

Declaration of Isaac Davenport, Ph.D. in Support of
Petition for *Inter Partes* Review of
U.S. Patent No. 11,835,421 B2

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

REVVO TECHNOLOGIES, INC.,
Petitioner

v.

CEREBRUM SENSOR TECHNOLOGIES, INC.,
Patent Owner

IPR2025-00632

U.S. Patent No. 11,835,421 B2
Issue Date: December 5, 2023

Title: SENSOR ASSEMBLIES AND SYSTEMS FOR MONITORING A DYNAMIC OBJECT

DECLARATION OF ISAAC DAVENPORT, PH.D.

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I, Isaac Davenport, Ph.D., declare as follows:

I. INTRODUCTION AND QUALIFICATIONS

A. Qualifications and Experience

1. I received my B.S. in Electrical Engineering from the Georgia Institute of Technology in 1995. Afterward, I pursued and received a M.S., then a Ph.D., in Electrical Engineering from the University of Colorado at Boulder in 1997 and 1998, respectively.

2. Over the course of my career, I have become well-versed in the design and development of products including circuit boards using accelerometers, pressure sensors, and transmitters, often encased in protective assemblies to allow survival in harsh environments. For example, in 2004 at Schlumberger I developed a circuit board for a down hole instrument which had an epoxy-based potting scheme that integrated a custom aluminum frame to allow the sensor system to survive the high temperatures, vibrations, and moisture of the down hole environment of well drill strings. Similarly, in 2015 I helped Continental Control Systems with connections to electronics that were potted to survive outdoors for long durations.

3. My prior work experience extends into applications in the automotive industry. While working with Synergos I developed a system to dynamically measure tire pressure in truck fleets using a combination of optical and piezoelectric

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sensing.

4. I am primarily an independent engineering consultant with a range of clientele across multiple industries. But I also serve an advisory role for a variety of technical organizations, including Actall Corp., a company providing wireless security devices; Continental Control Systems, an energy metering equipment company; and Insight Photonic Solutions that produces akinetic semiconductor swept lasers. I also advise Colorado State University STRATA Technology Transfer Group.

5. Before my current roles, I founded and ran Toys2Life from 2016-2020. Toys2Life was a startup focused on technology to measure distance between toys to detect which toys a child was moving close together in order to trigger a spoken dialog between those toys. My work included the development of a small circular circuit board that contained an accelerometer and Bluetooth chip housed in a plastic enclosure that secured the circuit board using multiple types of surface features in the plastic.

6. Before Toys2Life, I served as the VP of Engineering at Orbotix/Sphero where I led the Software Developer Kit (SDK) team, Firmware team, Electrical and Mechanical Engineering teams through the release of Sphero 2, a robotic ball controlled by a smart phone. As head of product development, I assisted in the

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integration of an inertial measurement unit, a Bluetooth radio module, custom antenna, processor, motor, battery, charger, and injection-molded parts. Because the product was a rolling ball, the housing and electronics were uniquely retained in relative position with tiny rubber wheels.

7. I am the named inventor to several patents involved in various aspects of sensor system design, including but not limited to U.S. Patent No. 11,599,761 entitled “Adaptable Tracking Tag” and U.S. Patent No. 10,111,035 entitled “Real Time Proximity Tracking Using Received Signal Strength Indication.”

8. A more detailed description of my qualifications is appended to this Declaration as **Appendix A**.

9. I am being compensated for my time working on this matter at my standard hourly rate plus expenses. I do not have any personal or financial stake or interest in the outcome of the present proceeding, and my compensation is not dependent on the outcome of this IPR and in no way affects the substance of my statements in this Declaration.

B. Materials Considered

10. The analysis that I provide in this Declaration is based on my education, research, and experience, as well as the documents I have considered. In forming my opinions, I have read and considered U.S. Patent No. 11,835,421 (“’421 patent”

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or “’421”) [EX1001] and its prosecution history [EX1002]. I have cited to or considered the following documents in my analysis below:

Ex. No.	Description of Document
1001	U.S. Patent No. 11,835,421 to Keith George Ferry (filed October 29, 2020, issued December 5, 2023) (“’421 patent”)
1002	File History of the ’421 patent
1004	U.S. Patent Application No. 16/671,105 (“’105 application”)
1005	U.S. Patent Application Publication No. 2019/0184773 to Toshiaki Saito (filed February 22, 2019, published June 20, 2019) (“Saito”)
1006	U.S. Patent Application Publication No. 2021/0370727 to Shigeru Yamaguchi (PCT application filed July 19, 2019, published December 2, 2021) (“Yamaguchi-727”)
1007	U.S. Patent Application Publication No. 2021/0394566 to Shigeru Yamaguchi (PCT application filed July 19, 2019, published December 23, 2021) (“Yamