a DOSA and is submitting a declaration (Exhibit 1003) in connection with this proceeding. I have therefore relied on Mr. Delman’s discussions, analyses, and opinions from the perspective of a DOSA to support the discussions, analyses, and opinions I have set forth in my Declaration.

29. I understand the technical capabilities of a POSITA as of June 2018. Indeed, I possessed those capabilities myself before, during, and after that time. As a professor of electrical and computer engineering for over three decades, I have taught many such POSITAs and understand the level of knowledge and skill that persons with such academic experience would have possessed in June 2018. Through my education and decades of experience, such as teaching relevant engineering courses and working with Professor Yitzhak Mendelson in designing and developing pulse oximetry devices, I am familiar with what a POSITA would have understood in June 2018 and qualified to provide opinions from the perspective of a POSITA at the relevant time.

VII. APPLICABLE LEGAL STANDARDS

30. I am an electrical and computer engineer by training and profession. The opinions I express in this Declaration involve the application of my knowledge and experience to the evaluation of the D'279 Patent and certain prior art to the D'279 Patent.

31. Although I have been involved as a technical expert in patent matters before, I am not an expert in patent law. Therefore, I have been advised of certain principles of patent law applicable in this matter, which I have used in arriving at my determinations and opinions. The paragraphs below express my understanding of the legal requirements I have used in forming my opinions.

A. Claim Construction

32. I understand that in an *inter partes* review, a design claim should be construed in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art in view of the solid lines shown in the patent's figures, the description of those figures, and the prosecution history pertaining to the patent.

33. I understand that, while the preferable course for design patent claim construction is not to provide a detailed verbal description, using verbal or written guidance is beneficial in certain circumstances. I understand that using verbal or

written guidance to describe a claimed design is often helpful to point out various features of the claimed design as they relate to the prior art.

34. I understand that a design patent, unlike a utility patent, limits protection to the ornamental design of an article of manufacture. It is my experience that most articles and designs sold into the stream of commerce have some function or purpose. Where a design patent contains functional and ornamental elements, I understand that the scope of the claimed design is limited to the ornamental aspects alone and does not extend to functional elements. I further understand that, where a design contains both functional and non-functional (i.e., ornamental) elements, the scope of the design claim must be construed to identify the non-functional aspects of the claimed design. I understand that using verbal or written guidance to describe a claimed design is helpful to outline the distinction between ornamental and functional elements of the claimed design. I also understand that a claim to a design with numerous functional elements requires a narrow construction. I further understand that functional aspects may be factored out of the claimed design, and that claim construction and the design obviousness analysis should focus on only the non-functional aspects of the claimed design.

35. While I understand that a particular test has not been mandated for assessing the functionality of a claimed design, I understand that there are numerous factors to be considered in evaluating functionality. First, I understand that the

availability of comparable alternative designs is an important if not dispositive factor in evaluating the functionality of a claimed design. I also understand that if other designs would not produce the same or similar functional capabilities, or would not properly function with the claimed design, such other designs are not comparable alternative designs. Second, I understand that there are various other factors useful for assessing claim construction functionality, including: whether the claimed design represents the best design; whether alternative designs would adversely affect the article's utility; whether there are any concomitant utility patents; whether advertising touts particular design features as having specific utility; and whether there are any design elements or an overall appearance clearly not dictated by function. I also understand that where an element of a claimed design has been specifically designed to fit into, or mate with, some other article, the design element has been deemed functional.

B. Priority

36. I understand that a prior art patent/patent publication is entitled to the filing date of its foreign priority application for prior art purposes if the priority application's disclosure provides written description support for, and enables, the claims of the prior art patent/patent publication in compliance with 35 U.S.C. § 112(a). I understand that to satisfy the written description requirement, the specification of the foreign priority application must reasonably convey to one of

ordinary skill in the art that the inventors possessed the invention(s) claimed by the prior art patent/publication at the time the priority application was filed. I understand that the level of detail required to satisfy the written description requirement depends on the nature and scope of the claims and on the complexity and predictability of the relevant technology. I understand that the written description analysis focuses on disclosure, and that analysis of the sufficiency of a patent application's disclosure requires an objective inquiry into the four corners of the patent application's specification from the perspective of a person of ordinary skill in the art as of the effective filing date of that patent application. Further, I understand that to satisfy the enablement requirement, the specification of the foreign priority application must teach a person of ordinary skill in the art how to make and use the full scope of the claimed invention without undue experimentation.

C. Obviousness

37. I understand that a patent is invalid as obvious if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious, before the effective date of the claimed invention, to a person of ordinary skill in the art. I further understand that the obviousness analysis assesses (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences between the claimed invention and the prior art; and (4) secondary considerations nonobviousness (if present). For design

patents, I understand that the ultimate obviousness inquiry asks whether the claimed design would have been obvious to a designer of ordinary skill in the art who designs articles of the type involved in the design patent at issue (a “DOSA”).

38. In a design patent obviousness inquiry, I understand that the first step is to identify a single, “primary” reference with design characteristics that are “basically the same” as the claimed design. I understand that once a primary reference is found, secondary references may be used to modify the primary reference to create a design that has the same overall visual appearance as the claimed design. I understand that secondary references may only be used to modify the primary reference if they are so related to the primary reference that the appearance of certain ornamental features in one would suggest the application of those features to the other. I further understand that when a secondary reference is “so related” to the primary reference, the similarity in appearance among them is enough to motivate a designer of ordinary skill to combine features from one with features from the other. In addition to the relatedness of the prior art and claimed designs, I understand that other reasons could have motivated a designer of ordinary skill in the art to combine the features from a secondary reference with the features of the primary reference. Once the primary and secondary references have been combined, I understand that the design obviousness analysis asks whether the combination design has the same overall visual appearance as the claimed design. I

understand that comparing the prior art and claimed designs as a whole is what is important, and that *de minimis* or trivial differences between the claimed and combination designs cannot prevent a finding of obviousness.

39. Further, I understand that secondary considerations of nonobviousness should be considered if evidence of such considerations is present, and that such secondary considerations cannot overcome a strong case of obviousness.

40. I understand that an assessment of what a reference discloses or teaches—for purposes of an obviousness analysis—must be conducted from the perspective of one of ordinary skill in the art at the time of the invention. I also understand that something is only “inherent in,” and therefore taught by, the prior art if it necessarily flows from the explicit disclosure of the prior art.

VIII. CLAIM CONSTRUCTION FOR THE D’279 PATENT

41. Below, I set forth my understanding of the design claimed by the D’279 Patent. My understanding of the claimed design is consistent with the understanding that a designer of ordinary skill in the art would have had at the relevant time. Exhibit 1003 ¶¶24, 39-42.

42. The D’279 Patent claims the design of a protrusion from the back of an electronic device, where the protrusion includes two arc-shaped portions (gray), a circular arrangement of rectangles (blue) that is surrounded by the arc-shaped

portions, and concentric circles (orange) that are surrounded by the circular arrangement of rectangles, as shown in the following figures.

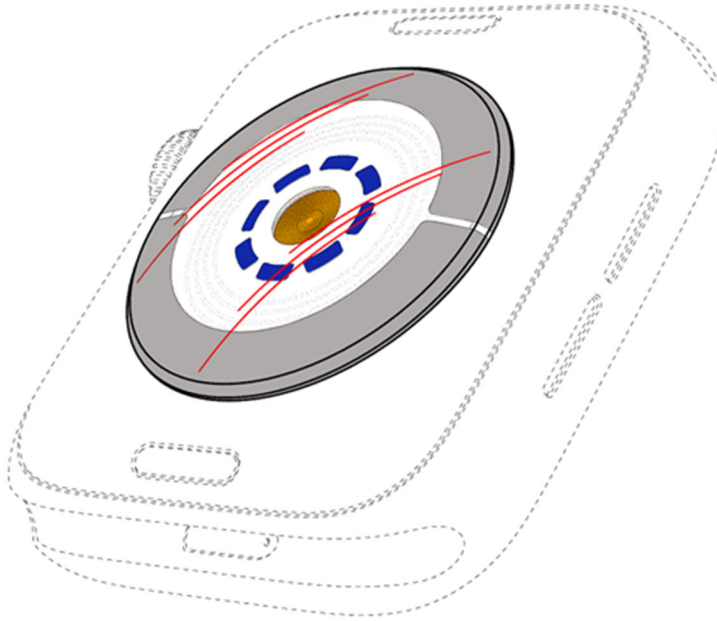


FIG. 2



FIG. 5

Exhibit 1001, FIGS. 2, 5; Exhibit 1003 ¶39. As shown in red above, the outermost surface of the claimed protrusion is a convex surface. *Id.* As is also shown above, the convex surface (red) forms a convex dome that covers the claimed rectangles (blue) and the claimed concentric circles (orange), which are on an interior surface of the electronic device. *Id.* I understand that the claimed convex surface is transparent because it is drawn using obliqued lines to indicate transparency, and because the arc-shaped portions, rectangles, and concentric circles are below and visible through that convex surface, as shown above. *Id.*

43. As shown below, the claimed convex protrusion also includes a sidewall consisting of a vertical edge (colored pink) and a chamfered edge (colored green) between the convex surface (red) and the back of the electronic device.

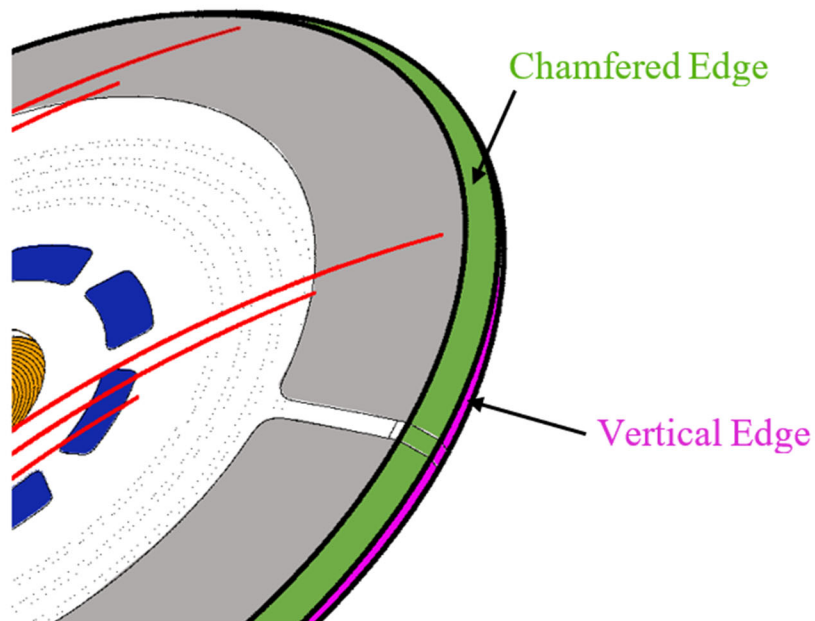
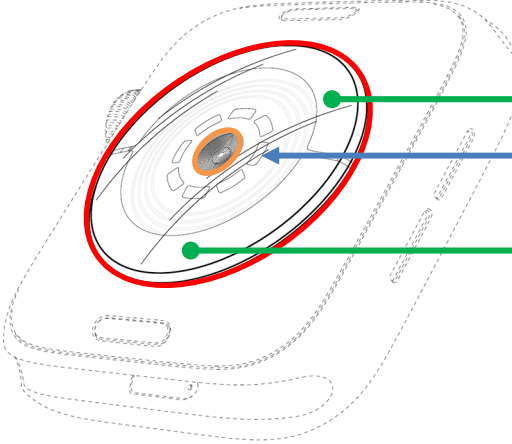
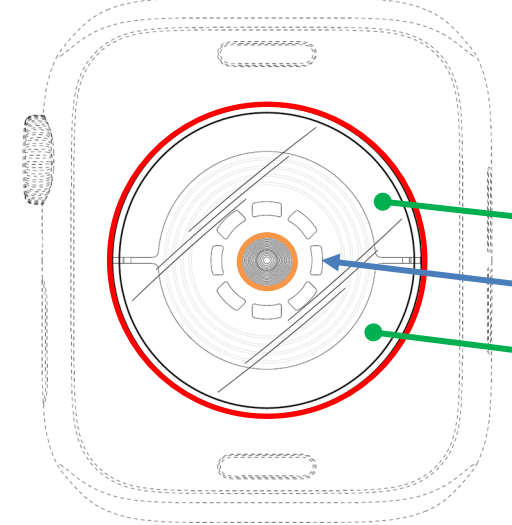
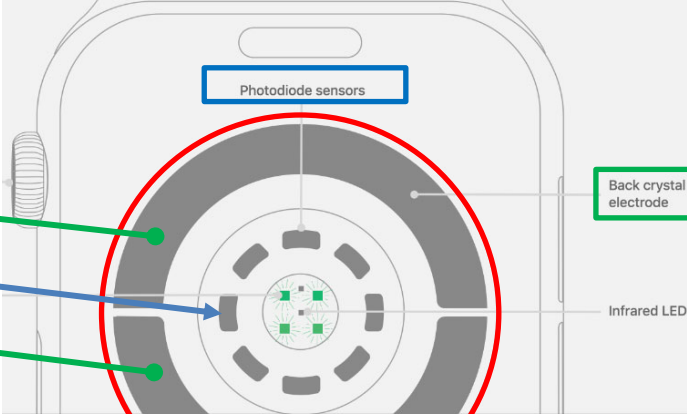


Exhibit 1001, FIG. 2 (excerpted); Exhibit 1003 ¶40. Further, the D’279 Patent states that “[t]he broken lines in the figures ... form no part of the claimed design.” Exhibit 1001, Description.

44. I understand that the D’279 Patent was purportedly filed in June 2018, Exhibit 1001, 2, and that Apple released the Apple Watch Series 4 in September 2018. Exhibit 1018. As shown in the below comparison: (1, using green) the arc-shaped portions claimed by the D’279 Patent depict the arc-shaped electrodes “built-in” to the back of Apple Watch Series 4; (2, using blue) the circular arrangement of rectangles claimed by the D’279 Patent depicts the circular arrangement of

photodiodes of the optical sensor inside Apple Watch Series 4; (3, using orange) the concentric circles claimed by the D'279 Patent depict the Fresnel lens of the optical sensor inside Apple Watch Series 4; and (4, using red) the convex protrusion claimed by the D'279 Patent is the convex protrusion on the back of the Apple Watch Series 4.

Claimed Design (Exhibit 1001)	Apple Watch Series 4
 FIG. 2	 Exhibit 1020, 5
 FIG. 4	 Exhibit 1019, 3 (depicting green and infrared LEDs under Fresnel lens (not shown))

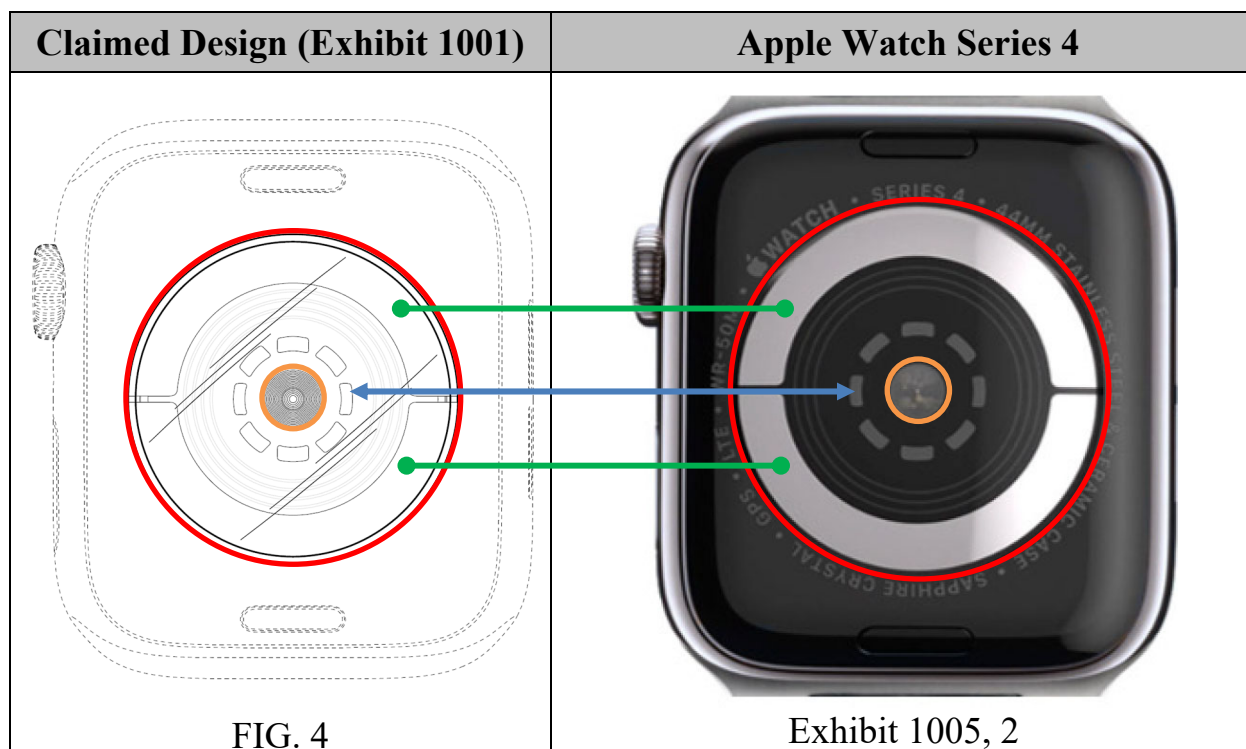


Exhibit 1003 ¶¶41; Exhibit 1019, 2-3; Exhibit 1020, 5.

45. The arc-shaped electrodes of Apple Watch Series 4 are a functional element of its ECG sensor, and the photodiodes and Fresnel lens of Apple Watch Series 4 are functional elements of its optical sensor. The function of the arc-shaped electrodes is to measure electrical impulses across the user’s chest. Exhibit 1019, 3. Further, the Watch’s photodiodes and Fresnel lens are part of its optical sensor, which is a type of photoplethysmography (“PPG”) sensor that is used to measure the user’s heart rate. *Id.* (“The optical heart sensor in Apple Watch uses what is known as photoplethysmography” to measure the user’s heart rate.). In use, the LEDs of the Apple Watch Series 4’s PPG sensor emit light, and the Fresnel lens above those LEDs directs the emitted light into the user’s wrist. *Id.*; *see, e.g.*, Exhibit 1028 ¶¶53,

56 (explaining functionality of Fresnel lens over PPG sensor's light emitters). After passing through (and being attenuated by) the user's wrist tissue, some of that light is reflected back to the Watch's PPG sensor, which receives it with eight "light-sensitive photodiodes." *Id.* The light received by the photodiodes is used by the Watch "to detect the amount of blood flowing through your wrist" and thereby determine the user's heart rate. Exhibit 1019, 2-3. Therefore, the function of the Watch's Fresnel lens is to direct emitted light into the tissue, and the function of the Watch's photodiodes is to receive the reflected light that is used to calculate physiological measurements, such as heart rate. *Id.* Also, as I have explained below in Section VIII.A, the convex protrusion that includes the Watch's electrodes, photodiodes, and Fresnel lens functions to both improve the performance (specifically, the signal-to-noise ratio) of the Watch's PPG sensor and to ensure that the Watch and its charger connect in the manner needed for efficient wireless charging. Moreover, the claimed elements corresponding to these features of Apple Watch Series 4 (i.e., the convex protrusion, arc-shaped portions, rectangles, and concentric circles claimed by the D'279 Patent), are functional design elements, as explained below.

A. The Claimed Convex Protrusion Is Functional

46. The claimed convex protrusion includes a convex surface, which is a functional design element as explained below. Apple confirmed during the

parties' ITC investigation (Inv. No. 337-TA-1276, the "ITC Investigation") that the same "dome" or "curved" (i.e., convex) surface has been included on the back of every Apple Watch, starting with the 2015 release of the original Apple Watch (called "Series 0"). Exhibit 1021, 47:12-16 (explaining convex surface on back of Apple Watch "has been constant since the Series 0"), 46:22-23 ("The original Apple Watch, the Series 0, was released in 2015."). Apple admitted two "very practical reason[s] for that dome shape" of Apple Watch: (1) because that convex surface "fits snugly in the [wireless charging] cradle"; and (2) because that convex surface "is designed to align the watch with the charging hardware components so that the charging can occur in an efficient way." *Id.*, 47:20-24. The development of Apple Watch's health sensors was led by Apple's "distinguished engineer," Brian Land. *Id.*, 954:15-955:9. And Mr. Land confirmed this functionality of the convex surface on the back of every Apple Watch by testifying that this element of Apple Watch was designed to achieve two functions: (1) to mate with the charging cradle or "dock that has a complementary shape" and (2) to align the Watch's charging coil with that of its charger for "efficient wireless charging." *Id.*, 959:14-960:2. Consistent with these admissions from Apple, the back of every Apple Watch has the same convex surface (which is the convex surface claimed in the D'279 Patent) so that the back of the Watch mates snugly with the complementary surface of its charger, as shown in the annotated figure below.



Exhibit 1005, 7; Exhibit 1023, 2 (confirming every Apple Watch uses the same charger design that is shown above). A prior art Apple patent confirms the need to align the charging coil in the Apple Watch with the corresponding coil in the charger for efficient wireless charging. Exhibit 1025, FIG. 19, 45:18-28 (explaining, with reference to FIG. 19) that “the complementary geometries [of the Watch’s back and its charging dock] may facilitate aligning of the [Watch] and dock for efficient wireless power transfer”). Thus, this evidence shows that the convex surface claimed in the D’279 Patent was designed so that the Apple Watch Series 4 underlying the claimed design could performed its intended functions of (1) mating snugly with the corresponding surface of its established charger design and (2) aligning with that charger for efficient wireless charging. The same evidence shows that an alternative design to the convex surface claimed in the D’279 Patent was unavailable because a different surface shape would not mate snugly or precisely

align with the concave surface of the Watch's established charger design, both of which are needed for efficient wireless charging. *See, e.g.*, Exhibit 1005, 2; Exhibit 1001, FIGS. 5-8; Exhibit 1025, 42:63-43:4 (explaining "power transfer efficiency ... may decrease as misalignment increases" between the Watch and its charging dock). That is, using a different shape for the outermost surface of the claimed protrusion would make the Watch incompatible with the established concave surface of its charger. *Id.* Accordingly, the claimed convex surface is dictated by function because the convex surface must be designed as claimed to perform the intended functions of mating and aligning with the corresponding charger for efficient wireless charging.

47. Additionally, numerous other factors support my opinion that the claimed convex surface is a functional element of the design claimed by the D'279 Patent. One such factor is that the claimed convex surface is the best design for that element because only the claimed convex surface allows the underlying article (Apple Watch Series 4) to mate snugly and properly align with the complementary concave surface of the Watch's pre-existing charger. Exhibit 1021, 47:20-24, 959:14-960:2, Exhibit 1005, 7; Exhibit 1025, FIG. 19, 45:18-28. Indeed, as discussed above, using a different surface for the outermost surface of the claimed protrusion would result in a worse design because such an alternative design would be incompatible with the established concave surface of the Watch's charger. For

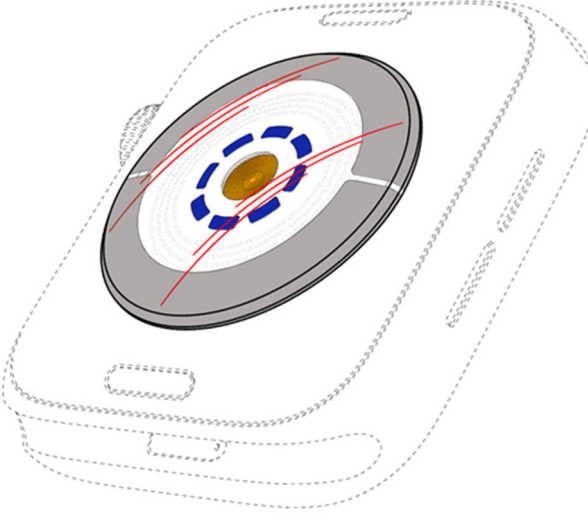
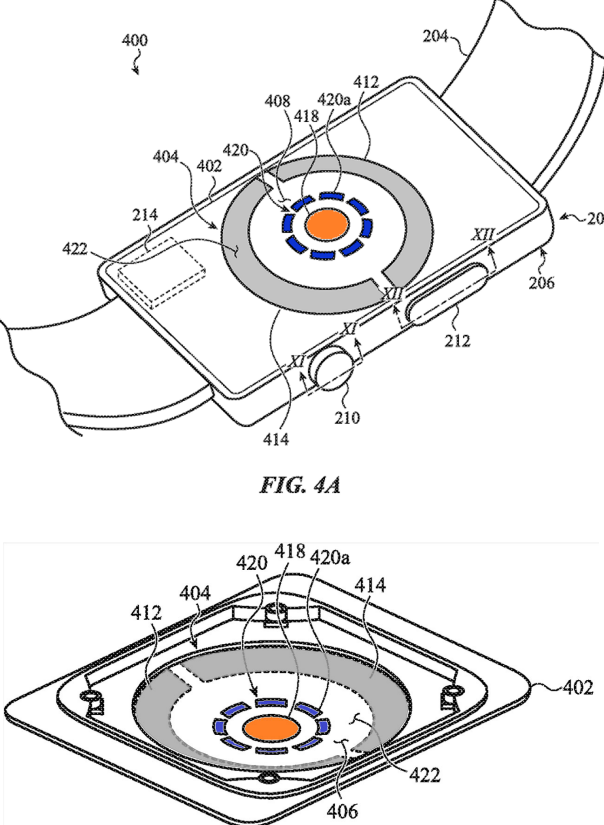
example, using a different surface shape for the outermost surface of the protrusion would make the Watch-charger connection less secure, thereby allowing the Watch to become misaligned on the charger, which would impair or eliminate the Watch's ability to recharge. Exhibit 1025, 42:63-43:4 (explaining "power transfer efficiency ... may decrease as misalignment increases" between the Watch and its charging dock); 45:18-28 (explaining how complementary curved Watch-back and charger surface geometries, like in FIGS. 18-19, enable "efficient wireless power transfer"), FIGS. 18-19).

48. Using a different surface shape for the outermost surface of the claimed protrusion could adversely affect the utility of the underlying article by harming or eliminating the Watch's ability to mate snugly and/or properly align with the complementary concave surface of its established charger design, thus harming or eliminating the Watch's ability to be recharged and used. Exhibit 1021, 959:14-960:2 (Watch's charging dock (i.e., cradle) has a "complementary shape" to the Watch's "dome-shape" "so that, when you place [the Watch] on the cradle, [the Watch] aligns itself well to the ... charger for efficient wireless charging."); Exhibit 1025, 45:18-28 ("complementary geometries" of Apple Watch and its charger allow "efficient wireless power transfer"), 42:63-43:4 (explaining "power transfer efficiency ... may decrease as misalignment increases" between the Watch and its charging dock). The Apple Watch underlying the D'279 Patent charges by mating

snugly and aligning with the complementary surface of its charger, as explained above, and thus the claimed convex surface enabling the Watch-charger connection is needed for charging and, therefore, essential to the use of the Watch.

49. Apple also presents the convex surface claimed by the D’279 Patent as having a particular utility for aligning the Watch with its charger. Apple’s website, for example, indicates that the back of every Apple Watch has a convex surface to mate with “[t]he concave end of the charging cable” and ensure the Watch and charger are properly aligned. Exhibit 1022, 1; *id.*, 1-3 (showing the back of every Apple Watch from Series 4 to the present mates and aligns with the concave end of the same charging cable).

50. Further, the functionality of the convex surface claimed in the D’279 Patent is confirmed by multiple concomitant utility patents from Apple. For example, Apple filed U.S. Pat. No. 10,610,157 (the “’157 patent”) in August 2018, just after the D’279 Patent but before the September 2018 launch of the Apple Watch Series 4. Exhibit 1024, Cover; Exhibit 1018, 1-2. And, as shown below, both the D’279 Patent and the ’157 patent disclose the design of the article underlying both patents, which is Apple Watch Series 4 (as shown above in Section VIII).

D'279 Patent	'157 patent (Exhibit 1024)
 FIG. 4	 FIG. 4A FIG. 4C

As shown in the table above, the D'279 Patent's claimed design (left) is depicted in FIGS. 4A and 4C of the '157 patent (right). The '157 patent explains that the device of FIGS. 4A-4C has a convex or "dome-shaped" carrier 404, which has a "surface 408 [that] protrudes or extends away from a back member 402 of the watch." Exhibit 1024, 12:67-13:3, FIGS. 4A-4C. The convex, protruding surface 404 disclosed by the '157 patent includes "first and second electrodes 412, 414" that are "arc-shaped," as shown above. *Id.*, 13:36-38, 13:21-24, FIGS. 4A, 4C, 5D. The '157 patent even claims the convex surface and its arc-shaped electrodes. *Id.*, claim 15 (reciting first

and second “arc-shaped electrode[s]” and “a carrier protruding from” the “electronic watch”). By claiming the convex surface in a utility patent, Apple’s ’157 patent, therefore, shows that the convex surface claimed in the D’279 Patent is a functional design element.

51. Apple has another utility patent, U.S. Pat. No. 10,627,783 (the “’783 patent”), which shows that the convex surface claimed in the D’279 Patent is for achieving the charging mating and alignment functions discussed above. The ’783 patent teaches to avoid misalignment between the Watch and its charging dock, because misalignment decreases “power transfer efficiency.” Exhibit 1025, 42:63-43:4. To avoid such problematic misalignment between the Watch and its charger, the ’783 patent teaches using “alignment assistance features to effect alignment of the [Watch] 100 with the dock 1802 along a mutual axis.” *Id.*, 43:10-15. The ’783 patent specifically teaches that “the bottom surface of the [Watch] 100 is convex and the top surface of the [charging] dock 1802 is concave, following the same curvature as the bottom of the [Watch] 100.... [to] facilitate alignment of the [Watch] and dock for efficient wireless power transfer,” as shown below in FIGS. 18-19. *Id.*, 45:18-28, 43:28-32 (explaining that “protrusions and corresponding indentations ... may be used to align [the Watch and its dock]”), 43:19-22, FIGS. 18-19.

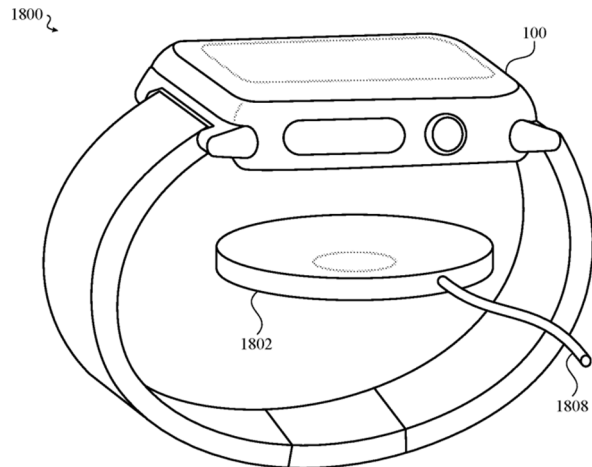


FIG. 18

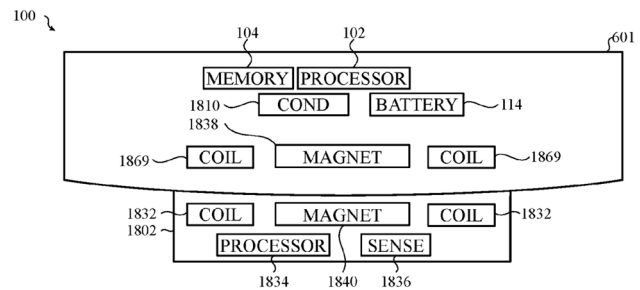


FIG. 19

Therefore, Apple's '783 patent confirms that the convex surface claimed in the D'279 Patent is dictated by the function of aligning the underlying Apple Watch with its corresponding charger.

52. Additionally, as explained below, Paulke, Yuen, and Bushnell are prior art utility patent publications that disclose a convex surface as claimed by the D'279 Patent. *Infra* §§IX.A.1-2, 4. Further, as explained above, the back of every Apple Watch has had the same convex-surfaced protrusion. Exhibit 1021, 47:12-16, 46:22-23. And the Apple Watch was recently found to infringe claims of two Masimo patents that require a protrusion with a convex surface. Exhibit 1040, 41, 44, 53, 55. The sensor design claimed by the D'279 Patent includes a protrusion with a convex surface, as discussed and shown above. *Supra* §§V.A, VIII. And the Masimo utility patents infringed by Apple explain that a protrusion with a convex surface provides functional benefits such as increasing the signal-to-noise ratio of the sensor. Exhibit 1041, 21:9-43, FIG. 5; Exhibit 1042, 21:1-35, FIG. 5. Therefore, at least seven

utility patent filings (Paulke, Yuen, Bushnell, Apple's '157 and '783 patents, and the two Masimo patents infringed by Apple Watch) confirm that the convex surface claimed by the D'279 Patent is functional.

53. Apple's technical expert in the parties' parallel district court litigation also testified that, for light-based physiological measurement devices, which would include the Apple Watch Series 4 underlying the D'279 Patent, a convex protruding feature like the claimed convex protrusion provides numerous functional benefits:

A protrusion can be used to [1] improve the contact between the sensor head and the skin and [2] reduce errors caused by ambient light entering into the sensor head without first propagating through tissue.... [A] protrusion could [3] make the device more comfortable to wear over extended periods of time, [4] improve measurement quality, and [5] reduce device slippage due to better contact with tissue. Protrusions can help to [6] improve the quality of light-based signals received by optical biosensing devices."

Exhibit 1026 ¶111; *id.* ¶112 (describing functional benefits of alleged protrusions shown in ¶113), ¶113. These admissions by Apple's technical expert further support my conclusion that the convex surface claimed by the D'279 Patent is a functional element of the claimed design.

54. **The claimed convex protrusion includes a chamfered edge, which is also a functional design element.** The sidewall of the claimed convex protrusion includes a chamfered edge between the convex surface and the vertical edge, as shown and explained above in Section VIII. The claimed chamfered edge is primarily functional for improving user comfort, as Apple's expert admitted by

testifying that “chamfered edges have been around for many decades as a means to soften transitions between surfaces and make items such as watches more wearable.” Exhibit 1021, 1236:17-1237:3; *id.*, 1229:8-10 (“chamfered edges [] make for a comfort issue with regard to the usage of the watch”). Indeed, chamfered edges as claimed in the D’279 Patent were known features for improving the comfort of sensor components that contact the user’s skin in use. Exhibit 1006, FIG. 2A; Exhibit 1009, FIG. 1A.

55. **The claimed convex protrusion includes a vertical edge, which is also a functional design element.** The sidewall of the claimed convex protrusion includes a vertical edge between the chamfered edge and the back of the device, as shown and explained above in Section VIII. The claimed vertical edge functions to increase the height of the protrusion (i.e., the distance between the protrusion’s convex surface and the back of the device) which, in use, “provides for greater thinning of the measurement site” and thus increases the signal-to-noise ratio of the Watch’s PPG sensor. Exhibit 1041, 25:47-61; *id.*, 21:9-43 (explaining that a convex protrusion increases the sensor’s signal-to-noise ratio by, for example, thinning the measurement site), 25:47-61 (explaining that a vertical edge or “extension” further increases the sensor’s signal-to-noise ratio by, for example, further thinning the measurement site).

56. Accordingly, for the reasons explained above, the claimed convex protrusion is a functional design element.

B. The Arrangement of the Claimed Arc-Shaped Portions Is Functional

57. Apple Watch Series 4 has arc-shaped electrodes with two intended functions: (1) measuring electrical impulses through the skin and (2) not interfering with the central circular array of rectangular photodiodes such that the photodiodes can receive the light used by the Watch to measure heart rate.

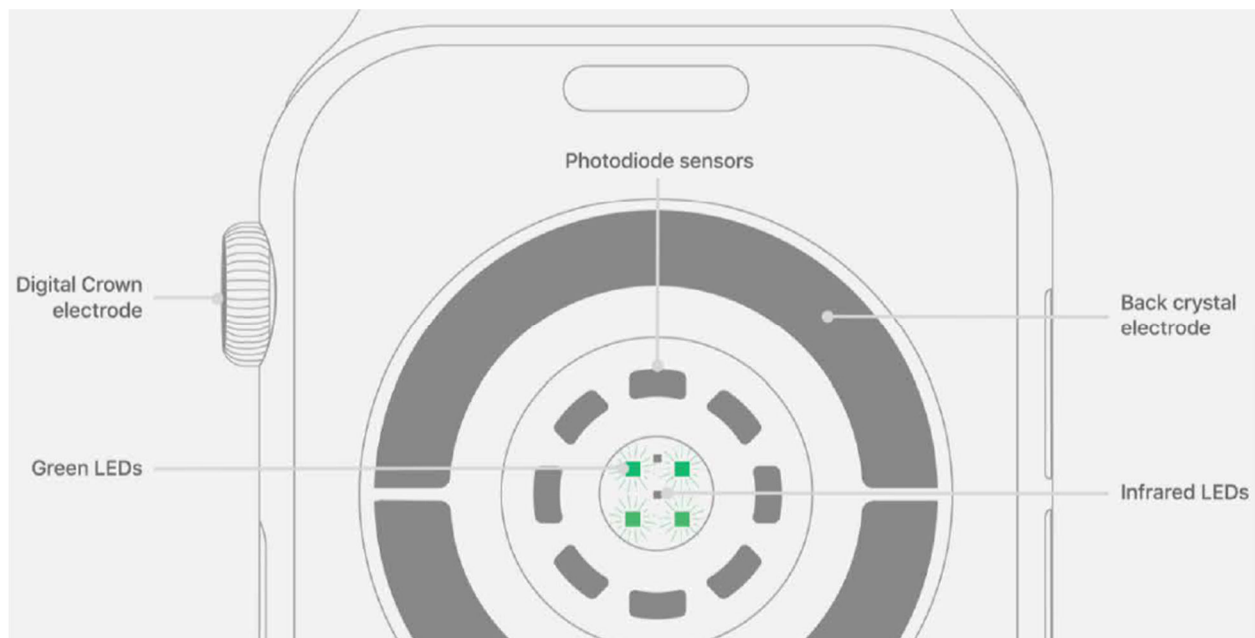
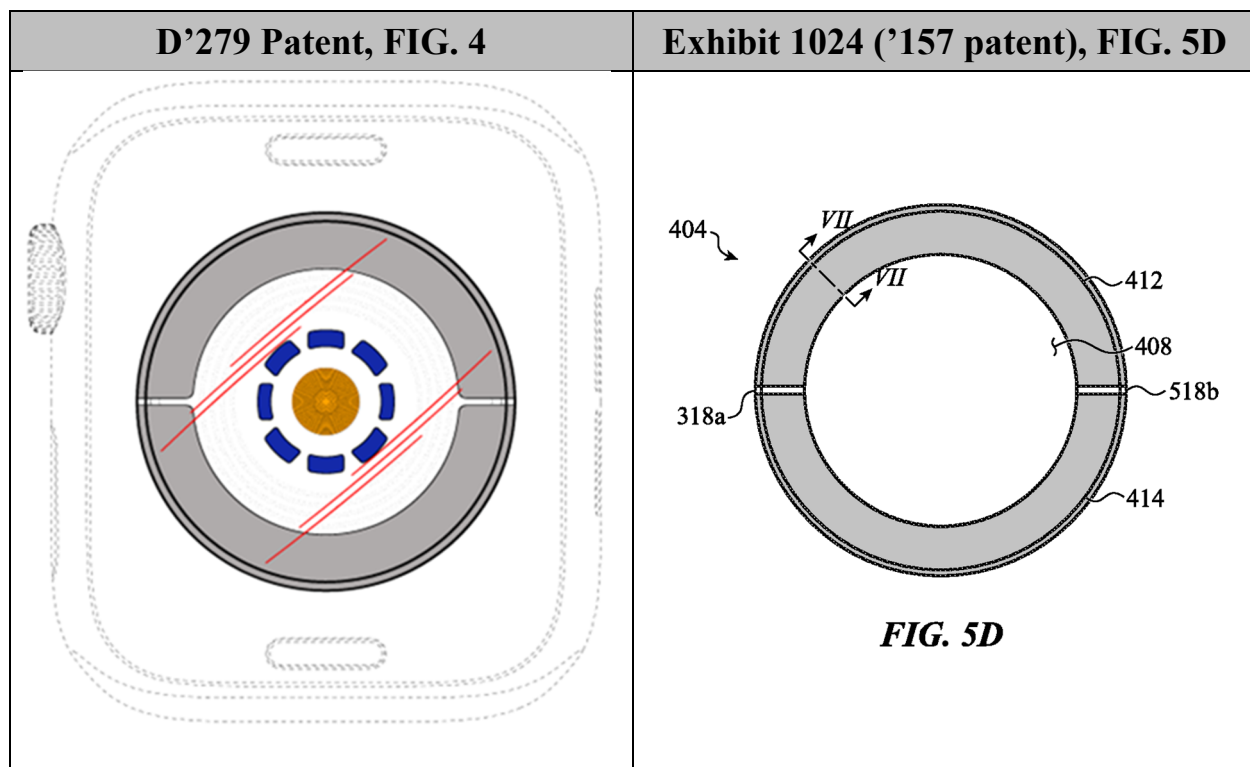


Exhibit 1019, 2-3. The D'279 Patent claims the same design. Exhibit 1001, FIG. 4.

58. Apple's '157 patent teaches that the device's electrodes should be arranged as claimed in the D'279 Patent in order to achieve these two functions. The '157 patent explains the electrodes are "arc-shaped and positioned" and "sized," for example, as shown in FIG. 5D (below, right), to achieve the same two functions:

(1) “provid[ing] good electrical contact between the electrodes 412, 414 and skin” and (2) “allow[ing] optical communication” between the optical sensor and skin. Exhibit 1024, 17:20-34; *id.*, 13:54-59 (“electrodes 412, 414 may be positioned ... so as not to interfere with optical communication between an optical sensor subsystem 416 interior to the watch body 200 ... and [the skin].”). As shown below, the arrangement of electrodes taught by the ’157 patent (gray, right) is basically identical to the claimed arrangement of arc-shaped portions (gray, left).



The arrangement of arc-shaped portions claimed by the D’279 Patent is also claimed in the ’157 patent. Exhibit 1024, Claims 3, 9 (reciting first and second arc-shaped electrodes separated by a gap). The ’157 patent also teaches, and a POSITA would understand, that the minimal spacing (or “gaps”) between the arc-shaped portions

claimed in the D'279 Patent and described in the '157 patent maximizes the area of “electrical contact between the electrodes [] and skin” to “improve electrical sensor efficiency.” Exhibit 1024, 17:20-28, 17:34-35, FIGS. 4A, 5C-5D. Apple's '157 patent, therefore, shows that the arrangement of the arc-shaped portions claimed in the D'279 Patent is a design element dictated by the intended skin contact and non-interference functions of such features in the underlying device (Apple Watch Series 4).

59. The circular array of rectangles claimed by the D'279 Patent are part of the optical sensor of the underlying article (Apple Watch Series 4). *Compare* Exhibit 1001, FIG. 4 *with* Exhibit 1019, 2-3. The optical sensor occupies the middle area on the back of the watch and is surrounded by a concentric circular area that includes a wireless charging coil. Exhibit 1019, 2-3; Exhibit 1027, 11. In the following figure, the area occupied by the Watch's optical sensor is shown in blue and the area occupied by the Watch's wireless charging coil is shown in purple.

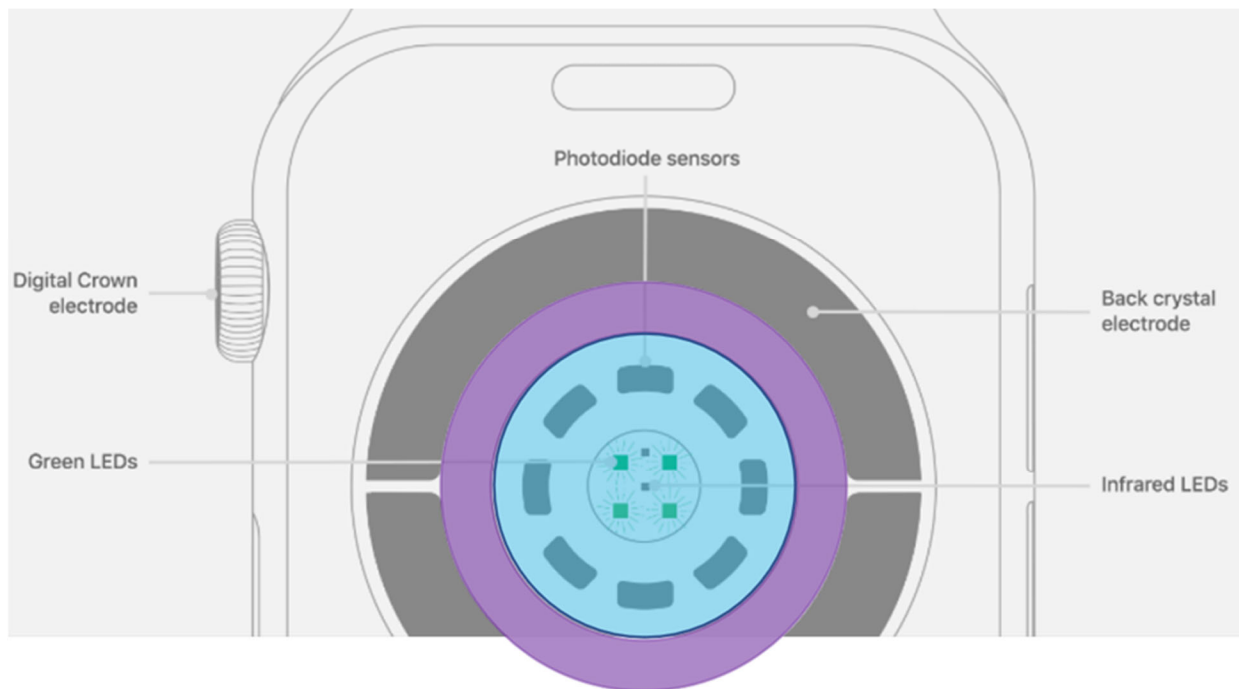


Exhibit 1019, 3 (annotated); Exhibit 1027, 11. As explained above, Apple’s ’157 patent discloses the same design of arc-shaped electrodes as is claimed by the D’279 Patent. Exhibit 1001, FIG. 4; Exhibit 1024, FIGS. 4A, 5C-5D. Apple’s ’157 patent also teaches that those arc-shaped electrodes are “positioned” and “sized” to avoid interference with (1) “electrical structures,” such as the charging coil shown above in purple and (2) “optical communication” between the skin and the optical sensor shown above in blue. Exhibit 1024, 17:20-34. These interference-avoiding functions of the arc-shaped portions’ design dictates that they must be arranged and sized as claimed in the D’279 Patent to avoid interfering with the wireless charging coil or the optical sensor of the Watch.

60. Further, Apple’s ’783 patent explains that aligning the charging coil of the device (e.g., Apple Watch), shown in purple below, with the corresponding

charging coil of its wireless charging dock or cradle, shown in green below, is required for efficient wireless charging.

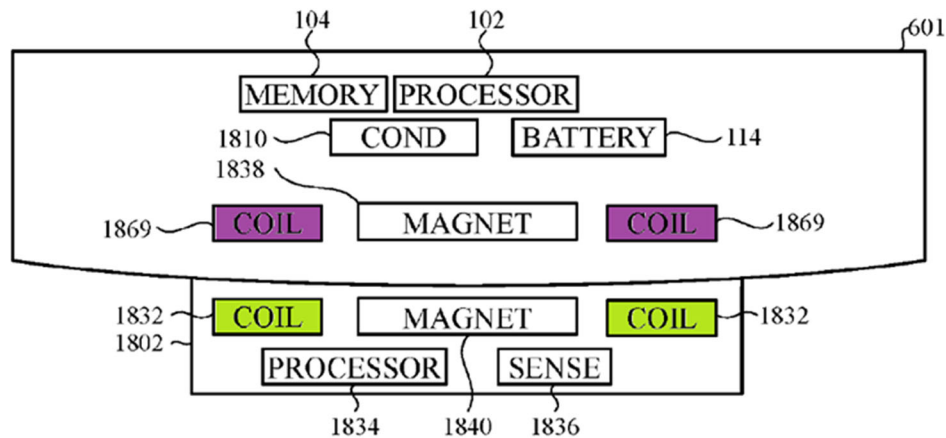


FIG. 19

Exhibit 1025, FIG. 19, 42:63-43:48, 45:18-51. For example, the '783 patent teaches that:

A transmit coil and receive coil may be disposed respectively within housings of the dock and electronic device so as to align along a mutual axis when the electronic device is placed on the dock. ***If misaligned, the power transfer efficiency between the transmit coil and the receive coil may decrease as misalignment increases.*** Accordingly, in many examples, the wireless power transfer system may include one or more alignment assistance features to effect alignment of the transmit and receive coils along the mutual axis.

Id., 42:63-43:4 (emphasis added); *see id.*, 43:5-48 (describing features to align the charging coils of the device (i.e., Apple Watch) and its charging dock), 45:18-51 (same), FIGS. 18-19. Consistent with the teachings of the '783 patent, Apple admitted during the ITC Investigation that the Apple Watch must properly align with its charging dock or cradle for efficient wireless charging. For example, Apple

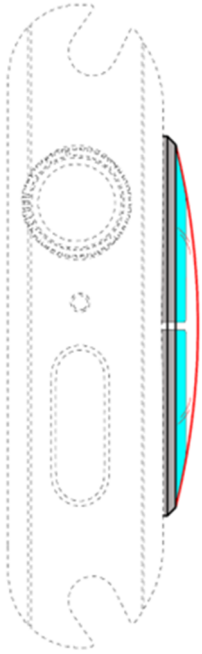
admitted the “dome” shape of every Apple Watch “is designed to align the watch with the charging hardware components so that the charging can occur in an efficient way.” Exhibit 1021, 47:17-23. Similarly, the Apple engineer leading development of Apple Watch’s health sensors, Mr. Land (*id.*, 954:15-955:12), testified that “the dome-shape [of Apple Watch], when in combination with the charging cradle ... provides a self-centering mechanism so that, when you place [the Watch] on the cradle, it aligns itself well to the other -- the charger for efficient wireless charging.” *Id.*, 959:14-960:2. Therefore, for efficient wireless charging, the location of the charging coil in the Watch must align with the location of the corresponding charging coil in the Watch’s established charger. Put simply, the location of the charging coil in the Watch’s charger dictates the location of the associated charging coil in the Watch, and thus, the location of the coil in the D’279 Patent, which claims the design of an article (Apple Watch Series 4) with such a charging coil. *See, e.g.*, Exhibit 1027, 11; Exhibit 1022, 1-3. Moreover, since the arc-shaped electrodes cannot interfere with the Watch’s charging coils or optical sensor, as explained above and in Exhibit 1024, 17:20-34, the arcs claimed by the D’279 Patent are the most efficient shape for maximizing the area of the electrodes that can contact the user’s skin.

61. Relatedly, if the Watch’s electrodes were not arc-shaped but had a different shape, they would either have to provide less area for electrical contact with

the skin or provide more area at the risk of interfering with the Watch's charging coil or optical communication (i.e., the passage of light) between the Watch's optical sensor and the skin. This trade-off between the area of electrical contact with the skin and the risk of interfering with the device's charging coil or optical sensor is avoided by using the arc-shaped electrode design claimed by the D'279 Patent.

62. Starting with Apple Watch Series 4 and continuing through Apple Watch Series 5, 6, 7, 8, and Ultra, which I understand constitutes five consecutive Apple Watch generations and six different Apple Watch models, Apple has retained the claimed arrangement of arc-shaped portions (i.e., electrodes) in every Apple Watch with ECG functionality. Exhibit 1022. In my opinion, that Apple kept the claimed arrangement of arc-shaped electrodes in every Apple Watch for at least five consecutive Watch generations indicates that the claimed arrangement of electrodes is the most useful arrangement for this functional feature (measuring electrical impulses) of the Watch.

63. Additionally, as shown below, like the Apple Watch Series 4 (right), the outermost surface of the claimed arc-shaped electrodes (colored cyan, below, left) follows the protrusion's convex surface (colored red).

D'279 Patent, FIG. 6	Apple Watch Series 4 (Exhibit 1027, 11)
 FIG. 6	

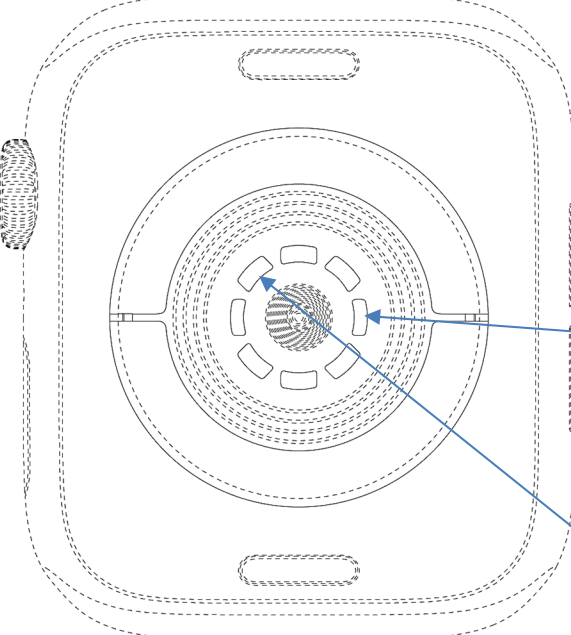
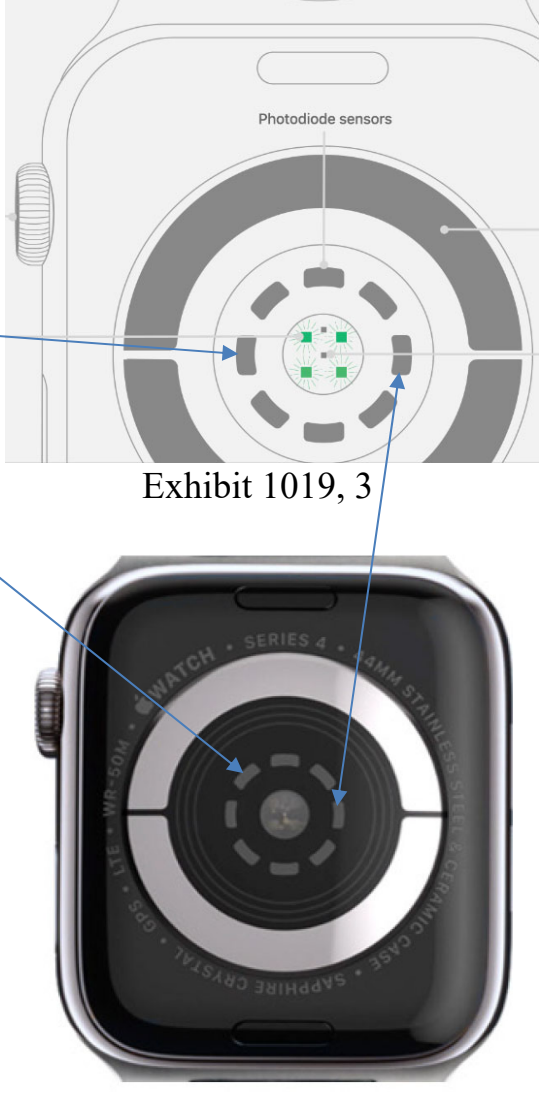
When the Watch is worn, the above convex surface can roll around the user's wrist (i.e., around the longitudinal axis of the user's arm) such that portions of the convex surface do not contact the skin. Such a lack of contact would be problematic because electrodes cannot measure electrical impulses through the skin if they are not in contact with the skin. *See, e.g.*, Exhibit 1007 ¶¶34 (“The electrocardiogram sensor 116 (‘ECG sensor 116’) ... may include at least two electrodes 130, 132 for contacting a user's skin ...”), 36 (“Via contact with a user's skin, the ECG sensor 116 may perform (i.e., take) an electrocardiogram measurement of a user wearing the smartwatch”). Thus, the claimed arrangement of arc-shaped portions ensures that at least a part of each electrode contacts the skin by positioning the arc-shaped

electrodes around the entire outer periphery of the convex surface, other than the two small gaps, as shown above (and in FIGS. 2, 4-6 of the D'279 Patent). An alternative design to the claimed arrangement of arc-shaped portions would necessarily cover less of the convex surface's outer periphery than the claimed design, and therefore would increase the possibility that the Watch could not measure electrical impulses because one or both electrodes failed to contact the skin when in use. Thus, an alternative design to the claimed arrangement of arc-shaped portions would adversely affect, or pose an unnecessary risk of adversely affecting, the electrical signal-measuring utility of the underlying device.

64. Accordingly, for the reasons explained above, the arrangement of the claimed arc-shaped portions is a functional design element.

C. The Arrangement of the Claimed Rectangles Is Functional

65. The article underlying the D'279 Patent, Apple Watch Series 4, includes an optical sensor that is a PPG sensor. Exhibit 1019, 2-3. The Watch's PPG sensor, like any PPG sensor, requires detectors to receive the light used by the sensor to measure heart rate. *Id.*; *infra* Section IX.A.1. In the Apple Watch Series 4, the detectors used to receive light for measuring heart rate are the circular array of eight "light-sensitive photodiodes." Exhibit 1019, 2-3. The following comparison shows that the Watch's circular array of eight photodiodes (right column) are the rectangles claimed by the D'279 Patent (left column).

Claimed Rectangles	Photodiodes in Apple Watch Series 4
 Exhibit 1001, FIG. 4	 Exhibit 1019, 3 Exhibit 1005, 2

Without these photodiodes, the Watch's PPG sensor could not measure the user's heart rate. Exhibit 1019, 2-3.

66. As shown above, the rectangular photodiodes claimed by the D'279 Patent and included in the Apple Watch Series 4 are arranged in a radially-symmetric array. Exhibit 1001, FIGS. 2, 4; Exhibit 1019, 3; Exhibit 1005, 2. The prior art teaches that the claimed radially-symmetric design of photodiodes has the primarily

functional purpose of “maximiz[ing] the detection of backscattered light from the skin.” Exhibit 1011, 4:59-62; *id.*, 4:14-50 (describing improved sensors with “six photodiodes arranged symmetrically around the LEDs”), 4:51-65 (explaining, with reference to prior art designs discussed at 4:14-50, that “a radially-symmetric photodetector array can help to maximize the detection of backscattered light from the skin”), FIG. 7 (showing sensor with two radially-symmetric arrays of six photodiodes; outer photodiode array 16 and inner photodiode array 18). Such a radially-symmetric design of photodiodes was ubiquitous in the prior art. Exhibit 1038, 2-3. The prior art also explains that the number and size of photodiodes is dictated by a functional purpose, which is improving the signal-to-noise ratio of the PPG sensor, thereby increasing the sensor’s accuracy. Exhibit 1011, 4:6-13 (increasing the “number of photodetectors” and their overall “active area” “increases the amount of backscattered light that can be detected” and thus achieves “improvements in signal-to-noise ratio”), 9:22-33 (describing the FIG. 7 sensor and explaining that its design “minimiz[es] some of the measurement inaccuracies” of PPG sensors). Therefore, the prior art confirms that the number and arrangement of rectangles claimed by the D’279 Patent are primarily functional elements for maximizing the signal-to-noise ratio, and thus the accuracy of, the PPG sensor.

67. As shown below, Apple’s ’157 patent discloses the same arrangement of rectangles claimed in the D’279 Patent.

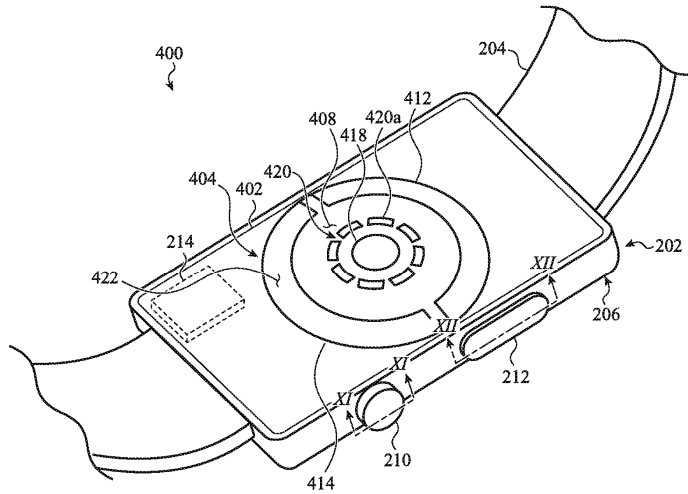


FIG. 4A

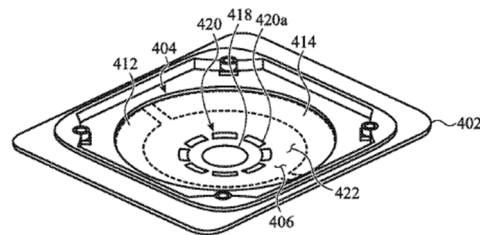


FIG. 4C

Exhibit 1024, FIGS. 4A, 4C. The '157 patent explains that the carrier 404, which has a convex surface as shown above, includes “eight radial openings” (420) that are positioned over corresponding “light receivers (e.g., photodetectors, such as photodiodes)” of the Watch’s optical sensor 416 (not shown) underlying the convex, protruding carrier 404. *Id.*, 15:5-7, 15:34-40. The '157 patent discloses a watch that, like Apple Watch Series 4, includes a circular array of eight photodiodes “to perform a sensor function (e.g., to determine a heart rate),” and that the array of photodiodes surrounds the central “light emitters (e.g., LEDs).” *Id.*, 15:34-37. The '157 patent also explains that receiving light is the “sensing operation for which the optical subsystem 416 is designed.” *Id.*, 15:7-15; *id.*, 15:65-16:2 (explaining the device “may activate the light emitters [i.e., LEDs] and light receives [i.e., photodiodes] to perform a sensor function (e.g., to determine a heart rate)”); Exhibit 1019, 2-3 (explaining that the Apple Watch’s PPG sensor uses “light-sensitive

photodiodes” to measure heart rate). Therefore, Apple’s ’157 patent confirms that the arrangement of rectangles claimed by the D’279 Patent is driven by the functionality of receiving the light needed to measure the user’s heart rate.

68. Accordingly, for the reasons explained above, the arrangement of the claimed rectangles is a functional design element.

D. The Claimed Concentric Circles Are Functional

69. Apple Watch Series 4 underlying the claimed design includes central green and infrared LEDs for emitting light, as shown below.

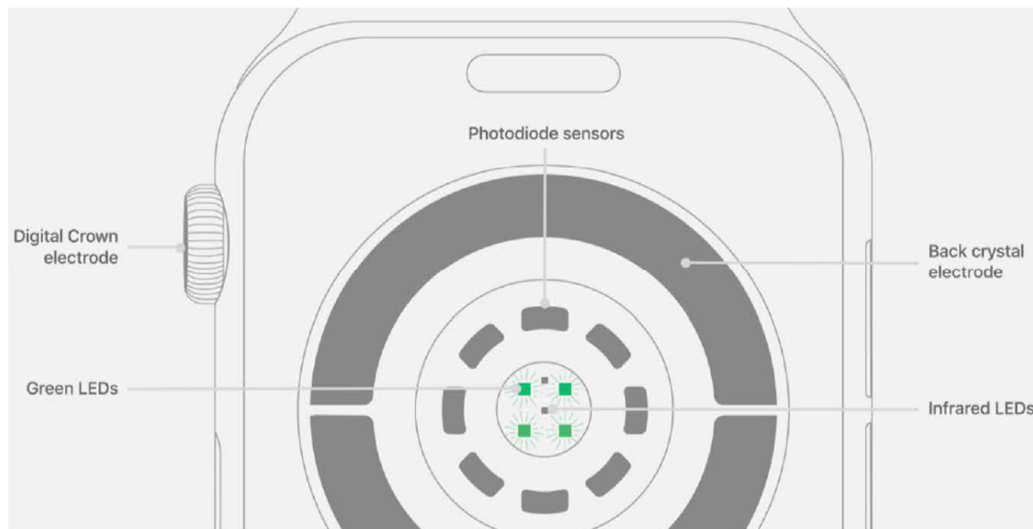


Exhibit 1019, 2-3. Above those central LEDs, the convex protrusion of the Watch includes a Fresnel lens (circled in orange, below, left), which is the translucent grooved structure over the LEDs that is visible from the back of the Watch. Exhibit 1005, 2. As shown below on the right, the D’279 Patent claims the Watch’s Fresnel lens using concentric circles (colored orange). Exhibit 1001, FIG. 4.



Exhibit 1005, 2

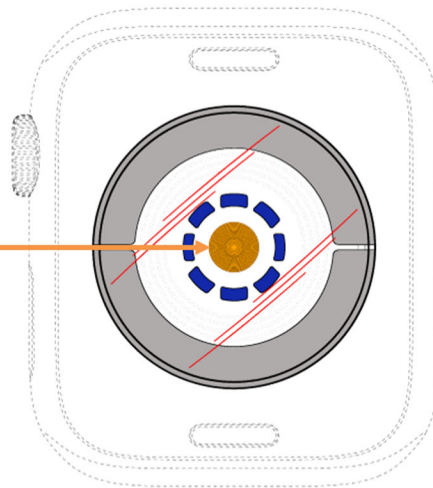
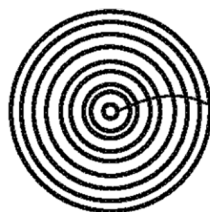


Exhibit 1001, FIG. 4

70. An Apple utility patent publication describing Apple Watch-like devices explains that the device’s “protrusion can include a Fresnel lens” for functional reasons. Apple’s utility patent publication explains that the device’s protrusion can include a Fresnel lens over the light emitter (e.g., LEDs) so that “the light emitter can retain its optical power, collection efficiency, beam shape, and collection area such that the light undergoes minimal change due to the cover structure [i.e., the protrusion].” Exhibit 1028 ¶53. Indeed, the publication explains that an example of this functional configuration is a device in which the Fresnel lens is “located in the protrusion.” *Id.* Apple’s patent publication depicts a Fresnel lens as a plurality of concentric rings, as shown below.



Id., FIG. 9B (excerpted). The publication also teaches that the device’s protrusion can include a Fresnel lens (like the one shown above) over the LEDs “for light collimation” or redirecting light. *Id.* ¶56. Specifically, the publication explains:

By collimating light, the [PPG sensor’s] optical efficiency can be improved. Without a lens or similar collimating optical element, emitted light may be directed at an angle away from the light sensor and can be lost. In some examples, light may be directed at an angle toward the light sensor [i.e., photodiode], but the angle may be shallow (e.g., less than 15°). Fresnel lens 712 can redirect light to one or more directions to prevent light from being lost or entering into the skin at shallow angles. Such redirected light can be collected instead of being lost and/or may militate against parasitic non-signal light, which can improve optical signal efficiency.

Id. The functional purpose of including a Fresnel lens over the LEDs or other light emitter in a PPG sensor is confirmed by Chung. For example, Chung describes the function served by placing “a Fresnel lens 260 for light emission [] above the light emitting unit 210 (e.g., between the sensing surface 130a and the light emitting unit 210).” Exhibit 1010 ¶62. Chung explains that the functional purpose of such a configuration is outputting “collimated light,” which is desirable because “[w]hen the propagation of the light is changed to travel in a straight line [i.e., when the light is collimated], the degree of [light] absorption and scattering due to compositions in a human body may be measured more easily....” *Id.* ¶63. Further, Apple’s utility patent on the Apple Watch Series 4 discloses using a “Fresnel lens” (436) in or below a central opening (418) in the convex protrusion (carrier 404) of the Watch, over the LEDs of its optical sensor (416). Exhibit 1024, 14:35-60, FIGS. 4A-4C.

71. Accordingly, for the reasons explained above, the claimed concentric circles are a functional design element.

E. The Overall Circular Shape of the Claimed Sensor Is Functional

72. The claimed Apple Watch sensor design has an overall circular shape. Exhibit 1001, FIGS. 2, 4. However, the prior art confirms that optical sensors with overall circular shapes like the claimed design (Exhibit 1001, FIGS. 2, 4) are functional because optical sensors with an overall circular shape were ubiquitous in the prior art, long before the D’279 Patent. *See, e.g.*, Exhibit 1006, FIGS. 1F-1G, 5C; Exhibit 1007, FIGS. 1B, 3-4; Exhibit 1008, FIGS. 2, 4; Exhibit 1009, FIGS. 1-7; Exhibit 1011, FIG. 7; Exhibit 1038, 2-3 (showing additional examples of prior art sensors with a circular shape). Additionally, the overall circular sensor shape of the claimed design is functional because that shape is more comfortable for wrist-worn devices. *See, e.g.*, Exhibit 1030, 20:41-42 (“Patient comfort can also be considered in determining the size and shape of the protrusion.”); Exhibit 1006, 5:29-31, 13:5-12, FIGS. 1F-1G; Exhibit 1017, 102 (Apple arguing that “it was well-known in the art that a sensor that comes in contact with tissue should incorporate ergonomic features to increase comfort and optimally contact the user’s tissue”). Also, using a radially-symmetric array of rectangular photodiodes was a well-known design for improving the signal-to-noise ratio and thus the performance of optical sensors, including PPG sensors. *Supra* Section VIII.C; *infra* Section IX.B.1. A POSITA

would have understood that an overall circular sensor shape was the most efficient shape for housing a circular optical sensor design, such as the design in Figure 7 of Mendelson (Exhibit 1011), with minimal wasted or excess space. *See, e.g.*, Exhibit 1025, FIG. 16 (showing wrist-worn device with overall circular sensor shape), 10:16-26 (“The components may also be configured to take up a minimal amount of space, which may facilitate the device body 11 [i.e., overall sensor shape] having a small form factor. In cases such as these, the components may be packaged [] in order to provide the most functionality in the smallest space.”), 1:46-50 (“The embodiments included herein are directed to a consumer product, which may include a portable or wearable electronic device that is configured to provide an expansive feature set integrated or incorporated into a compact form factor.”), 49:8-10 (discussing “[t]he space constraints associated with a small wrist-worn device”). Further, an overall circular sensor shape, as claimed in the D’279 Patent functions to provide a sensor with the largest usable sensor surface area (i.e., surface of the sensor that contacts the user’s skin in use) for a given sensor width.

73. Accordingly, for the reasons explained above, the overall circular shape of the claimed sensor is a functional design element.

74. In conclusion, for the reasons explained above, the following elements are functional elements of the design claimed by the D’279 Patent: (1) the claimed convex protrusion, including its convex surface, chamfered edge, and vertical edge,

(2) the arrangement, including the shape, size, and spacing, of the claimed arc-shaped portions, (3) the arrangement of the claimed rectangles, (4) the claimed concentric circles, and (5) the overall circular shape of the claimed sensor.

IX. TECHNICAL OPINIONS REGARDING OBVIOUSNESS FOR THE D'279 PATENT

A. Overview of the Prior Art

75. I understand that the obviousness inquiry for design patents is assessed from the perspective of a designer of ordinary skill in the art. As explained above in Section VI, a designer of ordinary skill in the art would have consulted and collaborated with a POSITA, such as myself, regarding technical concepts outside of the designer's area of expertise. Accordingly, below, I provide technical discussion regarding the applied prior art references from the perspective of a POSITA, who would have worked closely with a designer of ordinary skill in the art to design devices like the Apple Watch Series 4 sensor design claimed by the D'279 Patent.

1. Paulke (Exhibit 1006 – PCT Appl. Pub. No. WO 2017/165532)

76. Paulke discloses “designs and techniques for incorporating biosensor devices into a wearable article for making physiological measurements while being worn by a user (e.g., a person).” Exhibit 1006, 5:27-29. Paulke discloses arc-shaped biosensors 120 that surround a central, circular biosensor 120. Paulke's biosensors

120 are incorporated in the convex surface that protrudes from the back of Paulke's device, as shown below.

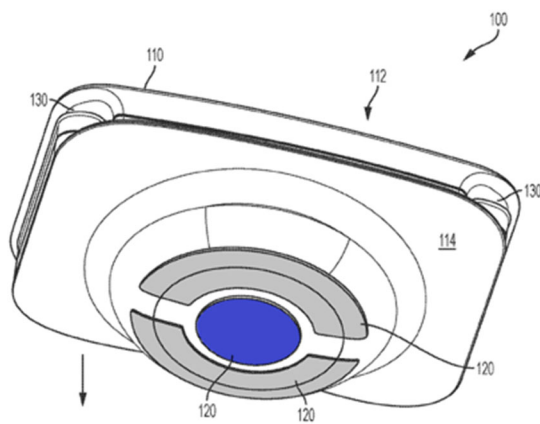


FIG. 1F

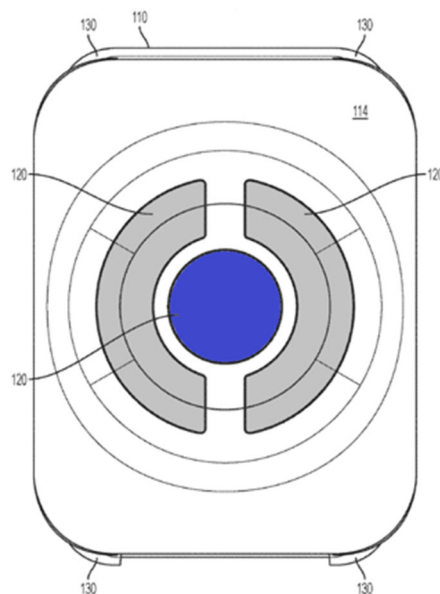


FIG. 1G

Exhibit 1006, FIGS. 1F-1G. In one example, Paulke explains that its arc-shaped biosensors 120 (shown in gray above) are electrodes, specifically, “galvanic skin response (GSR) sensor pads 122, which detect and/or measure electrodermal activity (e.g., skin conductance) of the wearer.” *Id.*, 14:29-32, FIG. 2A. Paulke’s arc-shaped electrodes 120/122 surround a circular biosensor 120, which Paulke teaches can be “a heart rate and/or blood oxygen sensor 124” that may be replaced with “any other suitable biosensor(s),” including “optical reflectance,” “oxygen saturation sensors,” and other PPG sensor. *Id.*, 14:26-28, 15:6-18, FIG. 2A. Paulke’s blood oxygen sensor 124, like any non-invasive pulse oximetry (i.e., oxygen saturation or blood oxygen) sensor, is a PPG sensor. Exhibit 1011, 1:33-2:27 (explaining that non-

invasively measuring oxygen saturation requires using PPG sensors and related algorithms), 4:1-65 (describing prior art blood oxygen sensor designs where “the computation of [oxygen saturation] is based on reflection photoplethysmograms measured by a single photodetector, regardless of whether one or multiple photodiodes chips are used to construct the sensor”).

77. Moreover, Paulke’s PPG sensor, like any PPG sensor, necessarily requires (1) a light source such as LEDs, (2) at least one light detector such as photodiodes, and (3) at least one opening that allows light to reach and be detected by the light detector. Exhibit 1011, FIGS. 3-4, 7, 1:33-2:27 (explaining how PPG sensors use light detected by photodiodes to calculate oxygen saturation), 4:6-65 (describing examples of PPG sensors with multiple LEDs and photodiodes); Exhibit 1030, FIGS. 3C (showing PPG sensor with multiple openings and photodiodes), 7A-7B (showing PPG sensor with LEDs, photodiodes, and an opening), 8:25-29 (describing PPG sensor with “one or more openings ... to allow attenuated light from a measurement site, such as a finger, to pass through to one or more detectors”), 12:1-12 (describing PPG sensor with emitter 104 and detectors 106, wherein the emitter 104 includes “one or more sources of optical radiation, such as LEDs”), 14:11-19 (“[T]he detectors 106 can capture and measure light transmitted from the emitter 104 that has been attenuated or reflected from the tissue in the measurement site ... [and] output a detector signal 107 responsive to the light captured or

measured. The detectors 106 can be implemented using one or more photodiodes....”). Rectangular photodiodes arranged in a radially-symmetric array were ubiquitous in prior art optical sensors. Exhibit 1011, 4:6-62 (radially-symmetric array of six rectangular photodiodes), FIG. 7 (radially-symmetric array of 12 rectangular photodiodes); Exhibit 1036, 6 (radially-symmetric array of six rectangular photodiodes); Exhibit 1037, 24 (radially-symmetric array of six rectangular photodiodes). Apple itself argued during the ITC Investigation that “there’s nothing patentable about multiple detectors [i.e., photodiodes]” because rectangular photodiodes arranged in a radially-symmetric array were ubiquitous in prior art optical sensors. Exhibit 1021, 58:3-13 (referring to Exhibit 1038, 2-3); Exhibit 1038, 2-3 (showing examples, starting in 1978, of optical sensors with radially-symmetric arrays of rectangular photodiodes). Because these features of PPG sensors were so well-known in the art, a POSITA would have understood that Paulke’s blood oxygen sensor included a rectangular photodiode (drawn in blue below) associated with an opening in the sensor, as shown in either of the exemplary composite figures below.

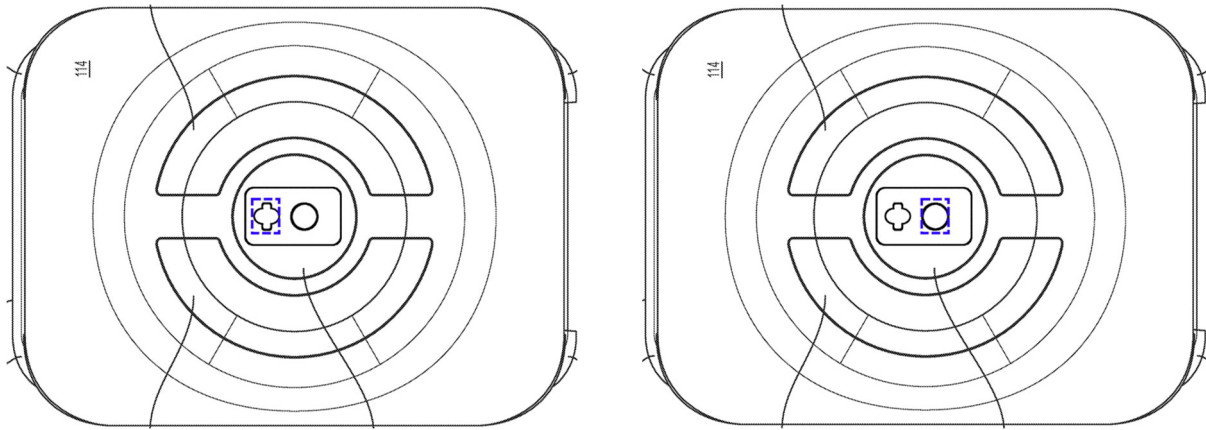


Exhibit 1006, FIG. 1G (composites of FIG. 1G combined with blood oxygen sensor 124 from FIG. 2A and a photodiode associated with an opening in that sensor).

2. Yuen (Exhibit 1007 – U.S. Pat. Appl. Pub. No. 2019/0196411)

78. Yuen discloses a smartwatch assembly 100 with arc-shaped electrodes 130, 132 and a central PPG sensor 118, as shown below.

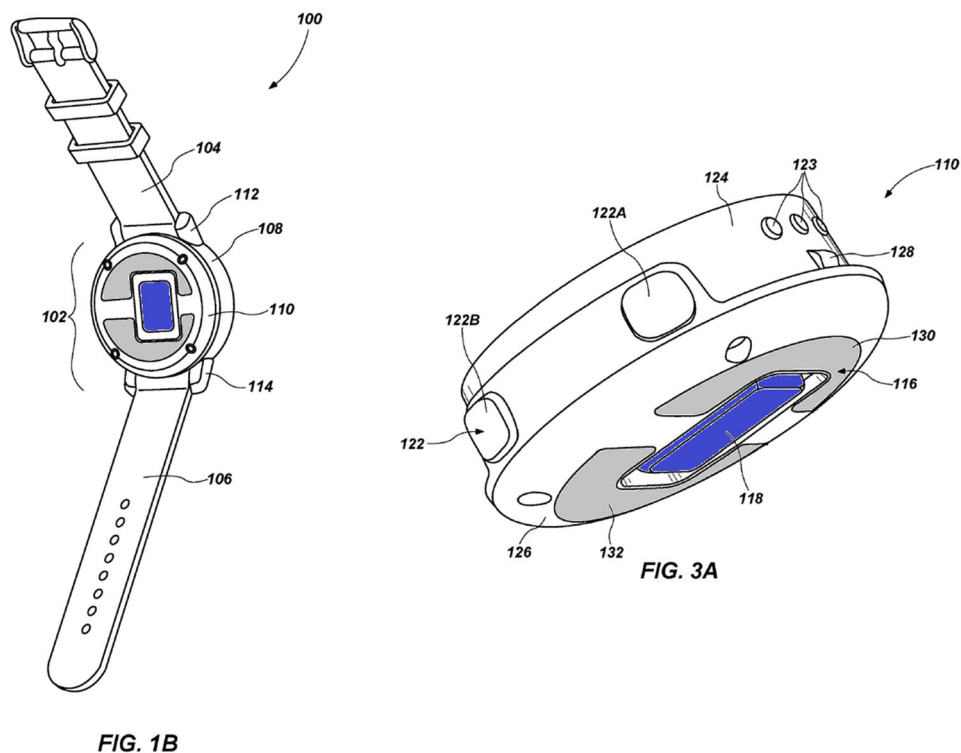


Exhibit 1007 ¶32, FIGS. 1B, 3A. The arc-shaped electrodes 130, 132 and PPG sensor 118 of Yuen are incorporated in the convex back surface 126 protruding from the back of the smartwatch assembly 100. *Id.* ¶¶35-36, 42, FIGS. 1B, 3A. Yuen's PPG sensor 118, like any PPG sensor, necessarily requires (1) a light source such as LEDs, (2) at least one light detector such as photodiodes, and (3) at least one opening that allows light to reach and be detected by the light detector, as explained above in the discussion of Paulke. *Supra* Section IX.A.1. For the reasons explained above in Section IX.A.1 regarding Paulke, a POSITA would have understood that Yuen's PPG sensor included a rectangular photodiode (drawn in blue below) associated with an opening in the sensor, as shown in the exemplary composite figure below.

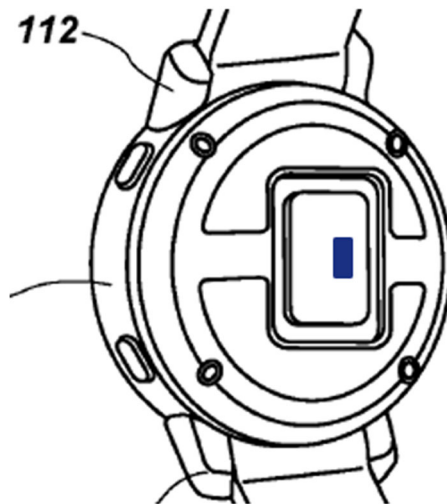
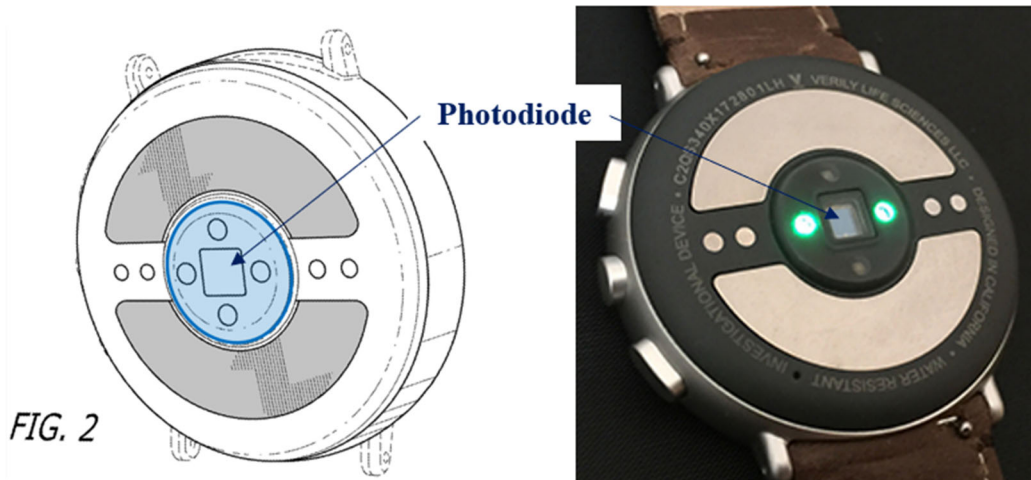


Exhibit 1007, FIG. 4 (composite of FIG. 4 combined with an exemplary photodiode in Yuen's PPG sensor).

3. **Fong (Exhibit 1008 – U.S. Pat. No. D827,831)**

79. Fong (left) discloses the design of the Study Watch from Verily Life Sciences (right), as shown in the annotated figures below.



Fong (Exhibit 1008, FIG. 2)

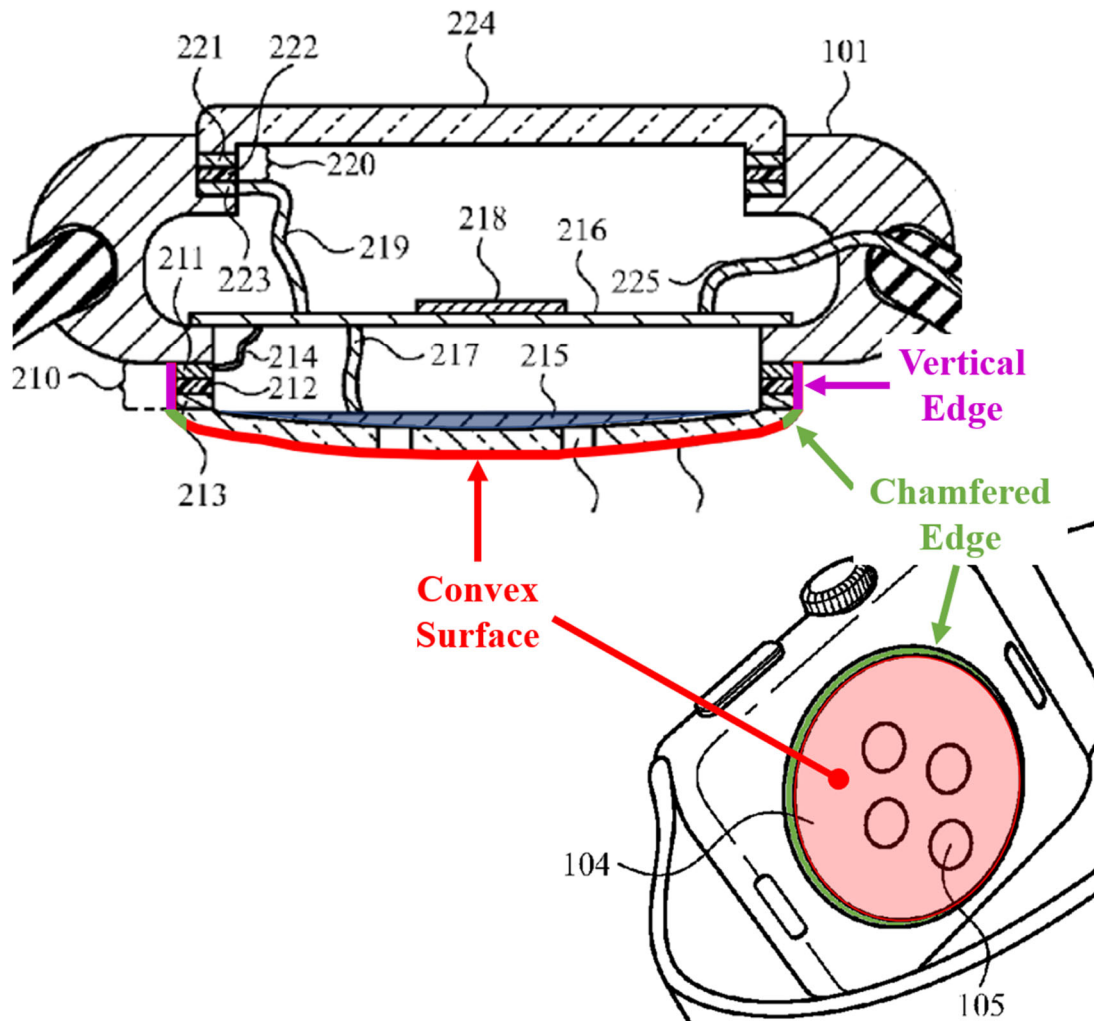
Verily Study Watch (Exhibit 1016, 3)

Exhibit 1008, FIG 2; Exhibit 1016, 2-3. Exhibit 1016 is an article describing the sensor design depicted in Fong. Exhibit 1016. Exhibit 1016 explains that, on the bottom of Fong’s sensor “are the green LEDs and optical sensors that detect heart rate, [and] metal electrodes that measure electrodermal activity.” *Id.*, 2-3. The arc-shaped electrodes of Fong are incorporated in the convex surface on the back of the watch. Exhibit 1029, which is a 510(k) premarket notification, states that the “Study Watch [i.e., Fong’s design] contains an optical sensor that collects the PPG waveform from blood flow and this PPG raw data is utilized for non-medical heart rate data.” Exhibit 1029, 1, 3. Accordingly, a POSITA would have understood that Fong’s central optical sensor is a PPG sensor with at least one photodiode, as shown

in the figures above. Fong's PPG sensor, like any PPG sensor, necessarily requires (1) a light source such as LEDs, (2) at least one light detector such as photodiodes, and (3) at least one opening that allows light to reach and be detected by the light detector, as explained above in the discussion of Paulke. *Supra* Section IX.A.1.

4. Bushnell (Exhibit 1009 – U.S. Pat. Appl. Pub. No. 2017/0086743)

80. Bushnell discloses a wrist-worn smartwatch with a “housing component 104” comprising a convex surface (red, below) that covers a “health sensor 215” (blue, below), which may be a “a photoplethysmogram (PPG) sensor.” Exhibit 1009 ¶¶37, 48, FIGS. 1A (below, right), 2A (top, left) (annotated, excerpted).



As shown above, Bushnell also discloses a chamfered edge (green) and a vertical edge (pink) between the convex surface (red) of its housing component and the back of the watch device (101). *Id.* As shown above, Bushnell's PPG sensor (e.g., 215 (colored blue above), 315, 415, etc.), is incorporated in the convex housing component protruding from the back of Bushnell's watch device. *Id.* ¶¶40, 48, FIGS. 2-7. Bushnell's PPG sensor, like any PPG sensor, necessarily requires (1) a light source such as LEDs, (2) at least one light detector such as photodiodes, and (3) at

least one opening that allows light to reach and be detected by the light detector, as explained above in the discussion of Paulke. *Supra* Section IX.A.1.

5. Mendelson (Exhibit 1011 – U.S. Pat. No. 6,801,799)

81. Mendelson discloses pulse oximetry (i.e., oxygen saturation or blood oxygen) sensors, which are PPG sensors. Exhibit 1011, 1:33-2:27 (explaining how “[p]rior art non-invasive optical sensors” use photoplethysmography (PPG) to measure physiological parameters like oxygen saturation). Mendelson discloses PPG sensor designs with “radially-symmetric” arrays of rectangular photodiodes, including (1) “a sensor having six photodiodes arranged symmetrically around the LEDs” and (2) a sensor with two symmetrical circular arrays of six rectangular photodiodes (twelve total photodiodes (16/18), shown in blue) surrounding the central red and infrared LEDs (12A-12C), as shown below.

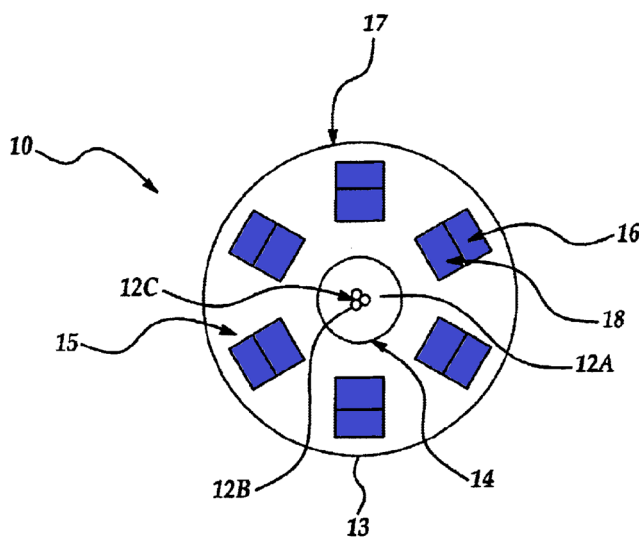
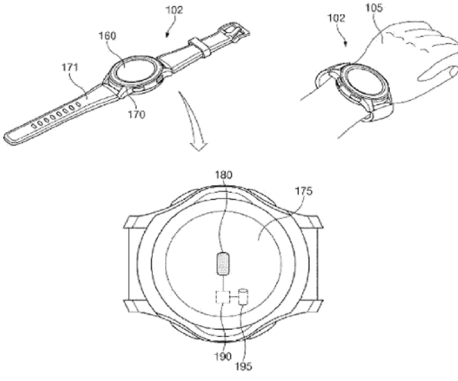


Figure 7

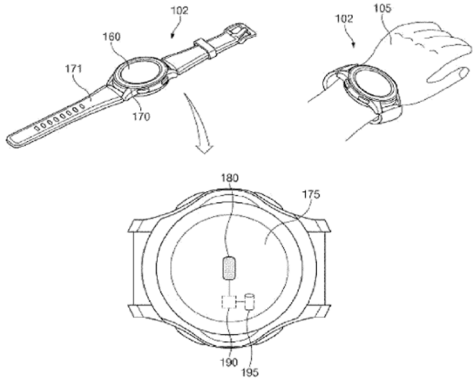
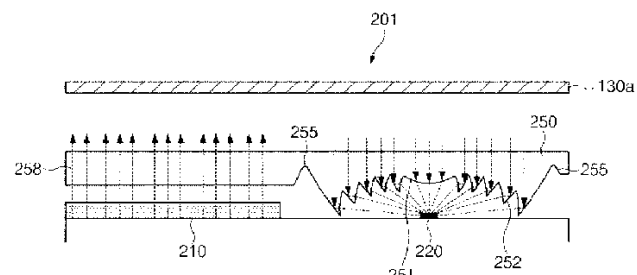
Exhibit 1011, FIG. 7, 9:22-40 (describing Mendelson’s FIG. 7 PPG sensor). Mendelson’s PPG sensors, like any PPG sensor, necessarily require (1) a light source such as LEDs, (2) at least one light detector such as photodiodes, and (3) at least one opening that allows light to reach and be detected by the light detector, as explained above in the discussion of Paulke. *Supra* Section IX.A.1.

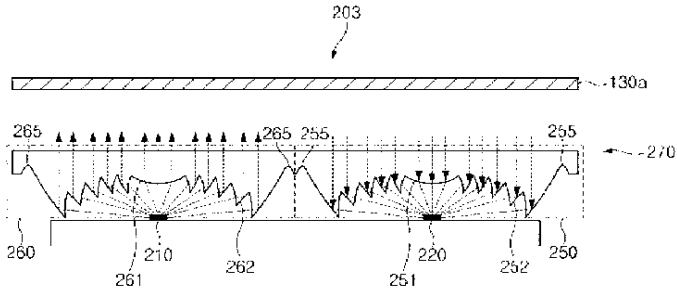
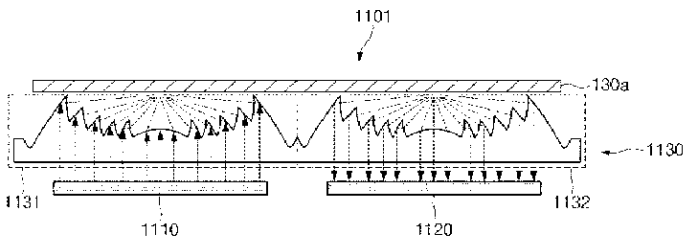
6. Chung (Exhibit 1010 – U.S. Pat. Appl. Pub. No. 2019/0324593)

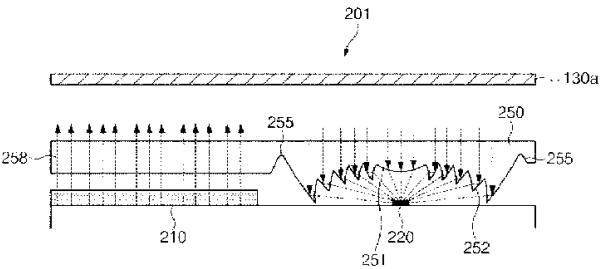
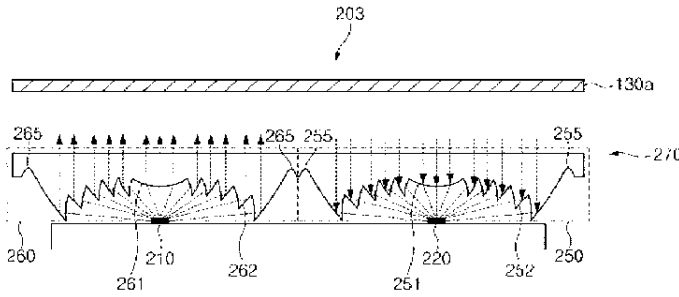
82. Chung claims priority to Korean Pat. Appl. No. 10-2018-0038206 (“Chung-KR-Application”), which was filed on April 2, 2018. To determine whether Chung is entitled to the April 2018 filing date of its priority application, I compared the claims of Chung to the disclosure of the Chung-KR-Application, as shown in the following table.

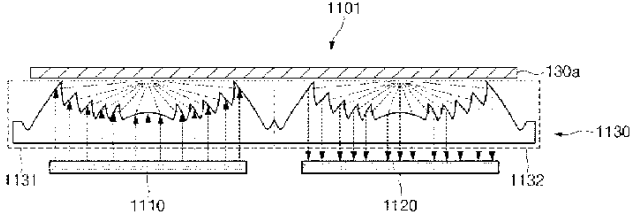
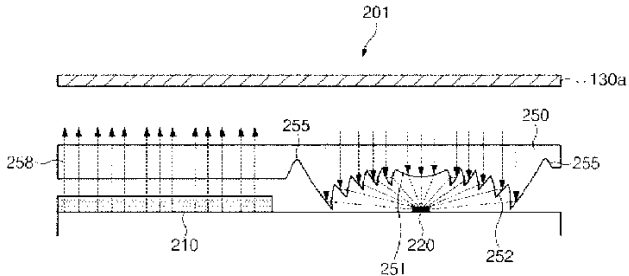
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung’s Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
[1 Preamble]¹ 1. An electronic device comprising:	FIG. 1B: 

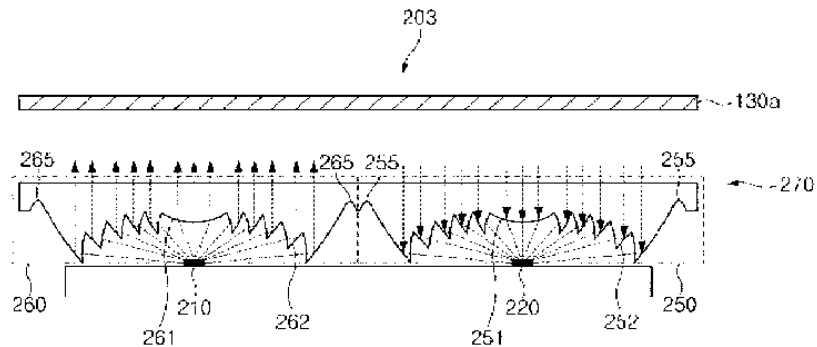
¹ The bracketed text in this column denotes the abbreviation I have used in this table to refer to a given element of Chung’s claims.

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶21: “FIGS. 1A and 1B illustrate exemplary cases where electronic devices 101 and 102 are smartphones or smart watches, but are not limited thereto. For example, an electronic device 101 may be a tablet PC or a laptop PC. For another example, an electronic device 102 may be a wearable device (e.g., a smart band, a smart necklace, or smart glasses).” Claim 1: “An electronic device comprising:”
[1A] a housing including a sensing surface;	FIG. 1B:  ¶30: “Referring to FIG. 1B, an electronic device 102 may be a wearable device including a display 160, a housing (or main body) 170, and a strap 171.” ¶32: “A housing (or main body) 170 may fix a display 160 and protect various configurations therein. The housing 170 may include an optical sensor 180, a processor 190, a memory 195, and a communication circuit required for driving an electronic device 102. The housing 170 may include a structure connected to a strap 171.” Claim 1: “a housing including a sensor plane;”
[1B] a light emitting unit configured to output a light through the sensing surface;	FIG. 2A:  ¶37: “Referring to FIG. 2A, an optical sensor 201 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 210, a light receiver 220, and a Fresnel lens 250 for receiving light.

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	The light emitter 210 may generate infrared light. In one exemplary embodiment, the light emitter 210 may output collimated light. The light generated by the light emitter 210 may be radiated to the outside through a sensor plane 130a.” <i>See also</i> FIG. 2C:  ¶55: “Referring to FIG. 2C, an optical sensor 203 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 210, a light receiver 220, and a plurality of Fresnel lenses 270 (a Fresnel lens 250 for receiving light and a Fresnel lens 260 for emitting light).” ¶57: “The function or operation of a light emitter 210, a light receiver 220, a Fresnel lens 250 for receiving light, and a Fresnel lens 260 for emitting light may be the same as or similar to the function or operation of the corresponding configuration of FIGS. 2A or 2B.” <i>See also</i> FIG. 11:  ¶109: “FIG. 11 is an exemplary view in which a patterned surface of a Fresnel lens is disposed to face a sensor plane according to various exemplary embodiments.” ¶110: “Referring to FIG. 11, an optical sensor 1101 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 1110, a light receiver 1120, and a plurality of Fresnel lenses 1130

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	(including a Fresnel lens 1131 for emitting light and a Fresnel lens 1132 for receiving light)." Claim 1: "a light emitter that generates the light radiated to the outside through the sensor plane;"
[1C] a light receiving unit configured to collect a reflection light reflected from an external object in contact with the sensing surface, after the light is output from the light emitting unit; and	FIG. 2A:  ¶38: "A light receiver 220 may collect light flowing from the outside and convert it into an electrical signal. In one exemplary embodiment, the light receiver 220 may collect the light (hereinafter, "reflected light") that is generated from a light emitter 210 and reflected to an external object (e.g., the user's body) and convert it to an electrical signal. The light receiver 220 may transmit the collected signal to a processor 140 or 190 inside an electronic device 101 or 102." See also FIG. 2C:  ¶55: "Referring to FIG. 2C, an optical sensor 203 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 210, a light receiver 220, and a plurality of Fresnel lenses 270 (a Fresnel lens 250 for receiving light and a Fresnel lens 260 for emitting light)." ¶57: "The function or operation of a light emitter 210, a light receiver 220, a Fresnel lens 250 for receiving light, and a Fresnel lens 260 for emitting light may be the same as or similar to the function or operation of the corresponding configuration of FIGS. 2A or 2B."

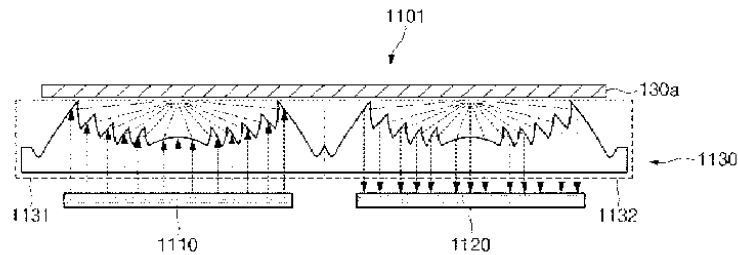
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	See also FIG. 11:  ¶109: “FIG. 11 is an exemplary view in which a patterned surface of a Fresnel lens is disposed to face a sensor plane according to various exemplary embodiments.” ¶110: “Referring to FIG. 11, an optical sensor 1101 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 1110, a light receiver 1120, and a plurality of Fresnel lenses 1130 (including a Fresnel lens 1131 for emitting light and a Fresnel lens 1132 for receiving light).” Claim 1: “a light receiver that collects the light reflected from an external object abutting the sensor plane; and”
[1D] a first Fresnel lens disposed between the light receiving unit and the sensing surface,	FIG. 2A:  ¶40: “A Fresnel lens 250 for receiving light may be disposed at the top of a light receiver 220 (i.e., between a sensor plane 130a and the light receiver 220).” See also FIG. 2C:



¶55: “Referring to FIG. 2C, an optical sensor 203 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 210, a light receiver 220, and a plurality of Fresnel lenses 270 (a Fresnel lens 250 for receiving light and a Fresnel lens 260 for emitting light).”

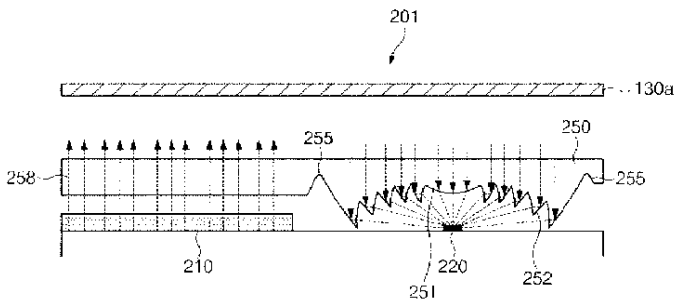
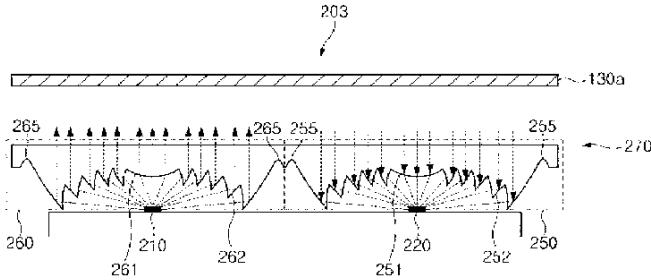
¶57: “The function or operation of a light emitter 210, a light receiver 220, a Fresnel lens 250 for receiving light, and a Fresnel lens 260 for emitting light may be the same as or similar to the function or operation of the corresponding configuration of FIGS. 2A or 2B.”

See also FIG. 11:



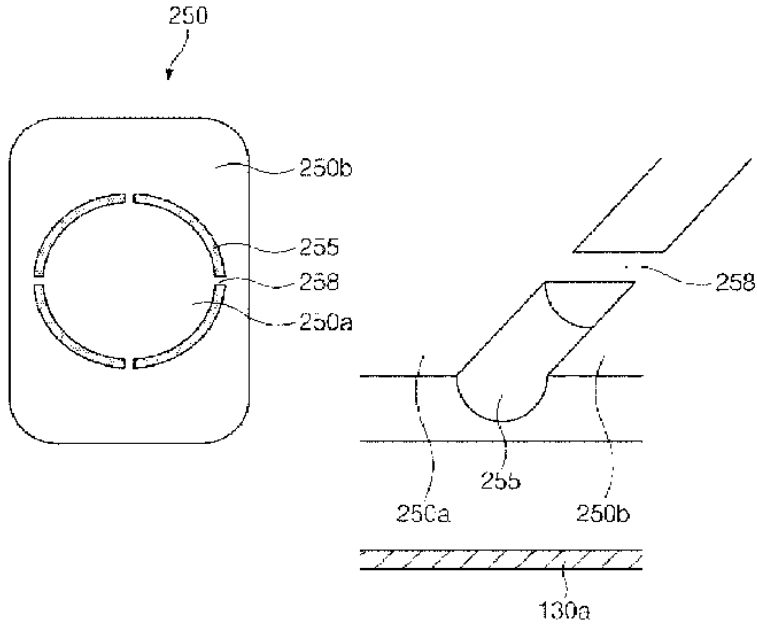
¶109: “FIG. 11 is an exemplary view in which a patterned surface of a Fresnel lens is disposed to face a sensor plane according to various exemplary embodiments.”

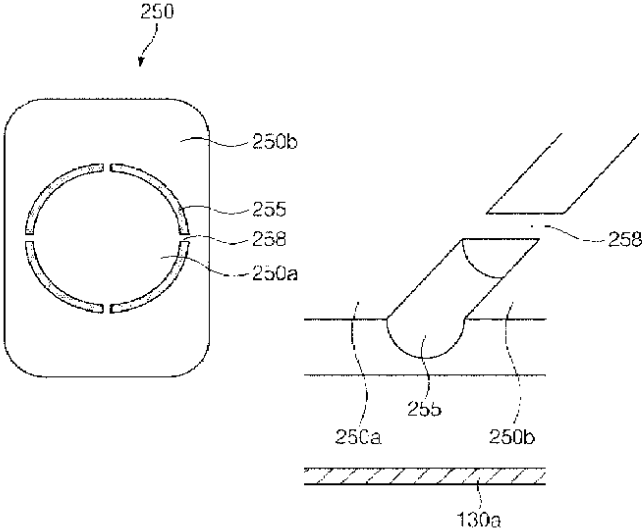
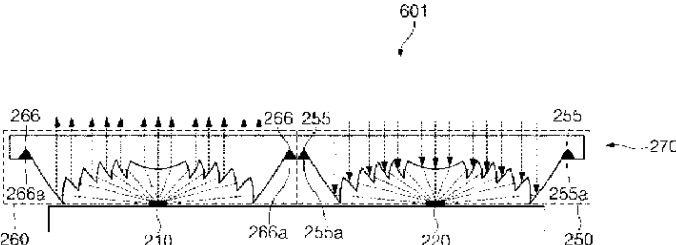
¶110: “Referring to FIG. 11, an optical sensor 1101 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 1110, a light receiver 1120, and a plurality of Fresnel lenses 1130 (including a Fresnel lens 1131 for emitting light and a Fresnel lens 1132 for receiving light).”

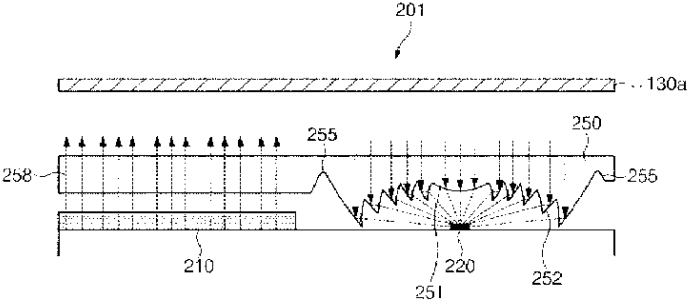
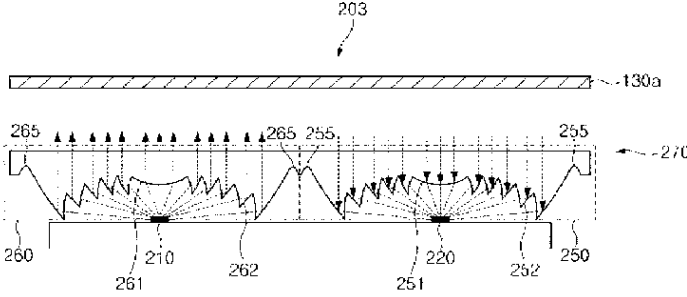
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶115: “A Fresnel lens 1132 for receiving light may be disposed at the top of a light receiver 1120 (between a sensor plane 130a and the light receiver 1120). The toothed, patterned surface of the Fresnel lens 1132 for receiving light may be disposed to face the sensor plane 130a.” Claim 1: “a first Fresnel lens disposed between the light receiver and the sensor plane...”
[1E] wherein a first surface of the first Fresnel lens total reflects the reflection light introduced in a direction perpendicular to the sensing surface, and a second surface of the first Fresnel lens refracts the total reflected light so as to be introduced to the light receiving unit.	Abstract: “An electronic device according to various exemplary embodiments of the present invention includes ... a first Fresnel lens disposed between the light receiver and the sensor plane. In this regard, a first surface of the first Fresnel lens may totally reflect the reflected light flowing in a direction perpendicular to the sensor plane and a second surface thereof may refract the totally reflected light to cause the light to flow into the light receiver.” FIG. 2A:  ¶40: “A Fresnel lens 250 for receiving light may be disposed at the top of a light receiver 220 (i.e., between a sensor plane 130a and the light receiver 220). The Fresnel lens 250 for receiving light may totally reflect and refract the light reflected from an external object (e.g., the user's body) and direct it to the light receiver 220.” See also FIG. 2C: 

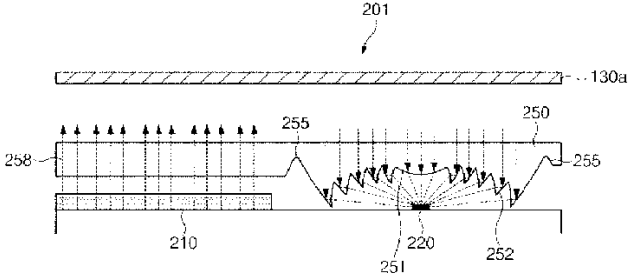
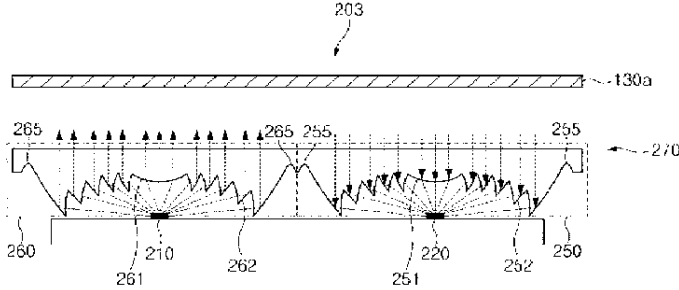
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶55: “Referring to FIG. 2C, an optical sensor 203 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 210, a light receiver 220, and a plurality of Fresnel lenses 270 (a Fresnel lens 250 for receiving light and a Fresnel lens 260 for emitting light).” ¶57: “The function or operation of a light emitter 210, a light receiver 220, a Fresnel lens 250 for receiving light, and a Fresnel lens 260 for emitting light may be the same as or similar to the function or operation of the corresponding configuration of FIGS. 2A or 2B.” ¶65: “According to various exemplary embodiments, incident light L1 (incidence angle i_1) which is incident perpendicularly to a sensor plane 130a may be totally reflected on an outer surface 252b. For example, when a Fresnel lens for receiving light 250 made of polymethyl methacrylate (PMMA) is used, the refractive index of a toothed lens 252 may be about 1.49. Since the refractive index in air is 1, total reflection may occur at the outer surface 252b if the incidence angle i_1 of incident light L1 perpendicular to the sensor plane 130a is greater than about 42 degrees.” ¶66: “According to various exemplary embodiments, the disposition angle, length, or curvature of an outer surface 252b may be determined, reflecting the properties of material (e.g., a refractive index, the distance R_n between the toothed lens 252 and the center point 0) of a Fresnel lens for emitting light 250.” ¶67: “When reflected light L1 is totally reflected on an outer surface 252b, incident light L1 may be directed toward an inner surface 252a without being emitted to the outside of a toothed lens 252.” ¶68: “An inner surface 252a may refract the light L2 (incident angle i_2) totally reflected on an outer surface 252b (refraction angle α) and direct the refracted light to a light receiver 220. Reflecting the properties of material (e.g., a refractive index, the distance R_n between a toothed lens 252 and the center point 0) of a Fresnel lens 250 for emitting light, the disposition angle, length, or curvature of the inner surface 252a may be determined.” ¶69: “Refracted light L3 may flow into a light receiver 220 and be converted into an electrical signal.” <i>See also</i> FIG. 11:

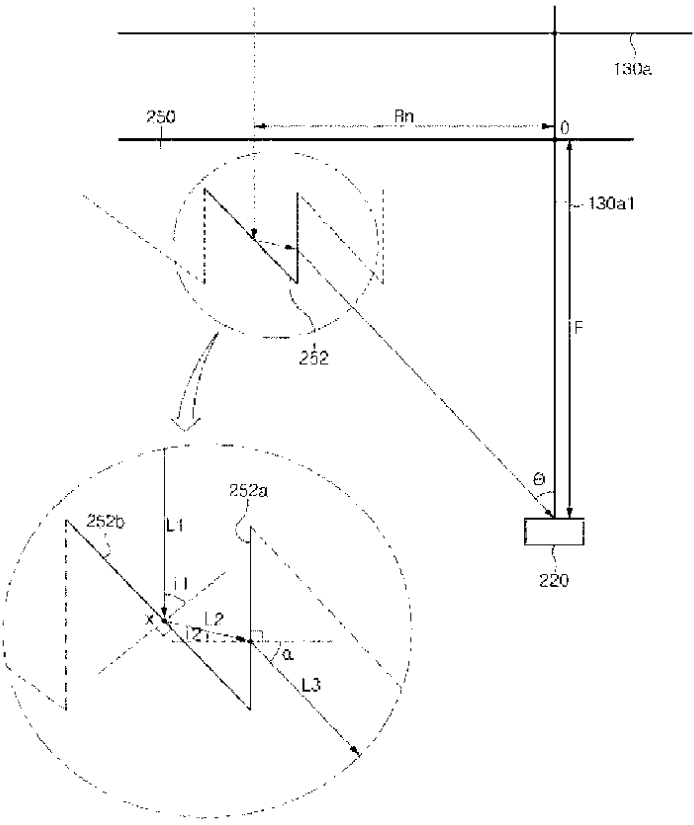
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶109: “FIG. 11 is an exemplary view in which a patterned surface of a Fresnel lens is disposed to face a sensor plane according to various exemplary embodiments.” ¶110: “Referring to FIG. 11, an optical sensor 1101 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 1110, a light receiver 1120, and a plurality of Fresnel lenses 1130 (including a Fresnel lens 1131 for emitting light and a Fresnel lens 1132 for receiving light).” ¶115: “A Fresnel lens 1132 for receiving light may be disposed at the top of a light receiver 1120 (between a sensor plane 130a and the light receiver 1120). ... The Fresnel lens 1132 for receiving light may refract and totally reflect the light reflected from an external object (e.g., the user's body) to direct it to the light receiver 1120.” Claim 1: “wherein a first surface of the first Fresnel lens totally reflects the reflected light flowing in a direction perpendicular to the sensor plane, and a second surface thereof refracts the totally reflected light, allowing it to flow into the light receiver.”
2. The electronic device of claim 1, wherein the first Fresnel lens includes a notch between a point corresponding to the light emitting unit and a point corresponding to the light receiving unit.	¶44: “According to various exemplary embodiments, a Fresnel lens for receiving light 250 may include a notch 255. The notch 255 may have a groove shape formed on a surface where the Fresnel lens 250 for receiving light faces a light receiver 220. The notch 255 may prevent the light output from a light emitter 210 from directly flowing into the light receiver 220 without being reflected to an external object (i.e., cross-talk). Additional information regarding the notch 255 may be provided through FIG. 5.” FIG. 5:

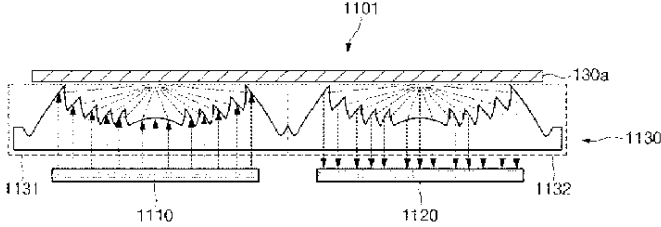
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	 ¶83: “Referring to FIG. 5, a Fresnel lens 250 for receiving light may include a notch 255. The notch 255 may prevent the light output from a light emitter 210 from directly flowing into a light receiver 220 without being reflected to an external object (i.e., cross-talk).” ¶84: “A notch 255 may be disposed between a central area 250a of a Fresnel lens 250 for receiving light and a peripheral area 250b thereof. The notch 255 may have a circular or arc shape surrounding the central area 250a. The notch 255 may have a groove shape formed on a surface where the Fresnel lens 250 for receiving light faces a light receiver 220.” Claim 2.
3. The electronic device of claim 2, wherein the first Fresnel lens further includes a support member configured to separate the notch.	FIG. 5:

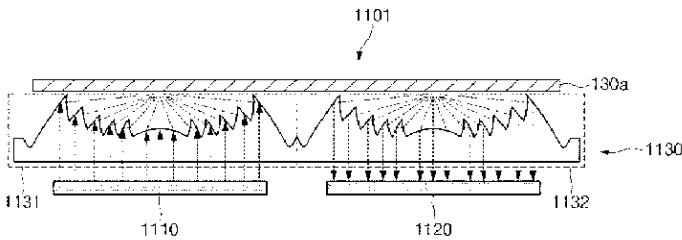
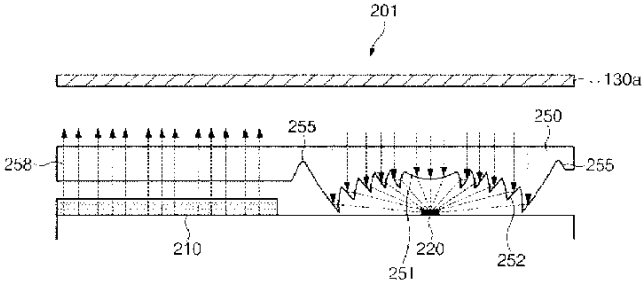
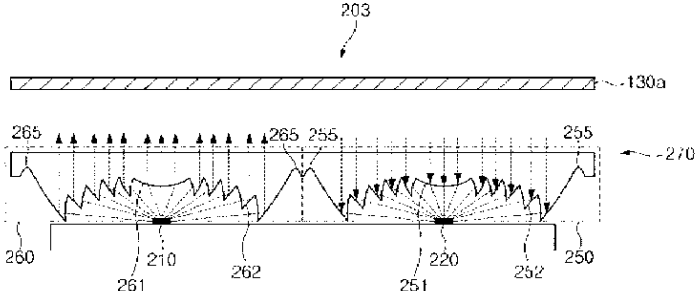
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	 ¶85: “According to various exemplary embodiments, a Fresnel lens 250 may include a support structure 258 (or a non-grooved portion of a notch 255). The support structure 258 may separate the notch 255. The support structure 258 may prevent the Fresnel lens 250 for receiving light from breaking as the notch 255 is formed.” Claim 3.
4. The electronic device of claim 2, further comprising a reinforcement material satisfying a specified light absorption rate in the notch.	FIG. 6:  ¶86: “FIG. 6 is an exemplary view of inserting a reinforcement into a notch according to various exemplary embodiments.” ¶91: “According to various exemplary embodiments, notches 255 and 265 may be filled with reinforcements 255a and 266a having good light absorption. The notches 255 and 265 may be filled with the reinforcements 255a and 266a in their entirety or only in part.” ¶139: “According to various exemplary embodiments, the first Fresnel lens may include a notch between a point corresponding to the light emitter and a point corresponding to the light receiver. The first Fresnel lens may

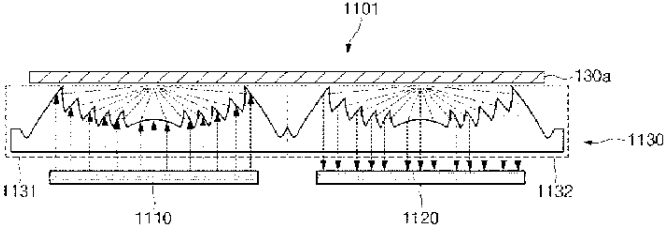
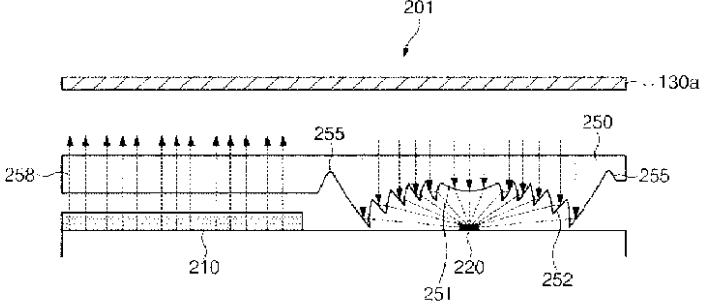
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	further include a support for separating the notch. The notch may be filled with a reinforcement that satisfies the specified light absorption rate.” Claim 4.
5. The electronic device of claim 1, wherein the first Fresnel lens includes one of poly methyl methacrylate (PMMA), acryl, and glass materials.	¶40: “The Fresnel lens for receiving light 250 may be implemented with the following materials: poly methyl methacrylate (PMMA), acryl, or glass material.” ¶140: “According to various exemplary embodiments, the first Fresnel lens may include one material among poly methyl methacrylate (PMMA), acryl, and glass.” Claim 5.
6. The electronic device of claim 1, wherein at least a portion of the first Fresnel lens includes a sawtooth shape, and	FIG. 2A:  ¶41: “According to various exemplary embodiments, a Fresnel lens for receiving light 250 may include a central lens 251 and a toothed lens 252.” See also FIG. 2C:  ¶57: “The function or operation of a light emitter 210, a light receiver 220, a Fresnel lens 250 for receiving light, and a Fresnel lens 260 for emitting light may be the same as or similar to the function or operation of the corresponding configuration of FIGS. 2A or 2B.”

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	Claim 6: “wherein at least a portion of the first Fresnel lens comprises a toothed shape and the toothed shape protrudes toward the light receiver.”
wherein the sawtooth shape protrudes toward the light receiving unit.	FIG. 2A:  ¶42: “In one exemplary embodiment, the toothed lens 252 may be in the shape of protruding towards a light receiver 220.” See also FIG. 2C:  ¶57: “The function or operation of a light emitter 210, a light receiver 220, a Fresnel lens 250 for receiving light, and a Fresnel lens 260 for emitting light may be the same as or similar to the function or operation of the corresponding configuration of FIGS. 2A or 2B.” Claim 6: “wherein at least a portion of the first Fresnel lens comprises a toothed shape and the toothed shape protrudes toward the light receiver.”
7. The electronic device of claim 6, wherein the sawtooth shape allows a light incident perpendicularly to the sensing surface to be total reflected at the	¶43: “According to various exemplary embodiments, a toothed lens 252 may direct reflected light incident perpendicularly to a sensor plane 130a to a light receiver 220 through total reflection and refraction. Further information regarding total reflection and refraction of the reflected light in the toothed lens 252 may be provided via FIG. 3.” FIG. 3:

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
first surface at a first distance from a center of the first Fresnel lens and the total reflected light to be refracted at a specified angle at the second surface at a second distance shorter than the first distance.	 ¶62: “Referring to FIG. 3, a Fresnel lens 250 for receiving light may be disposed at the top of a light receiver 220 (i.e., between a sensor plane 130a and the light receiver 220). The Fresnel lens 250 for receiving light may totally reflect and refract the reflected light L1 from an external object (e.g., the user’s body) and direct it to the light receiver 220. In one exemplary embodiment, a center point 0 of the Fresnel lens 250 for receiving light and a center point of the light receiver 220 may be disposed on a normal 130a1 perpendicular to the sensor plane 130a.” ¶63: “The Fresnel lens 250 for receiving light may include one or more toothed lenses 252. It may include an inner surface 252a relatively close to the center point 0 of the Fresnel lens 250 for receiving light and an outer surface 252b relatively far from the center point 0.” ¶64: “According to one exemplary embodiment, the inner surface 252a may form a first angle with a sensor plane 130a. The outer surface 252b may form a second angle with the sensor plane 130a. The first angle may be greater than the second angle.”

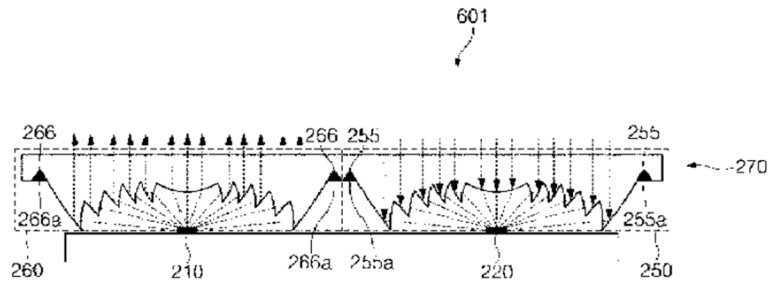
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶65: “According to various exemplary embodiments, incident light L1 (incidence angle i_1) which is incident perpendicularly to a sensor plane 130a may be totally reflected on an outer surface 252b.” ¶67: “When reflected light L1 is totally reflected on an outer surface 252b, incident light L1 may be directed toward an inner surface 252a without being emitted to the outside of a toothed lens 252.” ¶68: “An inner surface 252a may refract the light L2 (incident angle i_2) totally reflected on an outer surface 252b (refraction angle α) and direct the refracted light to a light receiver 220.” Claim 7: “wherein the toothed shape may generate total reflection on a first surface of a first distance at the center of the first Fresnel lens and refraction on a second surface of a second distance shorter than the first distance, with respect to the light incident perpendicularly to the sensor plane.”
8. The electronic device of claim 1, wherein at least a portion of the first Fresnel lens includes a sawtooth shape, and	FIG. 11:  ¶109: “FIG. 11 is an exemplary view in which a patterned surface of a Fresnel lens is disposed to face a sensor plane according to various exemplary embodiments.” ¶110: “Referring to FIG. 11, an optical sensor 1101 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 1110, a light receiver 1120, and a plurality of Fresnel lenses 1130 (including a Fresnel lens 1131 for emitting light and a Fresnel lens 1132 for receiving light).” ¶115: “A Fresnel lens 1132 for receiving light may be disposed at the top of a light receiver 1120 (between a sensor plane 130a and the light receiver 1120). The toothed, patterned surface of the Fresnel lens 1132 for receiving light may be disposed to face the sensor plane 130a.” Claims 6, 8.

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
wherein the sawtooth shape protrudes toward the sensing surface.	FIG. 11:  ¶115: “A Fresnel lens 1132 for receiving light may be disposed at the top of a light receiver 1120 (between a sensor plane 130a and the light receiver 1120). The toothed, patterned surface of the Fresnel lens 1132 for receiving light may be disposed to face the sensor plane 130a.” Claims 6, 8.
9. The electronic device of claim 1, wherein the first Fresnel lens includes a convex lens shape in a central area aligned with the light receiving unit.	FIG. 2A:  ¶41: “According to various exemplary embodiments, a Fresnel lens for receiving light 250 may include a central lens 251 and a toothed lens 252. The central lens 251 may be disposed in a central area of the Fresnel lens for receiving light 250. The central lens 251 may have a similar shape to a typical convex lens. In one exemplary embodiment, a center point of the central lens 251 and a center point of a light receiver 220 may be disposed on a normal perpendicular to a sensor plane 130a.” See also FIG. 2C: 

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶57: “The function or operation of a light emitter 210, a light receiver 220, a Fresnel lens 250 for receiving light, and a Fresnel lens 260 for emitting light may be the same as or similar to the function or operation of the corresponding configuration of FIGS. 2A or 2B.” <i>See also</i> FIG. 11:  Claim 9: “wherein the first Fresnel lens comprises a convex lens shape in a central area aligned with the light receiver.”
10. The electronic device of claim 1, wherein the first Fresnel lens is elongated between the light emitting unit and the sensing surface.	FIG. 2A:  ¶45: “According to various exemplary embodiments, an extension 258 of a Fresnel lens 250 for receiving light may be disposed between a light emitter 210 and a sensor plane 130a. The extension 258 may be integrally formed with the Fresnel lens 250 for receiving light. The Fresnel lens 250 may transmit the light generated from the light emitter 210.” The above figure depicts that the first Fresnel lens (250) is elongated between the light emitting unit (210) and the sensing surface (130a). Claim 10: “wherein the first Fresnel lens extends between the light emitter and the sensor plane.”
11. The electronic device of claim 1, further comprising a second Fresnel	FIG. 2B:

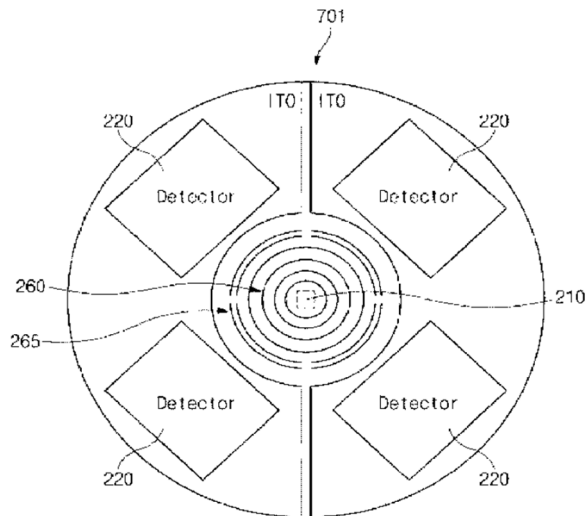
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
lens disposed between the light emitting unit and the sensing surface.	¶47: “A Fresnel lens 260 for emitting light may be disposed at the top of a light emitter 210 (i.e., between a sensor plane 130a and the light emitter 210).” FIG. 2C: ¶55: “Referring to FIG. 2C, an optical sensor 203 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 210, a light receiver 220, and a plurality of Fresnel lenses 270 (a Fresnel lens 250 for receiving light and a Fresnel lens 260 for emitting light).” ¶56: “FIG. 2C illustrates an exemplary case in which a Fresnel lens for receiving light 250 and a Fresnel lens 260 for emitting light are integrally formed, but is not limited thereto. For example, the Fresnel lens 250 for receiving light and the Fresnel lens 260 for emitting light may be formed and disposed separately from each other.” ¶57: “The function or operation of a light emitter 210, a light receiver 220, a Fresnel lens 250 for receiving light, and a Fresnel lens 260 for emitting light may be the same as or similar to the function or operation of the corresponding configuration of FIGS. 2A or 2B.”

FIG. 6:



¶87: “Referring to FIG. 6, an optical sensor 601 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 210, a light receiver 220, and a plurality of Fresnel lenses 270 (including a Fresnel lens 250 for receiving light and a Fresnel lens 260 for emitting light).”

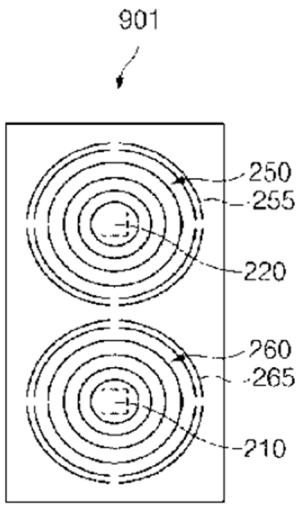
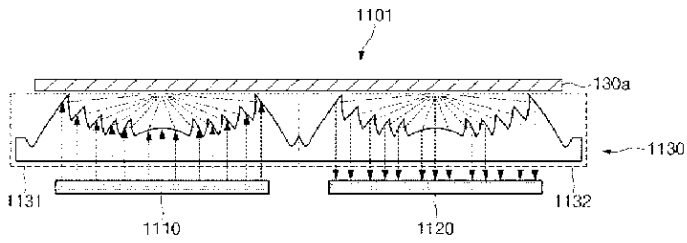
FIG. 7:

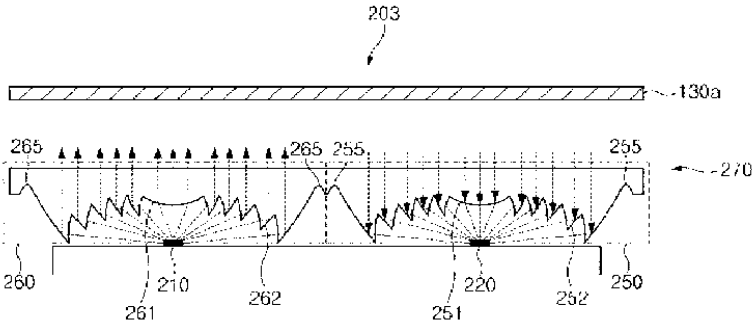


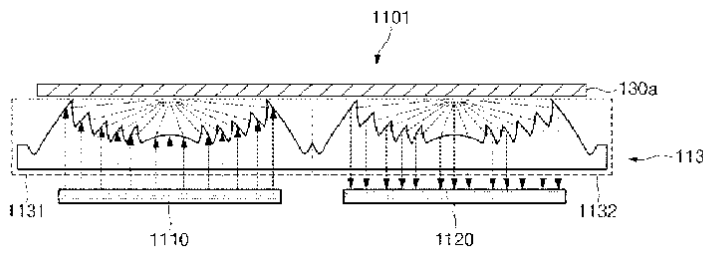
¶92: “FIG. 7 illustrates a configuration form of an optical sensor having one light emitter and a plurality of light receivers according to various exemplary embodiments. Fig. 7 is illustrative and not limited thereto.”

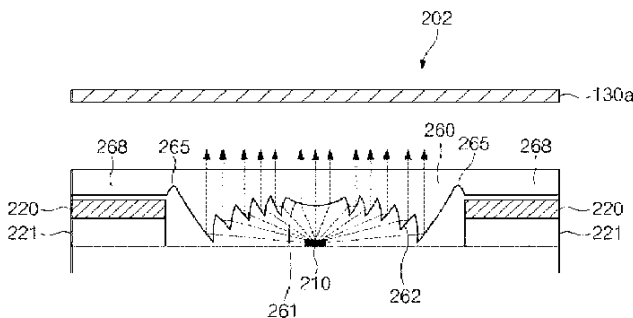
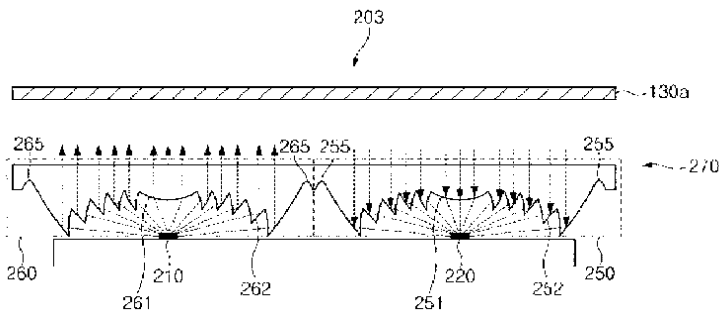
¶93: “Referring to FIG. 7, an optical sensor 701 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include one light emitter 210, one Fresnel lens 260 for emitting light, and a plurality of light receivers 220.”

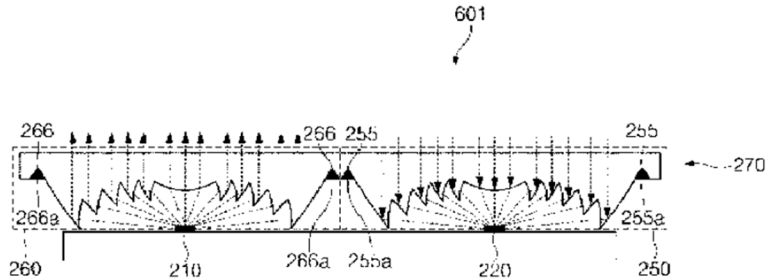
¶94: “A light emitter 210 may be disposed at the center of an optical sensor 701. In one exemplary embodiment, the light emitter 210 may be in the

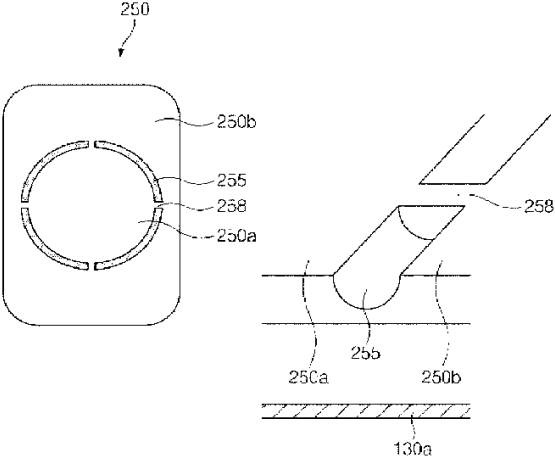
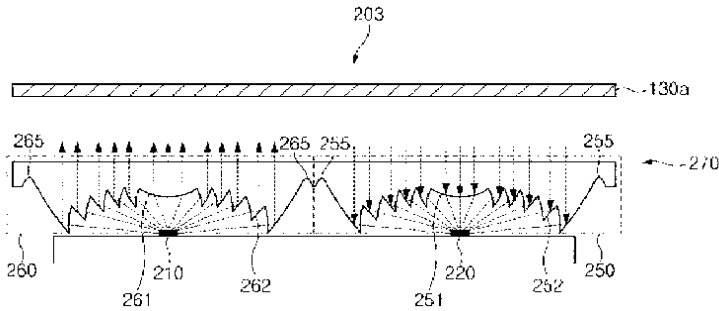
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	form of a plurality of small light sources combined. A Fresnel lens 260 for emitting light may be disposed on the upper part (a surface on which light is output, a surface facing a sensor plane) of the light emitter 210.” FIG. 9:  ¶104: “Referring to FIG. 9, an optical sensor 901 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include one light emitter 210, one Fresnel lens 260 for emitting light, one light receiver 220, and one Fresnel lens 250 for receiving light. The Fresnel lens 260 for emitting light and the Fresnel lens 250 for receiving light may include notches 265 and 255, respectively.” ¶105: “The optical sensor 901 is equipped with one light emitter 210 and one light receiver 220, so that it may be mounted in a space smaller than the optical sensors 701 and 801 in FIGS. 7 and 8. The light emitter 210 and the light receiver 220 may be installed without a separate partition, so that mounting efficiency may be improved. For example, the optical sensor 901 may be mounted on a wearable device, such as a smart necklace or a smart ring, with a relatively small mounting space.” FIG. 11: 

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶109: “FIG. 11 is an exemplary view in which a patterned surface of a Fresnel lens is disposed to face a sensor plane according to various exemplary embodiments.” ¶110: “Referring to FIG. 11, an optical sensor 1101 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 1110, a light receiver 1120, and a plurality of Fresnel lenses 1130 (including a Fresnel lens 1131 for emitting light and a Fresnel lens 1132 for receiving light).” ¶113: “A Fresnel lens 1131 for emitting light may be disposed at the top of a light emitter 1110 (between a sensor plane 130a and the light emitter 1110).” ¶114: “A Fresnel lens 1131 for emitting light supports total reflection, allowing the light output from a light emitter 1110 to turn to a different direction up to about 90 degrees. This allows light incident parallel to the Fresnel lens 1131 for emitting light from the light emitter 1110 to be concentrated at a first point A of a sensor plane 130a.” ¶145: “According to various exemplary embodiments, the electronic device may further include a second Fresnel lens disposed between the light emitter and the sensor plane.” Claim 11: “The electronic device of claim 1, further comprising: a second Fresnel lens disposed between the light emitter and the sensor plane.”
12. The electronic device of claim 11, further comprising a notch between the first Fresnel lens and the second Fresnel lens.	FIG. 2C:  ¶89: “According to various exemplary embodiments, a Fresnel lens 260 for emitting light and a Fresnel lens 250 for receiving light may include notches 265 and 255, respectively. The notches 265 and 255 formed between the

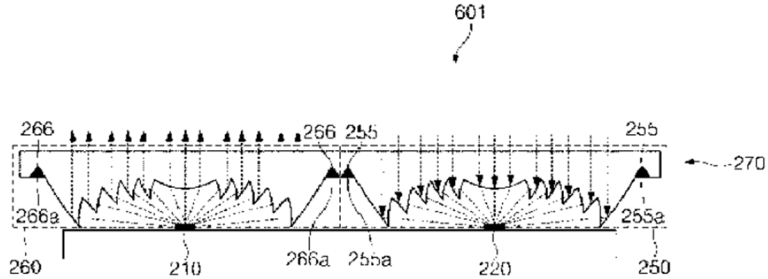
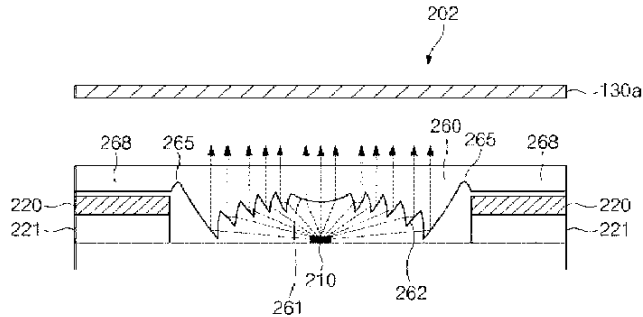
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	Fresnel lens 260 for emitting light and the Fresnel lens 250 for receiving light may be integrated into one groove.” FIG. 11:  Claim 12: “The electronic device of claim 11, comprising a notch between the first Fresnel lens and the second Fresnel lens.” Claim 14: “The electronic device of claim 13, wherein the first Fresnel lens comprises a notch between a point corresponding to the light emitter and a point corresponding to the light receiver.”
[13 Preamble] 13. An electronic device comprising:	<i>See disclosure of Chung's Korean Priority Application identified above for Chung claim element [1 Preamble].</i>
[13A] a housing including a sensing surface;	<i>See disclosure of Chung's Korean Priority Application identified above for Chung claim element [1A].</i>
[13B] a light emitting unit configured to output a light through the sensing surface;	<i>See disclosure of Chung's Korean Priority Application identified above for Chung claim element [1B].</i>
[13C] a light receiving unit configured to collect a reflection light reflected from an external object in contact with the sensing surface, after the light is output	<i>See disclosure of Chung's Korean Priority Application identified above for Chung claim element [1C].</i>

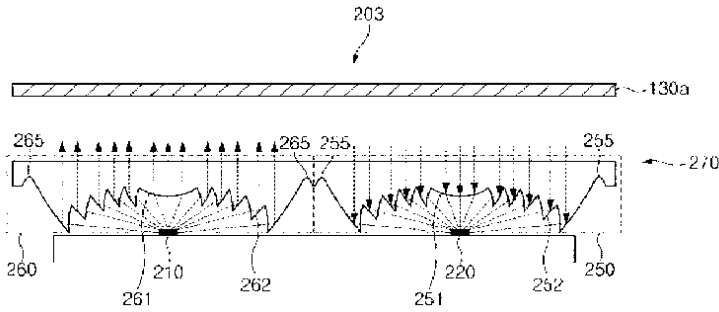
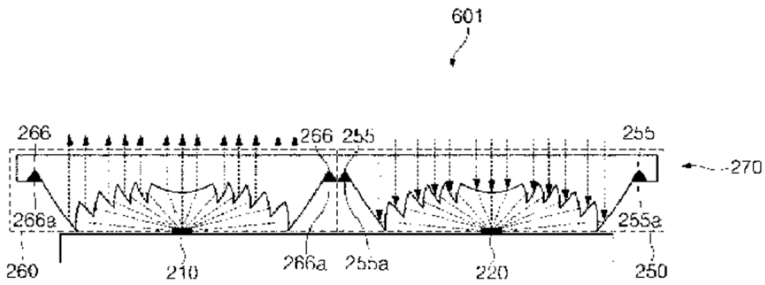
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
from the light emitting unit; and	
[13D] a first Fresnel lens disposed between the light emitting unit and the sensing surface,	See disclosure of Chung's Korean Priority Application identified above for Chung claim 11.
[13E] wherein a first surface of the first Fresnel lens refracts the light output from the light emitting unit, and a second surface of the first Fresnel lens total reflects the refracted light so as to be emitted to be perpendicular to the sensing surface.	FIG. 2B:  ¶47: “A Fresnel lens 260 for emitting light may be disposed at the top of a light emitter 210 (i.e., between a sensor plane 130a and the light emitter 210). The Fresnel lens 260 for emitting light may refract and totally reflect the light generated from the light emitter 210 to cause the light to be incident perpendicularly to the sensor plane 130a.”
	FIG. 2C:  ¶55: “Referring to FIG. 2C, an optical sensor 203 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 210, a light receiver 220, and a plurality of Fresnel lenses 270 (a Fresnel lens 250 for receiving light and a Fresnel lens 260 for emitting light).” ¶57: “The function or operation of a light emitter 210, a light receiver 220, a Fresnel lens 250 for receiving light, and a Fresnel lens 260 for emitting

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	light may be the same as or similar to the function or operation of the corresponding configuration of FIGS. 2A or 2B.” FIG. 6:  ¶87: “Referring to FIG. 6, an optical sensor 601 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B) may include a light emitter 210, a light receiver 220, and a plurality of Fresnel lenses 270 (including a Fresnel lens 250 for receiving light and a Fresnel lens 260 for emitting light).” ¶147: “An electronic device (e.g., the electronic device 101 of FIG. 1A or the electronic device 102 of FIG. 1B) according to various exemplary embodiments may include a housing (e.g., the housing 120 of FIG. 1A or the housing 170 of FIG. 1B) including a sensor plane (e.g., the sensor plane 130a of FIG. 2C); a light emitter (e.g., the light emitter 210 of FIG. 2C) generating the light radiated to the outside via the sensor plane; a light receiver (e.g., the light receiver 220 of FIG. 2C) collecting the light reflected from an external object in contact with the sensor plane; and a first Fresnel lens (e.g., the Fresnel lens 260 of FIG. 2C) disposed between the light emitter and the sensor plane. In this regard, a first surface of the first Fresnel lens may refract the light generated from the light emitter and a second surface thereof may totally reflect the refracted light, allowing it to be emitted perpendicularly to the sensor plane.” Claim 13: “a first Fresnel lens disposed between the light emitter and the sensor plane, wherein a first surface of the first Fresnel lens refracts the light generated from the light emitter and a second surface totally reflect the refracted light, allowing it to be emitted perpendicularly to the sensor plane.”
14. The electronic device of claim 13, wherein the first Fresnel lens	¶52: “According to various exemplary embodiments, a Fresnel lens 260 for emitting light may include a notch 265. The notch 265 may have a groove shape formed on a surface where the Fresnel lens 260 for emitting light faces a light emitter 210. The notch 265 may prevent the light output from

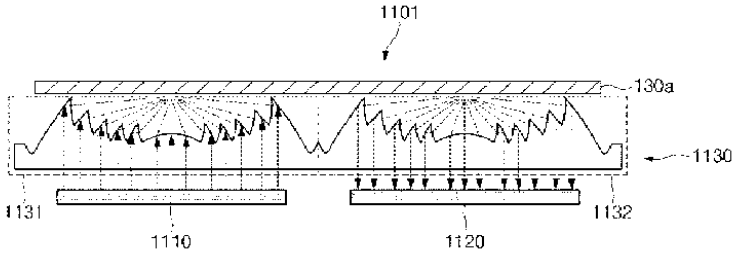
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
includes a notch between a point corresponding to the light emitting unit and a point corresponding to the light receiving unit.	a light emitter 210 from directly flowing into a light receiver 220 without being reflected to an external object (i.e., cross-talk). Additional information regarding the notch 265 may be provided through FIG. 5.” FIG. 5:  ¶82: “FIG. 5 illustrates the structure of a notch formed in a Fresnel lens according to various exemplary embodiments. FIG. 5 mainly describes a Fresnel lens 250 for receiving light, but may also be applied to a Fresnel lens 260 for emitting light.” ¶84: “A notch 255 may be disposed between a central area 250a of a Fresnel lens 250 for receiving light and a peripheral area 250b thereof. The notch 255 may have a circular or arc shape surrounding the central area 250a. The notch 255 may have a groove shape formed on a surface where the Fresnel lens 250 for receiving light faces a light receiver 220.” FIG. 2C:  FIG. 6:

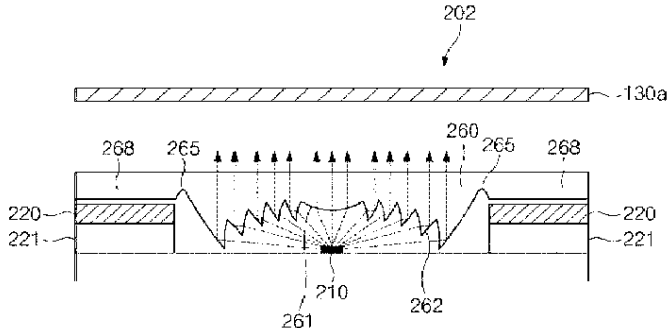
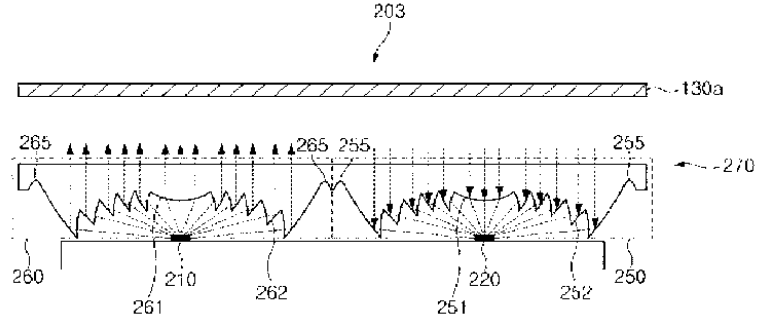
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶139: “According to various exemplary embodiments, the first Fresnel lens may include a notch between a point corresponding to the light emitter and a point corresponding to the light receiver. The first Fresnel lens may further include a support for separating the notch. The notch may be filled with a reinforcement that satisfies the specified light absorption rate.” ¶148: “According to various exemplary embodiments, the first Fresnel lens may include a notch between a point corresponding to the light emitter and a point corresponding to the light receiver.” Claim 14: “The electronic device of claim 13, wherein the first Fresnel lens comprises a notch between a point corresponding to the light emitter and a point corresponding to the light receiver.”
15. The electronic device of claim 14, wherein the first Fresnel lens further includes a support member configured to separate the notch.	FIG. 5: ¶82: “FIG. 5 illustrates the structure of a notch formed in a Fresnel lens according to various exemplary embodiments. FIG. 5 mainly describes a Fresnel lens 250 for receiving light, but may also be applied to a Fresnel lens 260 for emitting light.”

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶85: “According to various exemplary embodiments, a Fresnel lens 250 may include a support structure 258 (or a non-grooved portion of a notch 255). The support structure 258 may separate the notch 255. The support structure 258 may prevent the Fresnel lens 250 for receiving light from breaking as the notch 255 is formed.” FIG. 6:  ¶139: “According to various exemplary embodiments, the first Fresnel lens may include a notch between a point corresponding to the light emitter and a point corresponding to the light receiver. The first Fresnel lens may further include a support for separating the notch. The notch may be filled with a reinforcement that satisfies the specified light absorption rate.” ¶149: “According to various exemplary embodiments, the first Fresnel lens may further include a support for separating the notch.” Claim 15: “The electronic device of claim 14, wherein the first Fresnel lens further comprises a support separating the notch.”
16. The electronic device of claim 13, wherein at least a portion of the first Fresnel lens includes a sawtooth shape, and wherein the sawtooth shape protrudes toward the light emitting unit.	FIG. 2B:  ¶49: “A Fresnel lens 260 for emitting light may include a central lens 261 and a toothed lens 262.”

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶50: “A toothed lens 262 may be disposed in the shape of an arc surrounding the periphery of a central lens 261. The toothed lens 262 may have a larger arc as it moves away further from the central lens 261. The toothed lenses 262 may be disposed in a plurality of numbers and may have a symmetric shape based on a center point of the central lens 261. In one exemplary embodiment, the toothed lens 262 may be in the shape of protruding toward a light emitter 210.” FIG. 2C:  ¶57: “The function or operation of a light emitter 210, a light receiver 220, a Fresnel lens 250 for receiving light, and a Fresnel lens 260 for emitting light may be the same as or similar to the function or operation of the corresponding configuration of FIGS. 2A or 2B.” FIG. 6:  ¶150: “According to various exemplary embodiments, at least a portion of the first Fresnel lens may include a toothed shape, which may protrude toward the light emitter.” Claim 16: “wherein at least a portion of the first Fresnel lens comprises a toothed shape and the toothed shape protrudes toward the light emitter.”
17. The electronic device of claim 16, wherein the	FIG. 3:

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
sawtooth shape allows the light output from the light emitting unit to be refracted at the first surface at a first distance from a center of the first Fresnel lens and the light refracted at the first surface to be total reflected at the second surface at a second distance longer than the first distance.	¶61: “FIG. 3 shows the progression of light in a toothed lens of a Fresnel lens according to various exemplary embodiments. FIG. 3 illustrates an exemplary case where reflected light is incident on a light receiver, but may also be applied when light is generated from a light emitter. The path of movement of light in the light emitter and the Fresnel lens for emitting light may be in the opposite direction to FIG. 3.” ¶62: “Referring to FIG. 3, a Fresnel lens 250 for receiving light may be disposed at the top of a light receiver 220 (i.e., between a sensor plane 130a and the light receiver 220). The Fresnel lens 250 for receiving light may totally reflect and refract the reflected light L1 from an external object (e.g., the user’s body) and direct it to the light receiver 220. In one exemplary embodiment, a center point 0 of the Fresnel lens 250 for receiving light and a center point of the light receiver 220 may be disposed on a normal 130a1 perpendicular to the sensor plane 130a.” ¶63: “The Fresnel lens 250 for receiving light may include one or more toothed lenses 252. It may include an inner surface 252a relatively close to the center point 0 of the Fresnel lens 250 for receiving light and an outer surface 252b relatively far from the center point 0.”

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶64: “According to one exemplary embodiment, the inner surface 252a may form a first angle with a sensor plane 130a. The outer surface 252b may form a second angle with the sensor plane 130a. The first angle may be greater than the second angle.” ¶65: “According to various exemplary embodiments, incident light L1 (incidence angle i_1) which is incident perpendicularly to a sensor plane 130a may be totally reflected on an outer surface 252b.” ¶67: “When reflected light L1 is totally reflected on an outer surface 252b, incident light L1 may be directed toward an inner surface 252a without being emitted to the outside of a toothed lens 252.” ¶68: “An inner surface 252a may refract the light L2 (incident angle i_2) totally reflected on an outer surface 252b (refraction angle α) and direct the refracted light to a light receiver 220.”
18. The electronic device of claim 13, wherein at least a portion of the first Fresnel lens includes a sawtooth shape, and	See disclosure of Chung's Korean Priority Application identified above for Chung claim 16.
wherein the sawtooth shape protrudes toward the sensing surface.	FIG. 11:  ¶113: “A Fresnel lens 1131 for emitting light may be disposed at the top of a light emitter 1110 (between a sensor plane 130a and the light emitter 1110). The toothed, patterned surface of the Fresnel lens 1131 for emitting light may be disposed to face the sensor plane 130a.”

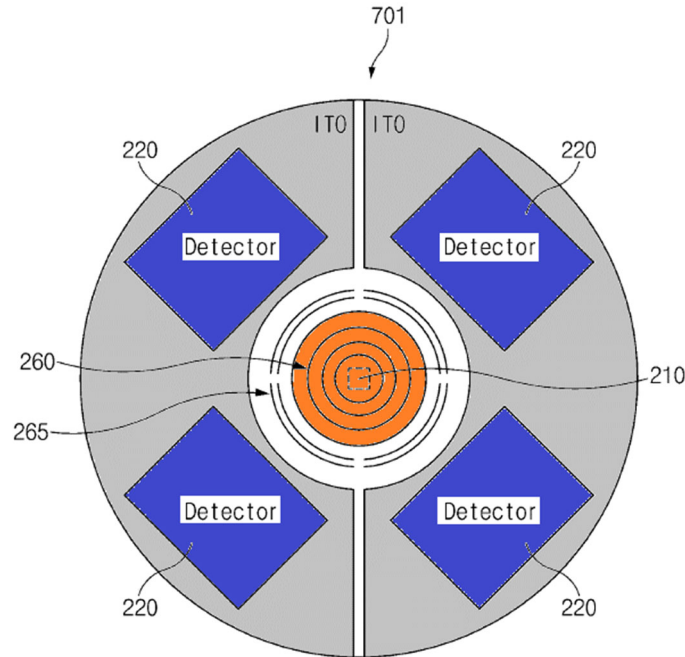
Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶142: “According to various exemplary embodiments, at least a portion of the first Fresnel lens may include a toothed shape, which may protrude toward the sensor plane.” ¶151: “According to various exemplary embodiments, at least a portion of the first Fresnel lens may include a toothed shape, which may protrude toward the sensor plane.” Claim 18: “The electronic device of claim 13, wherein at least a portion of the first Fresnel lens comprises a toothed shape and the toothed shape protrudes toward the sensor plane.”
19. The electronic device of claim 13, wherein the first Fresnel lens includes a convex lens shape in a central area aligned with the light emitting unit.	FIG. 2B:  ¶49: “A Fresnel lens 260 for emitting light may include a central lens 261 and a toothed lens 262. The central lens 261 may be disposed in a central area of the Fresnel lens 260 for emitting light. The central lens 261 may have a similar shape to a typical convex lens. In one exemplary embodiment, a center point of the central lens 261 and a center point of a light emitter 210 may be disposed on a normal perpendicular to a sensor plane 130a.” FIG. 2C:  FIG. 6:

Claims of Chung US2019/0324593 (Exhibit 1010)	Disclosure in Chung's Korean Priority Application Certified English Translation of Korean Pat. Appl. No. 10-2018-0038206 (Exhibit 1013)
	¶57: “The function or operation of a light emitter 210, a light receiver 220, a Fresnel lens 250 for receiving light, and a Fresnel lens 260 for emitting light may be the same as or similar to the function or operation of the corresponding configuration of FIGS. 2A or 2B.” ¶152: “According to various exemplary embodiments, the first Fresnel lens may include a convex lens shape in a central area aligned with the light emitter.” Claim 19: “The electronic device of claim 13, wherein the first Fresnel lens comprises a convex lens shape in a central area aligned with the light emitter.”
20. The electronic device of claim 13, wherein the first Fresnel lens is elongated between the light receiving unit and the sensing surface.	FIG. 2B: ¶53: “According to various exemplary embodiments, an extension 268 of a Fresnel lens 260 for emitting light may be disposed between a light receiver 220 and a sensor plane 130a. The extension 268 may be integrally formed with the Fresnel lens 260 for emitting light. The Fresnel lens 260 may transmit the reflected light flowing from the outside.” The above figure depicts that the first Fresnel lens (260) is elongated between the light receiving units (220) and the sensing surface (130a). Claim 20: “The electronic device of claim 13, wherein the first Fresnel lens extends between the light receiver and the sensor plane.”

As shown in the foregoing table, the specification of the Chung-KR-Application provides ample written description support for every claim (i.e., claims 1-20) of Chung, and thus it is my opinion that the Chung-KR-Application reasonably conveys to a POSITA that Chung's inventors were in possession of the subject matter claimed in Chung by April 2, 2018 when the Chung-KR-Application was filed. Additionally, Chung claims electronic devices comprising basic PPG sensor features that were well-known by 2018, including a housing, a sensing surface, a light emitting unit (e.g., LEDs), and a light receiving unit (e.g., photodiode(s)). Exhibit 1010, claims 1, 13. To these basic PPG sensor features, Chung's claims add: (1) a Fresnel lens between the sensing surface and the light receiving unit (*id.*, claim 1), between the light emitting unit and sensing surface (*id.*, claim 13), or between the light emitting unit and sensing surface and between the sensing surface and the light receiving unit (i.e., two Fresnel lenses) (*id.*, claim 11); (2) Fresnel lens material, notches, supporting members, and notch reinforcement material (*id.*, claims 2-5, 12, 14-15); (3) protruding sawtooth and convex shapes for the Fresnel lens (*id.*, claims 6-9, 16-19); and (4) that the Fresnel lens is elongated between the light emitting unit and the sensor surface or between the light receiving unit and the sensing surface (*id.*, claims 10, 20). In addition to describing all of the features claimed by Chung, the disclosures of the Chung-KR-Application identified in the above table explain and show a POSITA how to make the configurations of those features as recited in claims

1-20 of Chung. Accordingly, it is my opinion that a POSITA would have understood how to make and use the full scope of Chung's claims 1-20 from the disclosure of the Chung-KR-Application, and thus, that the disclosure of the Chung-KR-Application enables the claims of Chung. Therefore, in view of the Chung-KR-Application's disclosure, I understand that Chung was effectively filed the same day as the Chung-KR-Application (April 2, 2018), and thus, Chung qualifies as prior art to the D'279 Patent.

83. Chung discloses a wearable “electronic device including an optical sensor using a Fresnel lens.” Exhibit 1010 ¶¶2, 36, FIG. 1B. Chung describes and shows in FIG. 7 “an optical sensor 701 (e.g., the optical sensor 130 of FIG. 1A or the optical sensor 180 of FIG. 1B),” which is a PPG sensor, that “may be mounted on a back surface of the electronic device 102” to “emit a light to the wrist” and “collect biometric information of the user.” *Id.* ¶¶45, 49, 103, FIG. 7. Chung's optical sensor includes a Fresnel lens 260 (colored orange below) that is above a central “light emitting unit 210” (e.g., LEDs) and surrounded by “light receiving units 220 (e.g., detectors [such as photodiodes, colored blue below]).” *Id.* ¶103.



Further, as shown above in gray, the Fresnel lens of Chung's PPG sensor is surrounded by arc-shaped electrodes (labeled ITO in the figure). *Id.* ¶109. Also, Chung's PPG sensor, like any PPG sensor, necessarily requires (1) a light source such as LEDs, (2) at least one light detector such as photodiodes, and (3) at least one opening that allows light to reach and be detected by the light detector, as explained above in the discussion of Paulke. *Supra* Section IX.A.1.

B. GROUND 1: Obviousness Over Paulke, Mendelson, Bushnell, and Chung

84. I understand that the obviousness inquiry for design patents is assessed from the perspective of a designer of ordinary skill in the art. As explained above in Section VI, a designer of ordinary skill in the art would have consulted and collaborated with a POSITA, such as myself, regarding technical concepts outside

of the designer's area of expertise. Accordingly, below, I provide technical discussion from the perspective of a POSITA that is relevant to whether the Apple Watch Series 4 sensor design claimed in the D'279 Patent would have been obvious to a designer of ordinary skill in the art over Paulke, Mendelson, Bushnell, and Chung.

1. Motivation to Combine Paulke with Mendelson, Bushnell, and Chung

85. Paulke expressly suggests replacing its central blood oxygen sensor 124 with a suitable oxygen saturation sensor. Exhibit 1006, 15:9-18. PPG sensors with one or more circular arrays of rectangular photodiodes were well-known in the art many years before the July 2018 date of the D'279 Patent. Exhibit 1036, 6; Exhibit 1037, 24; Exhibit 1038, 2. Such circular arrays of rectangular photodiodes were known to improve the signal-to-noise ratio, and thus the measurement accuracy, of PPG sensors. Exhibit 1011, 4:1-65, 9:22-33, FIG. 7. Accordingly, a POSITA would have understood that Mendelson's FIG. 7 PPG sensor and Chung's FIG. 7 PPG sensor would be suitable prior art PPG sensors to use in place of Paulke's blood oxygen sensor 124. *Id.*; Exhibit 1010, FIG. 7.

86. A POSITA would have been motivated to incorporate Mendelson's FIG. 7 PPG sensor as the central circular biosensor 120 of Paulke's device. Specifically, a POSITA would have been motivated to incorporate the "radially-symmetric photodetector array" of the sensor shown in FIG. 7 of Mendelson as the

central biosensor 120 of Paulke's device, as shown below, to "maximize the detection of backscattered light," thereby increasing the signal-to-noise ratio, and thus improving the accuracy of, Paulke's sensor. Exhibit 1011, 4:6-62 (describing sensor performance-increasing benefit of "a sensor having six photodiodes arranged symmetrically around the LEDs"), 9:22-40 (explaining that Mendelson's FIG. 7 sensor, with its circular array of 12 rectangular photodiodes (16/18), "minimiz[es] some of the measurement inaccuracies" in blood oxygen sensors).

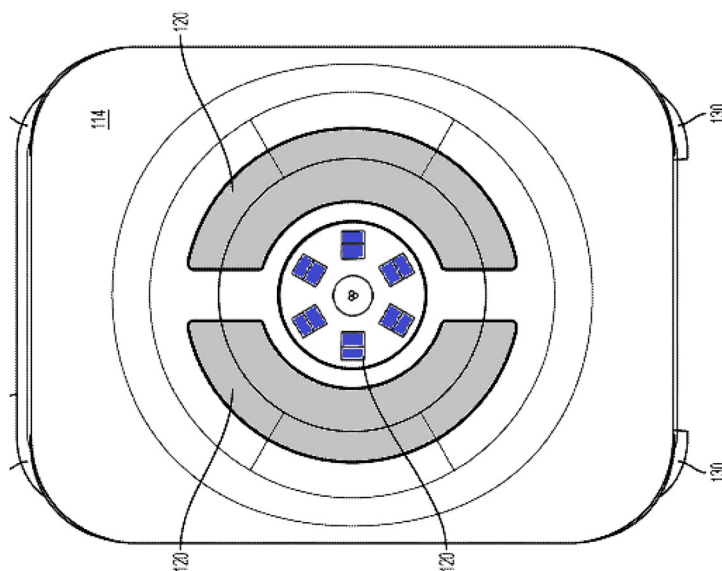


Exhibit 1006, FIG. 1G (combined with sensor from Exhibit 1011, FIG. 7). The pervasive use of radially-symmetric photodiode arrays in prior art optical sensors confirms that a POSITA in June 2018 would have been motivated to use Mendelson's well-known radially-symmetric photodiode array to improve the performance of Paulke's device using a well-known sensor design in a well-known way.

87. A POSITA further would have understood that using one of the six-photodiode arrays of Mendelson's FIG. 7 sensor with Paulke as shown below, rather than using both of Mendelson's photodiode arrays, would have considerably improved the performance of Paulke's rudimentary blood oxygen sensor 124 while being less expensive and easier to construct than Mendelson's FIG. 7 sensor because of the use of fewer photodiodes.

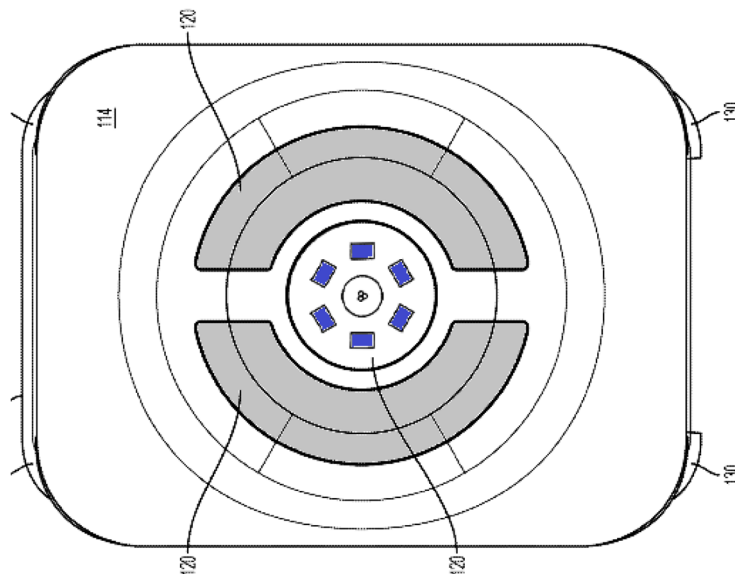


Exhibit 1006, FIG. 1G (combined with one six-photodiode array from Exhibit 1011, FIG. 7); Exhibit 1011, FIG. 7, 4:6-62 (describing sensor performance-increasing benefit of “a sensor having six photodiodes arranged symmetrically around the LEDs”), 9:22-34 (explaining FIG. 7 sensor has two six-photodiode arrays, including an outer array (16) and an inner array (18)). A POSITA also would have been motivated to use more than six photodiodes in Paulke's single radially-symmetric array to improve the sensor's signal-to-noise ratio and thus, increase the accuracy of

the sensor in a manner that was still less expensive and easier to construct than the two-array, 12-photodiode design of Mendelson's FIG. 7 sensor. Exhibit 1011, 4:6-13 (increasing the "number of photodetectors" and their overall "active area" "increases the amount of backscattered light that can be detected" and thus achieves "improvements in signal-to-noise ratio").

88. The arc-shaped electrodes disclosed by Paulke (shown in gray below) are separated by a gap, which electrically isolates the electrodes from one another.

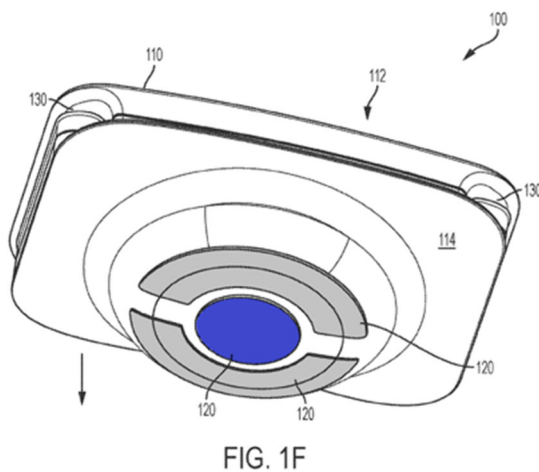


FIG. 1F

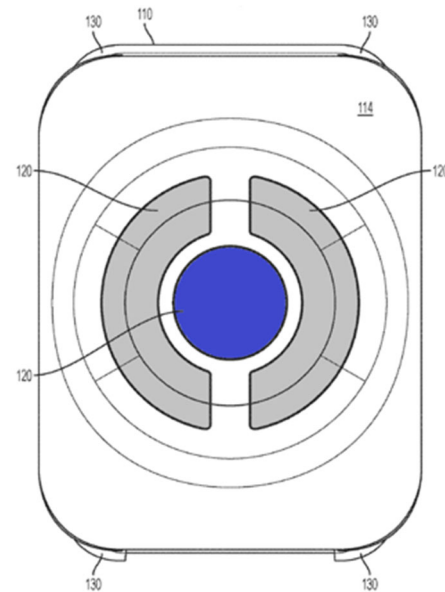


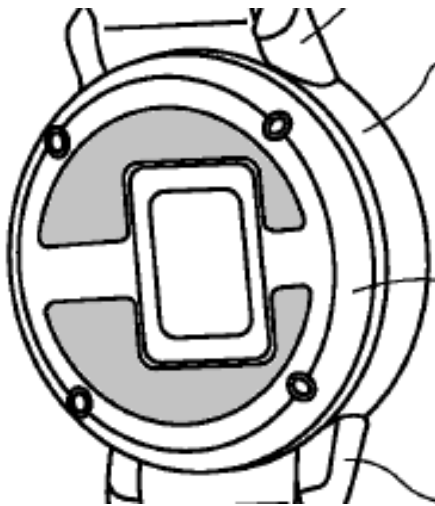
FIG. 1G

Exhibit 1006, FIGS. 1F-1G. A POSITA would understand that arc-shaped electrodes must contact the user's skin in order to measure electrical impulses or "electrodermal activity (e.g., skin conductance) of the wearer." *Id.*, 14:29-32. Paulke repeatedly discusses the importance of maintaining contact between its arc-shaped electrodes 120 and the user's skin. *Id.*, 15:3-5 (teaching that "biosensors 120

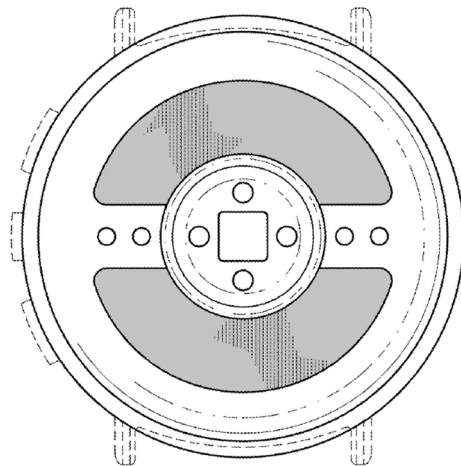
may protrude by any suitable amount ... to help maintain contact between biosensors 120 and the wearer's wrist when the biosensor module 100 is worn"), 5:31-32 ("[T]he wearable articles may hold the biosensors in a way that promotes accuracy of the measurements by the biosensors."), 6:5-7 ("Some embodiments relate to a wearable article housing one or more electronic components that maintains one or more of the electronic components in contact with the wearer's wrist."), 13:13-16 ("one or more biosensors positioned and configured to be held by the wrist band assembly in contact with ... the wearer's wrist"), 16:1-4 ("the module housing the sensor(s) may be designed to ... maintain contact between the sensor(s) and the wearer's body surface as the body surface moves."). A POSITA would have understood that Paulke suggests maximizing the area of its arc-shaped electrodes by teaching that "[a]ny suitable arrangement, alignment, shape, size, etc., of biosensor(s) may be utilized, and different configurations may be desirable" *Id.*, 15:22-24. A POSITA also would have known that it was advantageous to "increase the contact area of the skin-to-electrode interface to maintain lower impedance and exhibit better behavior in reducing motion artifacts." Exhibit 1043, 10. Accordingly, in view of these teachings, a POSITA would have been motivated to extend the ends of Paulke's arc-shaped electrodes closer together to maximize the surface area of the arc-shaped electrodes for contacting the user's skin. This motivation is consistent with the disclosure of Apple's own utility patent on the

Apple Watch Series 4 sensor design, which teaches that the “first and second electrodes 412, 414” can be “arc-shaped” and “sized” to “improve electrical sensor efficiency” by “providing a sufficient area to provide good electrical contact between the electrodes 412, 414 and the skin” while avoiding interference with electrical structures like wireless charging coils or optical sensors. Exhibit 1024, 17:22-31.

89. The arc-shaped electrodes (shown in gray below) of Yuen (below, left) and Fong (below, right) are also separated by a gap that electrically isolates the electrodes from one another.



Yuen (Exhibit 1007, FIG. 1B)



Fong (Exhibit 1008, FIG. 4)

As with Paulke’s arc-shaped electrodes, a POSITA would have been motivated to extend the ends of Yuen and Fong’s arc-shaped electrodes closer together to maximize the arc-shaped electrodes’ available surface area for contacting the user’s skin, as explained above with respect to Paulke.

90. As explained above, the Apple Watch Series 4 underlying the claimed design includes a charging coil between its arc-shaped electrodes and the circular array of photodiodes. *Supra* Section VIII.B. A POSITA would have understood that ECG electrodes, including the arc-shaped electrodes of Paulke, Yuen, and Fong were typically made of a conductive metal and/or coating. *See, e.g.*, Exhibit 1006, 14:29-32 (“galvanic skin response (GSR) sensors pads 122”); Exhibit 1043, 6-7 (showing that all categories of dry electrodes for cardiography involve metal or conductive material electrodes), 19 (“For some designs, a coating material is necessary to improve the conductivity of the electrode.”). Prior art wireless chargers had charging coils (1832, below) generally occupying the outer circumference of the charger, which would need to align with the correspondingly located charging coil (1869, below) in the wearable device, as shown below.

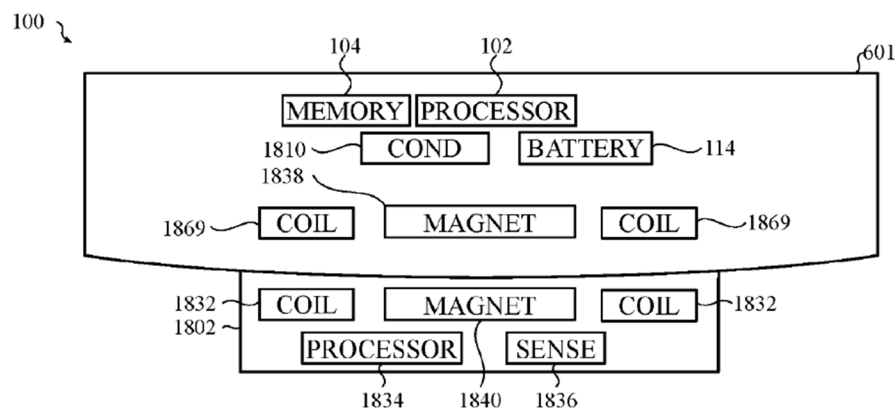
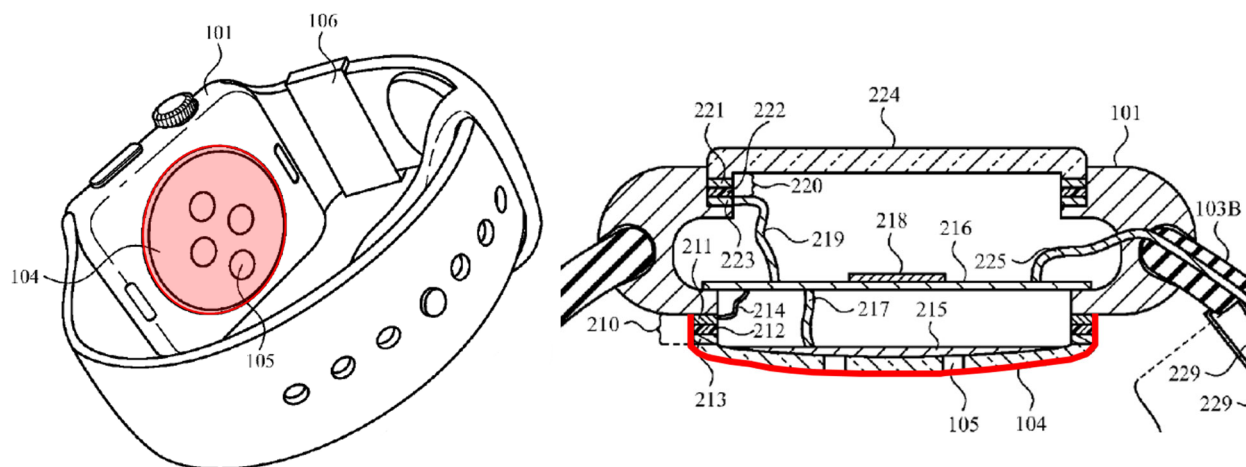


FIG. 19

Exhibit 1025, FIG. 19, 45:18-28 (“the complementary geometries [of the device 100 and charging dock 1802, above] may facilitate alignment of the electronic device

and dock for efficient wireless power transfer.”), 42:63-43:4 (explaining importance of aligning charging coil of device with charging coil of charger). A POSITA thus would have been motivated to shape Paulke’s arc-shaped electrodes to ensure the electrodes did not overlap the area occupied by the charging coil of the device or the area occupied by the charging coil of prior art wireless chargers, because using a “conductive member ... between the transmitter-side coil [i.e., the charger] and the receiver-side coil [i.e., the device] was known to “imped[e] the transmission” of power, which “is not appropriate” for efficient wireless power transfer. Exhibit 1044, 13:25-32; *id.*, 13:33-44, FIG. 15 (summarizing experiments regarding wireless power transmission efficiency through different materials). This motivation is consistent with the disclosure of Apple’s ’157 patent, which teaches to size and position the arc-shaped electrodes as claimed in the D’279 Patent to “improve wireless communication [e.g., charging] efficiency” by avoiding interference with “electrical structures of a device [e.g., the Watch’s charging coil].” Exhibit 1024, 17:22-31, FIGS. 4A, 5C-5D.

91. Bushnell discloses a wearable device with a convex housing component 104 (red, below) that protrudes from the back of the device, as shown in the following figures. Exhibit 1009, ¶37, FIGS. 1A, 2A. A POSITA would have understood the protruding housing component 104 of Bushnell (shown in red below) to be a convex protrusion. *Id.*



Id., FIGS. 1A (left), 2A (right). A POSITA would have been motivated to combine Bushnell's convex housing component (red, above) with Paulke's device because, by June 2018, it was known in the art that such a convex protruding feature would significantly improve the signal strength of the device's PPG sensor. For example, a prior art Masimo patent explains that "a convex [protrusion] ... was found to help signal strength by about an order of magnitude." Exhibit 1030, 20:29-33. The Masimo patent teaches that a convex protrusion "can have significant impact on increasing the SNR" (i.e., the signal-to-noise ratio) of the PPG sensor, including a signal strength increase of ten times or more, as shown below.

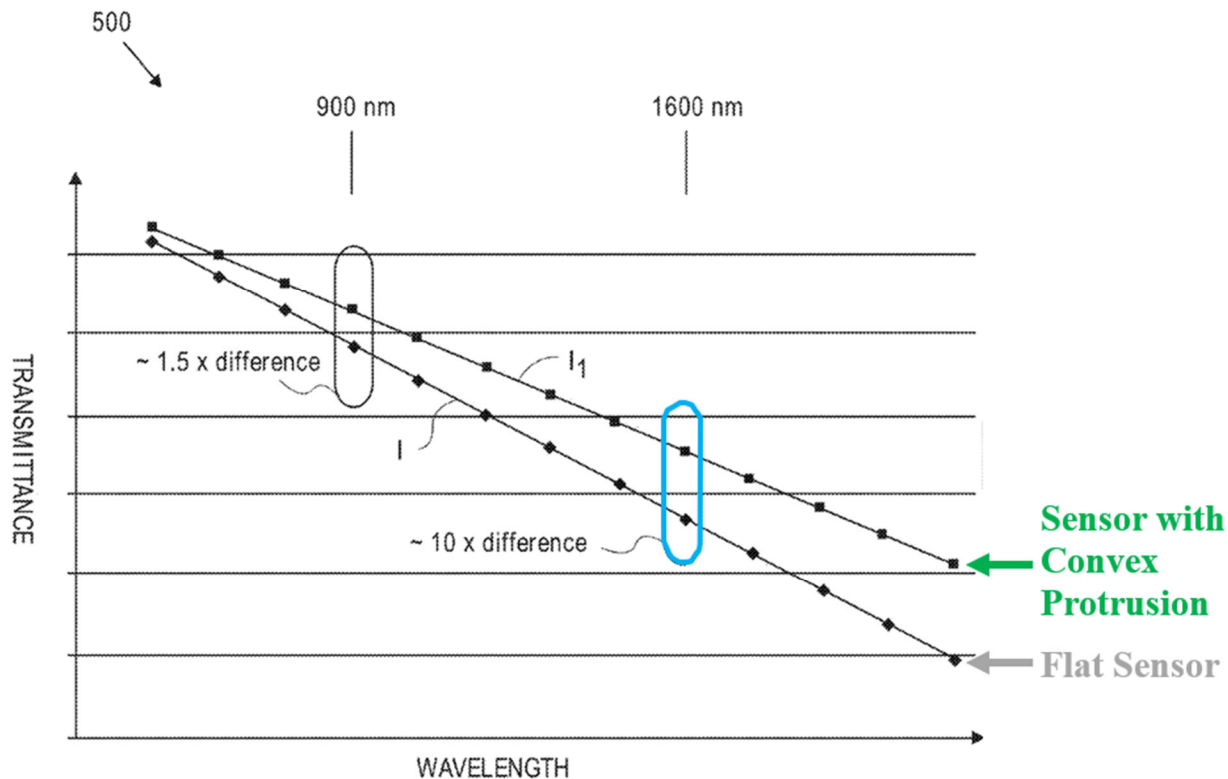


FIG. 5

Id., 21:9-43, FIG. 5. Thus, this prior art demonstrates that, by the time of the D'279 Patent in June 2018, those of ordinary skill in the art would have understood that convex protruding features like Bushnell's housing component 104 were known to increase signal strength in PPG sensors. *Id.*, 20:29-33, 21:9-43, FIG. 5. Consistent with my opinion that a POSITA would have been motivated to combine Bushnell's convex protrusion with Paulke's device to improve the signal strength of the device's PPG sensor, Apple and its expert argued during the parties' ITC Investigation that a POSITA would have had the same motivation to combine a convex protrusion with an optical sensor. Exhibit 1017, 75 ("A POSITA would have understood the benefits of including a convex protrusion, including to improve signal quality."); Exhibit

1021, 1210:13-1211:8 (Apple’s expert, Dr. Warren, opining that “it was already well-known that a convex curvature itself could be a useful element in increasing signal quality.”).

92. A POSITA also would have been motivated to combine Bushnell’s convex housing component (red, above) with Paulke’s device because it was known in the art that such a convex protruding feature would improve the contact (also called coupling) between the device’s PPG sensor and the user’s skin, resulting in more accurate measurements. Exhibit 1030, 20:52-55 (teaching that using “[r]igid materials [for the protrusion] can improve measurement accuracy of a blood analyte by conforming the measurement site to the contact area 370”; teaching that “[t]he contact area 370 [of the protrusion] can be an ideal shape for improving accuracy or reducing noise”). During the parties’ ITC Investigation, Apple argued that the same motivation existed to combine a convex protrusion with an optical sensor as proposed herein. Exhibit 1017, 117 (“A POSITA would have known there are benefits to using a protrusion with a convex surface, including, for example, to provide better coupling and thus better measurements.”).

93. A POSITA would have been motivated to incorporate Chung’s Fresnel lens over the light source of Paulke’s device as proposed (i.e., include Chung’s Fresnel lens over the LEDs of Mendelson’s PPG sensor and within the convex protrusion from Bushnell, as used with Paulke’s device) because such a

configuration was well-known to collimate or redirect light, thereby improving optical sensing efficiency. Chung itself motivates this combination by teaching that including “a Fresnel lens 260 for light emission [] above the light emitting unit 210” outputs “collimated light,” which is desirable because “[w]hen the propagation of the light is changed to travel in a straight line [i.e., when the emitted light is collimated], the degree of [light] absorption and scattering due to compositions in a human body may be *measured more easily*....” Exhibit 1010 ¶¶62-63. An Apple patent publication provides additional evidence that a POSITA would have been motivated to combine Chung’s Fresnel lens with Paulke as proposed by teaching the benefits of placing a Fresnel lens over LEDs in a PPG sensor:

By collimating light, the [PPG sensor’s] optical efficiency can be improved. Without a lens or similar collimating optical element, emitted light may be directed at an angle away from the light sensor and can be lost. In some examples, light may be directed at an angle toward the light sensor [i.e., photodiode], but the angle may be shallow (e.g., less than 15°). Fresnel lens 712 can redirect light to one or more directions to prevent light from being lost or entering into the skin at shallow angles. Such redirected light can be collected instead of being lost and/or may militate against parasitic non-signal light, which can improve optical signal efficiency.

Exhibit 1028 ¶56. Accordingly, a POSITA would have been motivated to incorporate Chung’s Fresnel lens over the light source of Paulke’s device as proposed in order to improve optical sensing efficiency of the PPG sensor used with Paulke’s device (i.e., Mendelson’s FIG. 7 sensor).

C. GROUND 2: Obviousness Over Yuen, Mendelson, Bushnell, and Chung

94. I understand that the obviousness inquiry for design patents is assessed from the perspective of a designer of ordinary skill in the art. As explained above in Section VI, a designer of ordinary skill in the art would have consulted and collaborated with a POSITA, such as myself, regarding technical concepts outside of the designer's area of expertise. Accordingly, below, I provide technical discussion from the perspective of a POSITA that is relevant to whether the Apple Watch Series 4 sensor design claimed in the D'279 Patent would have been obvious to a designer of ordinary skill in the art over Yuen, Mendelson, Bushnell, and Chung.

1. Motivation to Combine Yuen with Mendelson, Bushnell, and Chung

95. Yuen expressly suggests using "any PPG sensor 118 known in the art" for its central, circular PPG sensor 118. Exhibit 1007 ¶41. PPG sensors with one or more circular arrays of rectangular photodiodes were well-known in the art many years before the July 2018 date of the D'279 Patent. Exhibit 1036, 6; Exhibit 1037, 24; Exhibit 1038, 2. Such circular arrays of rectangular photodiodes were known to improve the signal-to-noise ratio, and thus the measurement accuracy, of PPG sensors. Exhibit 1011, 4:1-65, 9:22-33, FIG. 7. Accordingly, a POSITA would have understood that Mendelson's FIG. 7 PPG sensor and Chung's FIG. 7 PPG sensor would be suitable prior art PPG sensors to use for Yuen's PPG sensor 118. *Id.*; Exhibit 1010, FIG. 7.

96. A POSITA would have been motivated to use Mendelson's FIG. 7 PPG sensor as the central PPG sensor 118 of Yuen's device. Specifically, a POSITA would have been motivated to incorporate the "radially-symmetric photodetector array" of the sensor shown in FIG. 7 of Mendelson as the central PPG sensor 118 of Yuen's device, as shown below, to "maximize the detection of backscattered light," thereby increasing the signal-to-noise ratio, and thus improving the accuracy of, Yuen's sensor. Exhibit 1011, 4:6-62 (describing sensor performance-increasing benefit of "a sensor having six photodiodes arranged symmetrically around the LEDs"), 9:22-40 (explaining that Mendelson's FIG. 7 sensor, with its circular array of 12 rectangular photodiodes (16/18), "minimiz[es] some of the measurement inaccuracies" in blood oxygen sensors).

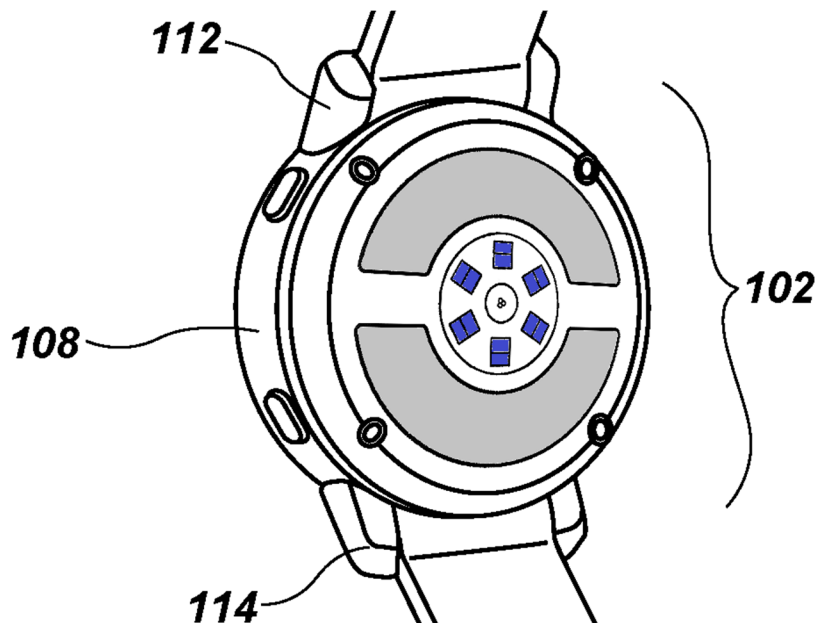


Exhibit 1007, FIG. 4 (combined with sensor from Exhibit 1011, FIG. 7). The pervasive use of radially-symmetric photodiode arrays in prior art optical sensors confirms that a POSITA in June 2018 would have been motivated to use Mendelson's well-known radially-symmetric photodiode array to improve the performance of Yuen's device using a well-known sensor design in a well-known way.

97. A POSITA further would have understood that using one of the six-photodiode arrays of Mendelson's FIG. 7 sensor with Yuen as shown below, rather than using both of Mendelson's photodiode arrays, would provide a well-known and accurate PPG sensor design for Yuen's PPG sensor 118 while being less expensive and easier to construct than Mendelson's FIG. 7 sensor because of the use of fewer photodiodes.

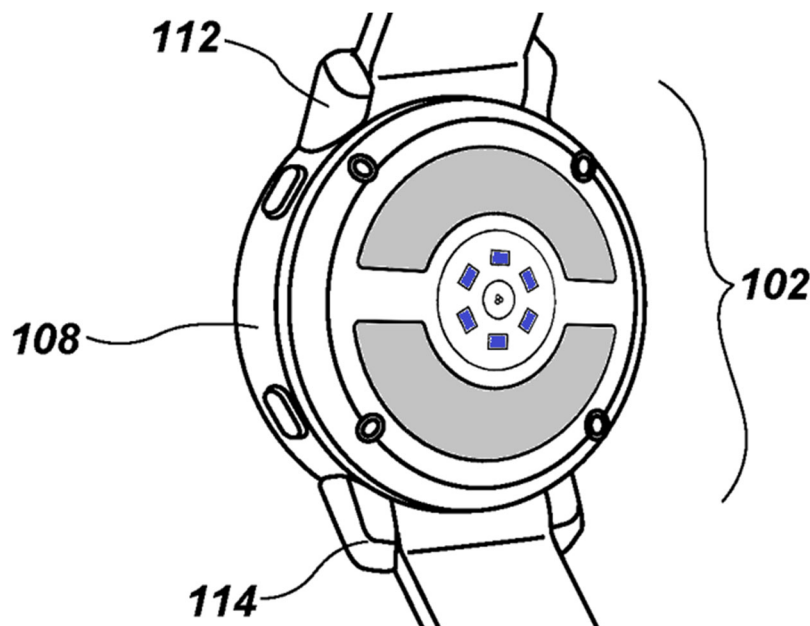


Exhibit 1007, FIG. 4 (combined with one six-photodiode array from Exhibit 1011, FIG. 7); Exhibit 1011, FIG. 7, 4:6-62 (describing sensor performance-increasing benefit of “a sensor having six photodiodes arranged symmetrically around the LEDs”); 9:22-34 (explaining that FIG. 7 sensor has two six-photodiode arrays, including an outer array (16) and an inner array (18)). A POSITA also would have been motivated to use more than six photodiodes in Yuen’s single radially-symmetric array to improve the sensor’s signal-to-noise ratio and thus, increase the accuracy of the sensor in a manner that was still less expensive and easier to construct than the two-array, 12-photodiode design of Mendelson’s FIG. 7 sensor. Exhibit 1011, 4:6-13 (increasing the “number of photodetectors” and their overall “active area” “increases the amount of backscattered light that can be detected” and thus achieves “improvements in signal-to-noise ratio”).

98. The arc-shaped electrodes disclosed by Yuen (shown in gray below) are separated by a gap, which electrically isolates the electrodes from one another.

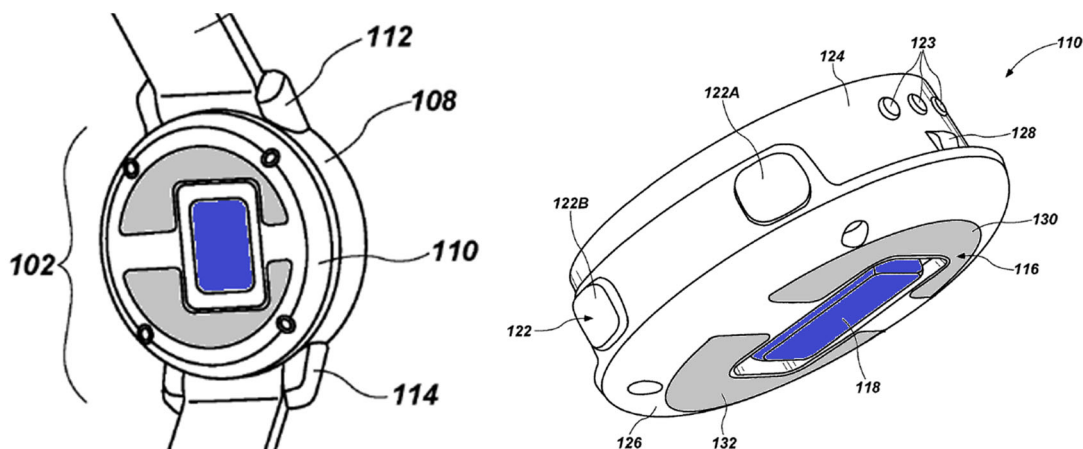


Exhibit 1007, FIGS. 1B (left), 3A (right). A POSITA would understand that arc-

shaped electrodes must contact the user's skin in order to measure electrical impulses through the skin. *Id.* ¶¶34 (“The electrocardiogram sensor 116 (‘ECG sensor 116’) ... may include at least two electrodes 130, 132 for contacting a user’s skin (e.g., a user wearing the smartwatch assembly 100.... For instance, the ECG sensor 116 may include a sensor for detecting and recording electrical activity ... in pulsating electrical waves [in] the skin of a user.”), 36 (“Via contact with a user’s skin, the ECG sensor 116 may perform (i.e., take) an electrocardiogram measurement of a user wearing the smartwatch assembly 100. For instance, the ECG sensor 116 may be configured to detect and measure a heart rate, an interbeat interval, and a heart rate variability of a user. Furthermore, the ECG sensor 116 may be configured to generate a graph of voltage over time of the heart muscle beating (i.e., an ‘EKG’).”), claim 1 (“A smartwatch assembly comprising ... an electrocardiogram sensor ..., the electrocardiogram sensor having at least two electrodes configured to be placed in contact with a user’s skin”). Yuen repeatedly explains that its arc-shaped electrodes 130, 132 are configured to maintain contact with the user’s skin. *Id.* A POSITA would have known that it was advantageous to “increase the contact area of the skin-to-electrode interface to maintain lower impedance and exhibit better behavior in reducing motion artifacts.” Exhibit 1043, 10. In view of these teachings, therefore, a POSITA would have been motivated to extend the ends of Yuen’s arc-shaped electrodes closer together to maximize the surface area of the arc-shaped

electrodes for contacting the user's skin. This motivation is consistent with the disclosure of Apple's own utility patent on the Apple Watch Series 4 sensor design, which teaches that the "first and second electrodes 412, 414" can be "arc-shaped" and "sized" to "improve electrical sensor efficiency" by "providing a sufficient area to provide good electrical contact between the electrodes 412, 414 and the skin...." Exhibit 1024, 17:22-28.

99. As explained above, the Apple Watch Series 4 underlying the claimed design includes a charging coil between its arc-shaped electrodes and the circular array of photodiodes. *Supra* Section VIII.B. A POSITA would have understood that ECG electrodes, including the arc-shaped electrodes of Paulke, Yuen, and Fong were typically made of a conductive metal and/or coating. *See, e.g.*, Exhibit 1006, 14:29-32 ("galvanic skin response (GSR) sensors pads 122"); Exhibit 1043, 6-7 (showing that all categories of dry electrodes for cardiography involve metal or conductive material electrodes), 19 ("For some designs, a coating material is necessary to improve the conductivity of the electrode."). Prior art wireless chargers had charging coils (1832, below) generally occupying the outer circumference of the charger, which would need to align with the correspondingly located charging coil (1869, below) in the wearable device, as shown below.

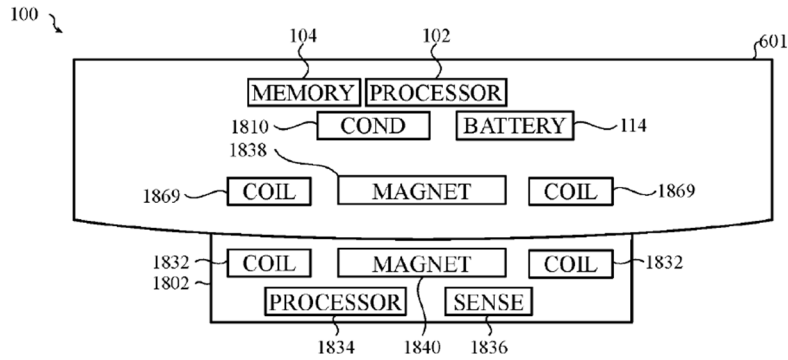
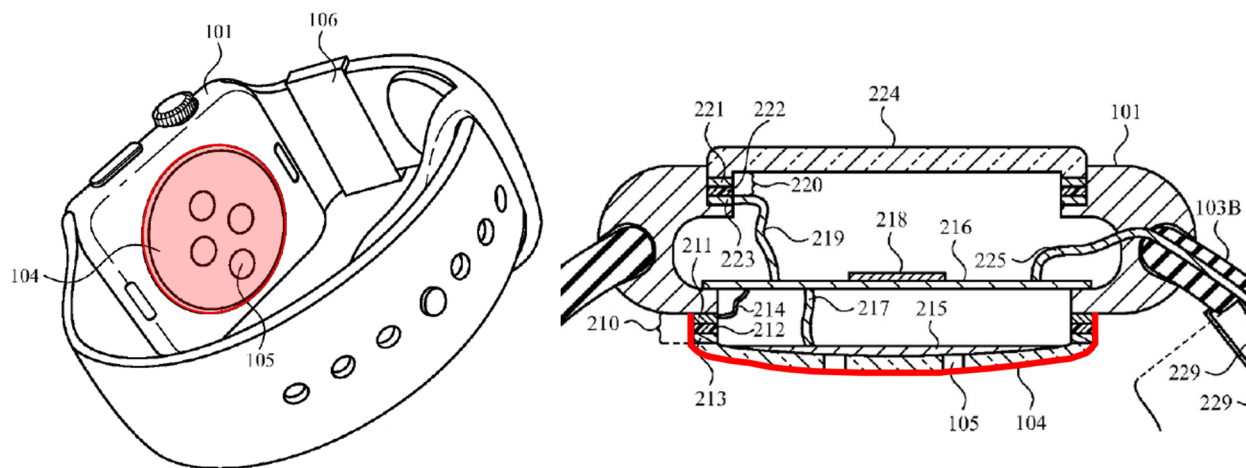


FIG. 19

Exhibit 1025, FIG. 19, 45:18-28 (“the complementary geometries [of the device 100 and charging dock 1802, above] may facilitate alignment of the electronic device and dock for efficient wireless power transfer.”), 42:63-43:4 (explaining importance of aligning charging coil of device with charging coil of charger). A POSITA thus would have been motivated to shape Yuen’s arc-shaped electrodes to ensure the electrodes did not overlap the area occupied by the charging coil of the device or the area occupied by the charging coil of prior art wireless chargers, because using a “conductive member ... between the transmitter-side coil [i.e., the charger] and the receiver-side coil [i.e., the device] was known to “imped[e] the transmission” of power, which “is not appropriate” for efficient wireless power transfer. Exhibit 1044, 13:25-32; *id.*, 13:33-44, FIG. 15 (summarizing experiments regarding wireless power transmission efficiency through different materials). This motivation is consistent with the disclosure of Apple’s ’157 patent, which teaches to size and position the arc-shaped electrodes as claimed in the D’279 Patent to “improve wireless communication [e.g., charging] efficiency” by avoiding interference with

“electrical structures of a device [e.g., the Watch’s charging coil].” Exhibit 1024, 17:22-31, FIGS. 4A, 5C-5D.

100. Bushnell discloses a wearable device with a convex housing component 104 (red, below) that protrudes from the back of the device, as shown in the following figures. Exhibit 1009, ¶37, FIGS. 1A, 2A. A POSITA would have understood the protruding housing component 104 of Bushnell (shown in red below) to be a convex protrusion. *Id.*



Id., FIGS. 1A (left), 2A (right). A POSITA would have been motivated to combine Bushnell’s convex housing component (red, above) with Yuen’s device because, by June 2018, it was known in the art that such a convex protruding feature would significantly improve the signal strength of the device’s PPG sensor. For example, a prior art Masimo patent explains that “a convex [protrusion] ... was found to help signal strength by about an order of magnitude.” Exhibit 1030, 20:29-33. The Masimo patent teaches that a convex protrusion “can have significant impact on

increasing the SNR” (i.e., the signal-to-noise ratio) of the PPG sensor, including a signal strength increase of ten times or more, as shown below.

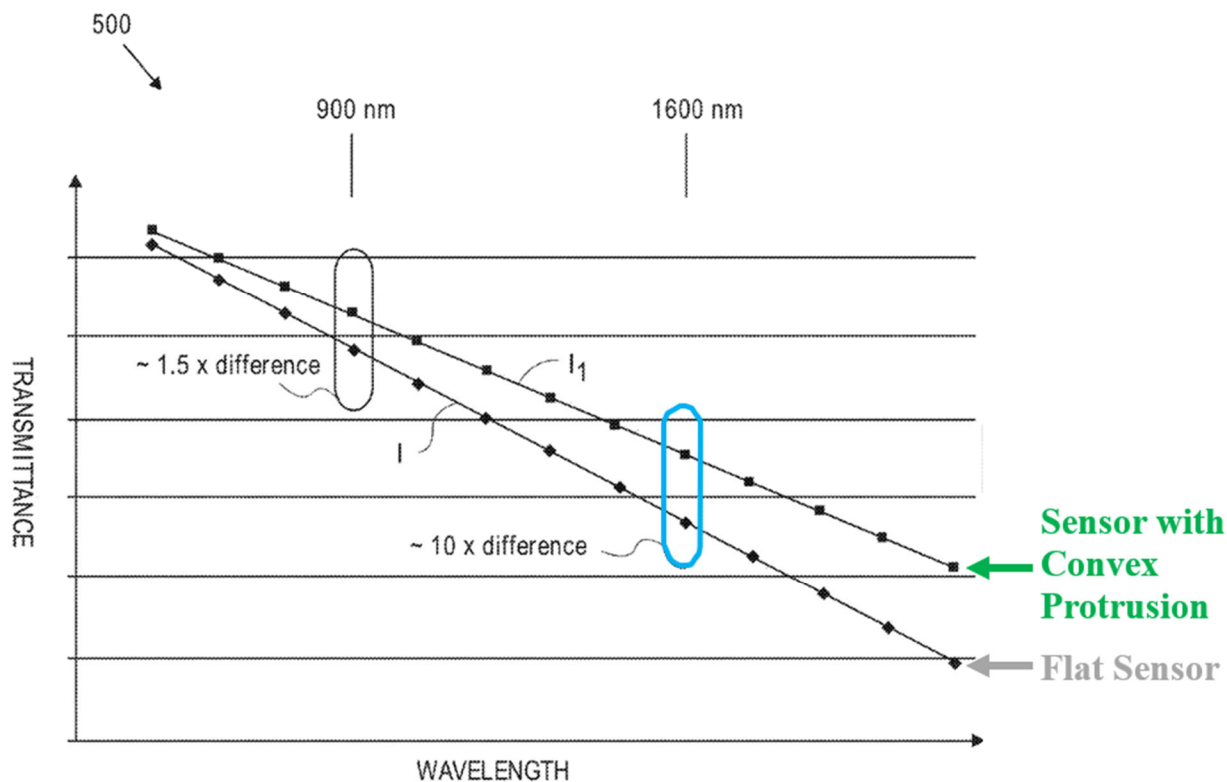


FIG. 5

Id., 21:9-43, FIG. 5. Thus, this prior art demonstrates that, by the time of the D’279 Patent in June 2018, those of ordinary skill in the art would have understood that convex protruding features like Bushnell’s housing component 104 were known to increase signal strength in PPG sensors. *Id.*, 20:29-33, 21:9-43, FIG. 5. Consistent with my opinion that a POSITA would have been motivated to combine Bushnell’s convex protrusion with Yuen’s device to improve the signal strength of the device’s PPG sensor, Apple and its expert argued during the parties’ ITC Investigation that a POSITA would have had the same motivation to combine a convex protrusion with

an optical sensor. Exhibit 1017, 75 (“A POSITA would have understood the benefits of including a convex protrusion, including to improve signal quality.”); Exhibit 1021, 1210:13-1211:8 (Apple’s expert, Dr. Warren, opining that “it was already well-known that a convex curvature itself could be a useful element in increasing signal quality.”).

101. A POSITA also would have been motivated to combine Bushnell’s convex housing component (red, above) with Yuen’s device because it was known in the art that such a convex protruding feature would improve the contact (also called coupling) between the device’s PPG sensor and the user’s skin, resulting in more accurate measurements. Exhibit 1030, 20:52-55 (teaching that using “[r]igid materials [for the protrusion] can improve measurement accuracy of a blood analyte by conforming the measurement site to the contact area 370”; teaching that “[t]he contact area 370 [of the protrusion] can be an ideal shape for improving accuracy or reducing noise”). During the parties’ ITC Investigation, Apple argued that the same motivation existed to combine a convex protrusion with an optical sensor as proposed herein. Exhibit 1017, 117 (“A POSITA would have known there are benefits to using a protrusion with a convex surface, including, for example, to provide better coupling and thus better measurements.”).

102. A POSITA would have been motivated to incorporate Chung’s Fresnel lens over the light source of Yuen’s device as proposed (i.e., include Chung’s Fresnel

lens over Mendelson's PPG sensor and within the convex protrusion from Bushnell, as used with Yuen's device) because such a configuration was well-known to collimate (or redirect) light, thereby improving optical sensing efficiency. Chung itself motivates this combination by teaching that including "a Fresnel lens 260 for light emission [] above the light emitting unit 210" outputs "collimated light," which is desirable because "[w]hen the propagation of the light is changed to travel in a straight line [i.e., is collimated], the degree of [light] absorption and scattering due to compositions in a human body may be measured more easily...." Exhibit 1010 ¶¶62-63. An Apple patent publication provides additional evidence that a POSITA would have been motivated to combine Chung's Fresnel lens with Yuen as proposed by teaching the benefits of placing a Fresnel lens over LEDs in a PPG sensor:

By collimating light, the [PPG sensor's] optical efficiency can be improved. Without a lens or similar collimating optical element, emitted light may be directed at an angle away from the light sensor and can be lost. In some examples, light may be directed at an angle toward the light sensor [i.e., photodiode], but the angle may be shallow (e.g., less than 15°). Fresnel lens 712 can redirect light to one or more directions to prevent light from being lost or entering into the skin at shallow angles. Such redirected light can be collected instead of being lost and/or may militate against parasitic non-signal light, which can improve optical signal efficiency.

Exhibit 1028 ¶56. Accordingly, a POSITA would have been motivated to incorporate Chung's Fresnel lens over the light source of Yuen's device as proposed in order to improve optical sensing efficiency of the PPG sensor used with Yuen's device (i.e., Mendelson's FIG. 7 sensor).

D. GROUND 3: Obviousness Over Fong, Mendelson, Bushnell, and Chung

103. I understand that the obviousness inquiry for design patents is assessed from the perspective of a designer of ordinary skill in the art. As explained above in Section VI, a designer of ordinary skill in the art would have consulted and collaborated with a POSITA, such as myself, regarding technical concepts outside of the designer's area of expertise. Accordingly, below, I provide technical discussion from the perspective of a POSITA that is relevant to whether the Apple Watch Series 4 sensor design claimed in the D'279 Patent would have been obvious to a designer of ordinary skill in the art over Fong, Mendelson, Bushnell, and Chung.

1. Motivation to Combine Fong with Mendelson, Bushnell, and Chung

104. The prior art expressly suggested using known PPG sensors in wearable devices like Fong that include arc-shaped electrodes surrounding a central PPG sensor. Exhibit 1006, 15:9-18, FIGS. 1F-2A; Exhibit 1007 ¶¶41, FIGS. 1B, 3A, 4. PPG sensors with one or more circular arrays of rectangular photodiodes were well-known in the art many years before the July 2018 date of the D'279 Patent. Exhibit 1036, 6; Exhibit 1037, 24; Exhibit 1038, 2. Such circular arrays of rectangular photodiodes were known to improve the signal-to-noise ratio, and thus the measurement accuracy, of PPG sensors. Exhibit 1011, 4:1-65, 9:22-33, FIG. 7. Accordingly, a POSITA would have understood that Mendelson's FIG. 7 PPG

sensor and Chung's FIG. 7 PPG sensor would be suitable prior art PPG sensors to use in place of Fong's central PPG sensor. *Id.*; Exhibit 1010, FIG. 7.

105. A POSITA would have been motivated to use Mendelson's FIG. 7 PPG sensor as the central PPG sensor of Fong's device. Specifically, a POSITA would have been motivated to incorporate the "radially-symmetric photodetector array" of the sensor shown in FIG. 7 of Mendelson as the central PPG sensor of Fong's device, as shown below, to "maximize the detection of backscattered light," thereby increasing the signal-to-noise ratio, and thus improving the accuracy of, Fong's sensor. Exhibit 1011, 4:6-62 (describing sensor performance-increasing benefit of "a sensor having six photodiodes arranged symmetrically around the LEDs"), 9:22-40 (explaining that Mendelson's FIG. 7 sensor, with its circular array of 12 rectangular photodiodes (16/18), "minimiz[es] some of the measurement inaccuracies" in blood oxygen sensors).

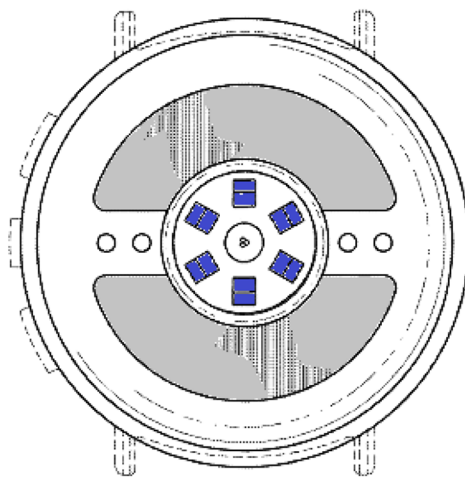


Exhibit 1008, FIG. 4 (combined with sensor from Exhibit 1011, FIG. 7). The pervasive use of radially-symmetric photodiode arrays in prior art optical sensors confirms that a POSITA in June 2018 would have been motivated to use Mendelson's well-known radially-symmetric photodiode array to improve the performance of Fong's device using a well-known sensor design in a well-known way.

106. A POSITA further would have understood that using one of the six-photodiode arrays of Mendelson's FIG. 7 sensor with Fong as shown below, rather than using both of Mendelson's photodiode arrays, would provide a well-known and accurate PPG sensor design for Fong's PPG sensor while being less expensive and easier to construct than Mendelson's FIG. 7 sensor because of the use of fewer photodiodes.

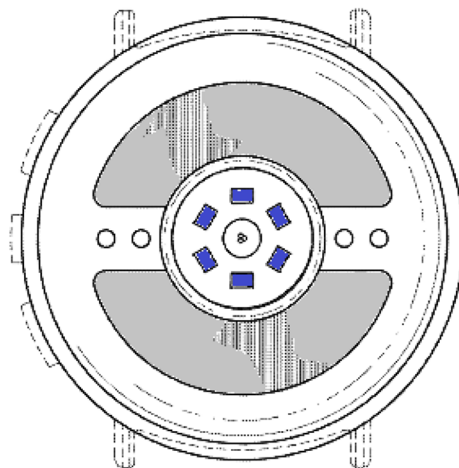


Exhibit 1008, FIG. 4 (combined with one six-photodiode array from Exhibit 1011, FIG. 7); Exhibit 1011, FIG. 7, 4:6-62 (describing sensor performance-increasing

benefit of “a sensor having six photodiodes arranged symmetrically around the LEDs”); 9:22-34 (explaining that FIG. 7 sensor has two six-photodiode arrays, including an outer array (16) and an inner array (18)). A POSITA also would have been motivated to use more than six photodiodes in Fong’s single radially-symmetric array to improve the sensor’s signal-to-noise ratio and thus, increase the accuracy of the sensor in a manner that was still less expensive and easier to construct than the two-array, 12-photodiode design of Mendelson’s FIG. 7 sensor. Exhibit 1011, 4:6-13 (increasing the “number of photodetectors” and their overall “active area” “increases the amount of backscattered light that can be detected” and thus achieves “improvements in signal-to-noise ratio”).

107. The arc-shaped electrodes disclosed by Fong (shown in gray below) are separated by a gap, which electrically isolates the electrodes from one another.

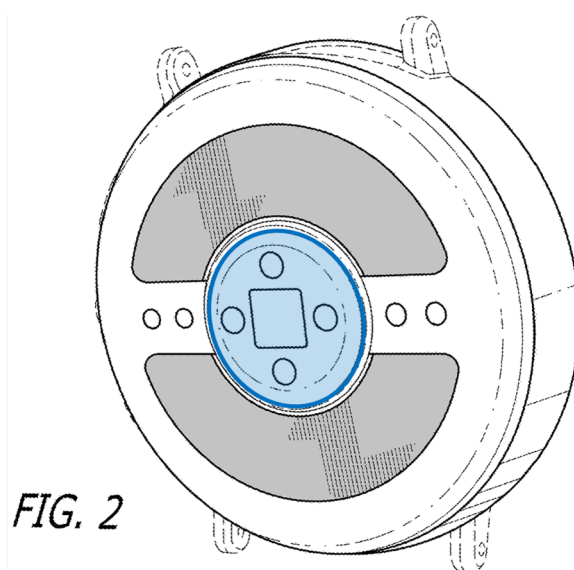


Exhibit 1008, FIG. 2. A POSITA would understand that arc-shaped electrodes must

contact the user's skin in order to measure electrical impulses through the skin. *See, e.g.,* Exhibit 1006, 14:29-32, 15:3-5 (teaching that arc-shaped electrodes “may protrude by any suitable amount ... to help maintain contact between [the electrodes] and the wearer's wrist when the biosensor module 100 is worn”), 5:31-32 (“[T]he wearable articles may hold the biosensors in a way that promotes accuracy of the measurements by the biosensors.”), 6:5-7 (“Some embodiments relate to a wearable article housing one or more electronic components that maintains one or more of the electronic components in contact with the wearer's wrist.”), 13:13-16 (“one or more biosensors positioned and configured to be held by the wrist band assembly in contact with ... the wearer's wrist”), 16:1-4; Exhibit 1007 ¶¶34 (“The electrocardiogram sensor 116 (‘ECG sensor 116’) ... may include at least two electrodes 130, 132 for contacting a user's skin (e.g., a user wearing the smartwatch assembly 100.... For instance, the ECG sensor 116 may include a sensor for detecting and recording electrical activity ... in pulsating electrical waves [in] the skin of a user.”), 36 (“Via contact with a user's skin, the ECG sensor 116 may perform (i.e., take) an electrocardiogram measurement of a user wearing the smartwatch assembly 100. For instance, the ECG sensor 116 may be configured to detect and measure a heart rate, an interbeat interval, and a heart rate variability of a user. Furthermore, the ECG sensor 116 may be configured to generate a graph of voltage over time of the heart muscle beating (i.e., an ‘EKG’).”), claim 1 (“A

smartwatch assembly comprising ... an electrocardiogram sensor ..., the electrocardiogram sensor having at least two electrodes configured to be placed in contact with a user's skin"). A POSITA would have known that it was advantageous to "increase the contact area of the skin-to-electrode interface to maintain lower impedance and exhibit better behavior in reducing motion artifacts." Exhibit 1043, 10. Therefore, in view of these teachings, a POSITA would have been motivated to extend the ends of Fong's arc-shaped electrodes closer together to maximize the surface area of the arc-shaped electrodes for contacting the user's skin. This motivation is consistent with the disclosure of Apple's own utility patent on the Apple Watch Series 4 sensor design, which teaches that the "first and second electrodes 412, 414" can be "arc-shaped" and "sized" to "improve electrical sensor efficiency" by "providing a sufficient area to provide good electrical contact between the electrodes 412, 414 and the skin...." Exhibit 1024, 17:22-28.

108. As explained above, the Apple Watch Series 4 underlying the claimed design includes a charging coil between its arc-shaped electrodes and the circular array of photodiodes. *Supra* Section VIII.B. A POSITA would have understood that ECG electrodes, including the arc-shaped electrodes of Paulke, Yuen, and Fong were typically made of a conductive metal and/or coating. *See, e.g.*, Exhibit 1006, 14:29-32 ("galvanic skin response (GSR) sensors pads 122"); Exhibit 1043, 6-7 (showing that all categories of dry electrodes for cardiography involve metal or

conductive material electrodes), 19 (“For some designs, a coating material is necessary to improve the conductivity of the electrode.”). Prior art wireless chargers had charging coils (1832, below) generally occupying the outer circumference of the charger, which would need to align with the correspondingly located charging coil (1869, below) in the wearable device, as shown below.

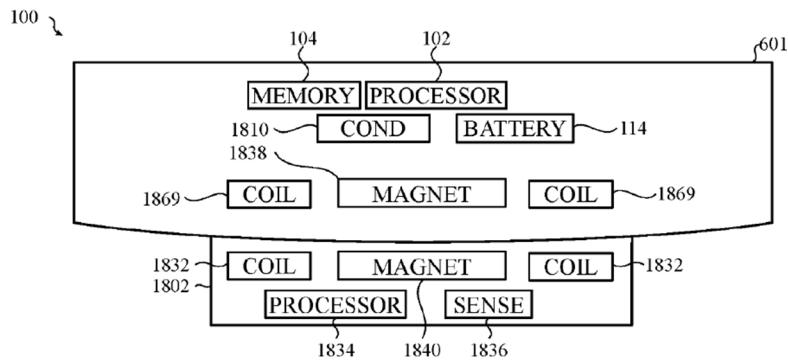
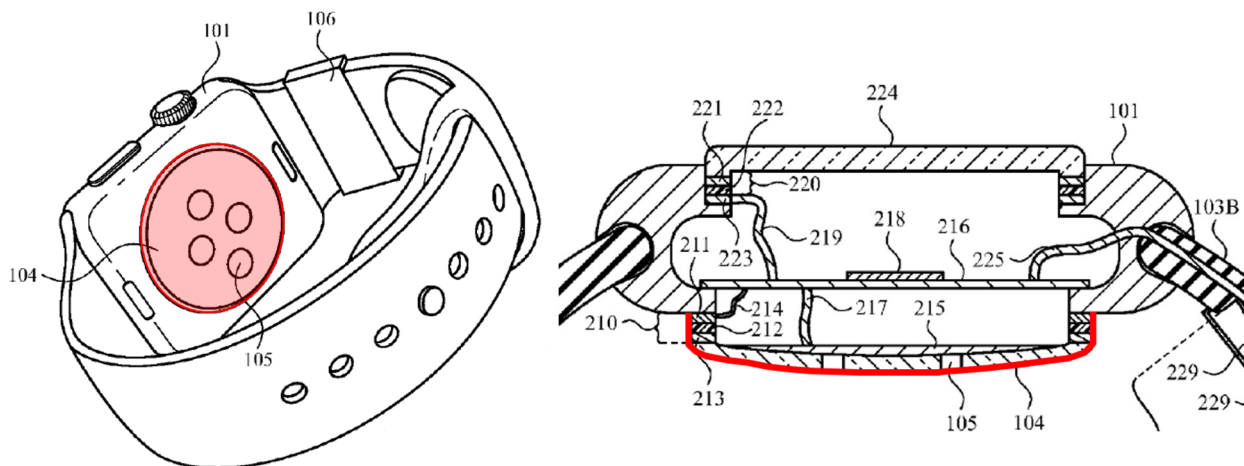


FIG. 19

Exhibit 1025, FIG. 19, 45:18-28 (“the complementary geometries [of the device 100 and charging dock 1802, above] may facilitate alignment of the electronic device and dock for efficient wireless power transfer.”), 42:63-43:4 (explaining importance of aligning charging coil of device with charging coil of charger). A POSITA thus would have been motivated to shape Fong’s arc-shaped electrodes to ensure the electrodes did not overlap the area occupied by the charging coil of the device or the area occupied by the charging coil of prior art wireless chargers, because using a “conductive member ... between the transmitter-side coil [i.e., the charger] and the receiver-side coil [i.e., the device] was known to “imped[e] the transmission” of power, which “is not appropriate” for efficient wireless power transfer. Exhibit

1044, 13:25-32; *id.*, 13:33-44, FIG. 15 (summarizing experiments regarding wireless power transmission efficiency through different materials). This motivation is consistent with the disclosure of Apple’s ’157 patent, which teaches to size and position the arc-shaped electrodes as claimed in the D’279 Patent to “improve wireless communication [e.g., charging] efficiency” by avoiding interference with “electrical structures of a device [e.g., the Watch’s charging coil].” Exhibit 1024, 17:22-31, FIGS. 4A, 5C-5D.

109. Bushnell discloses a wearable device with a convex housing component 104 (red, below) that protrudes from the back of the device, as shown in the following figures. Exhibit 1009, ¶37, FIGS. 1A, 2A. A POSITA would have understood the protruding housing component 104 of Bushnell (shown in red below) to be a convex protrusion. *Id.*



Id., FIGS. 1A (left), 2A (right). A POSITA would have been motivated to combine Bushnell’s convex housing component (red, above) with Fong’s device because it

was known in the art that such a convex protruding feature would improve the signal strength of the device's PPG sensor. For example, as explained above, a prior art Masimo patent explains that "a convex [protrusion] ... was found to help signal strength by about an order of magnitude." Exhibit 1030, 20:29-33. The same Masimo patent also teaches that a convex protrusion "can have significant impact on increasing the SNR" (i.e., the signal-to-noise ratio) of the PPG sensor, including a signal strength increase of ten times or more, as shown below.

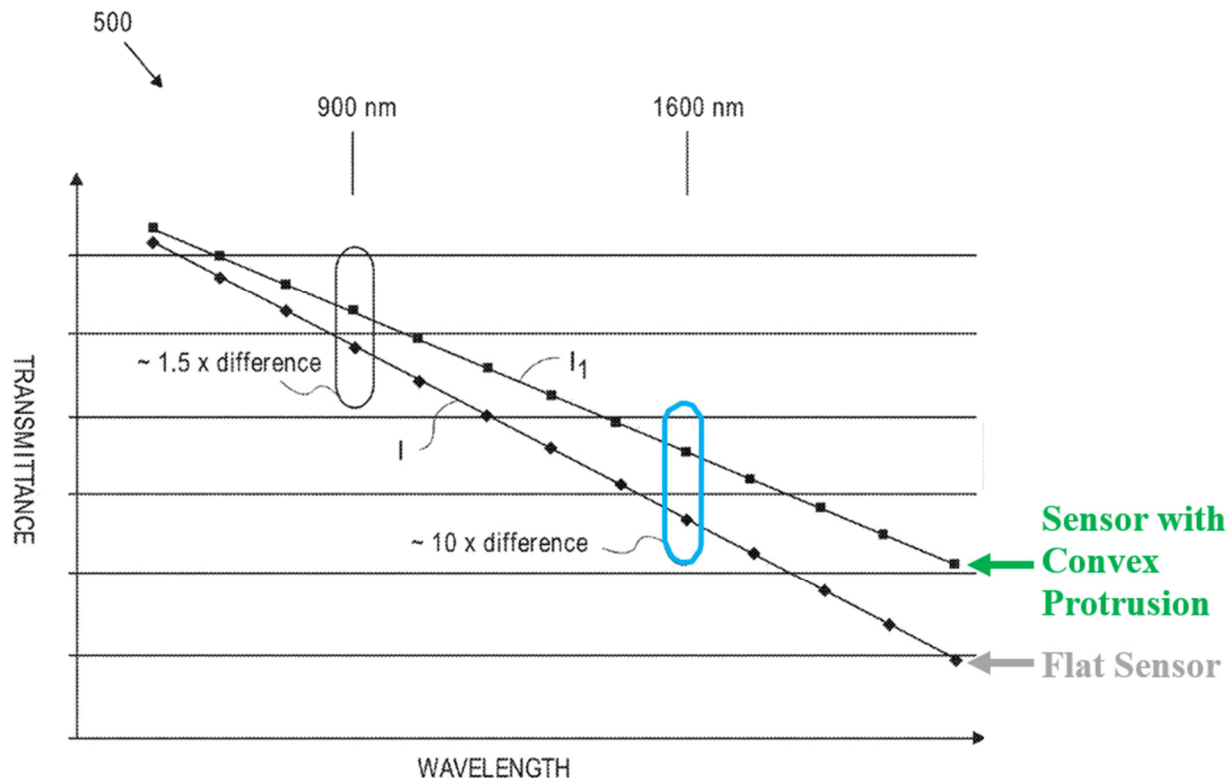


FIG. 5

Id., 21:9-43, FIG. 5. Thus, this prior art demonstrates that, by the time of the D'279 Patent in June 2018, those of ordinary skill in the art would have understood that convex protruding features like Bushnell's housing component 104 were known to

increase signal strength in PPG sensors. *Id.*, 20:29-33, 21:9-43, FIG. 5. Consistent with my opinion that a POSITA would have been motivated to combine Bushnell's convex protrusion with Fong's device to improve the signal strength of the device's PPG sensor, Apple and its expert argued during the parties' ITC Investigation that a POSITA would have had the same motivation to combine a convex protrusion with an optical sensor. Exhibit 1017, 75 ("A POSITA would have understood the benefits of including a convex protrusion, including to improve signal quality."); Exhibit 1021, 1210:13-1211:8 (Apple's expert, Dr. Warren, opining that "it was already well-known that a convex curvature itself could be a useful element in increasing signal quality.").

110. A POSITA also would have been motivated to combine Bushnell's convex housing component (red, above) with Fong's device because it was known in the art that such a convex protruding feature would improve the contact (also called coupling) between the device's PPG sensor and the user's skin, resulting in more accurate measurements. Exhibit 1030, 20:52-55 (teaching that using "[r]igid materials [for the protrusion] can improve measurement accuracy of a blood analyte by conforming the measurement site to the contact area 370"; teaching that "[t]he contact area 370 [of the protrusion] can be an ideal shape for improving accuracy or reducing noise"). During the parties' ITC Investigation, Apple argued that the same motivation existed to combine a convex protrusion with an optical sensor as

proposed herein. Exhibit 1017, 117 (“A POSITA would have known there are benefits to using a protrusion with a convex surface, including, for example, to provide better coupling and thus better measurements.”).

111. A POSITA would have been motivated to incorporate Chung’s Fresnel lens over the light source of Fong’s device as proposed (i.e., include Chung’s Fresnel lens over Mendelson’s PPG sensor and within the convex protrusion from Bushnell, as used with Fong’s device) because such a configuration was well-known to collimate (or redirect) light, thereby improving optical sensing efficiency. Chung itself motivates this combination by teaching that including “a Fresnel lens 260 for light emission [] above the light emitting unit 210” outputs “collimated light,” which is desirable because “[w]hen the propagation of the light is changed to travel in a straight line [i.e., is collimated], the degree of [light] absorption and scattering due to compositions in a human body may be measured more easily....” Exhibit 1010 ¶¶62-63. An Apple patent publication provides additional evidence that a POSITA would have been motivated to combine Chung’s Fresnel lens with Fong as proposed by teaching the benefits of placing a Fresnel lens over LEDs in a PPG sensor:

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lost and/or may militate against parasitic non-signal light, which can improve optical signal efficiency.

Exhibit 1028 ¶56. Accordingly, a POSITA would have been motivated to incorporate Chung's Fresnel lens over the light source of Fong's device as proposed in order to improve optical sensing efficiency of the PPG sensor used with Fong's device (i.e., Mendelson's FIG. 7 sensor).

X. CONCLUSION

112. I reserve the right to supplement my above analyses and opinions in the future to respond to any information, arguments, or positions Apple may raise, taking account of new information as it becomes available to me.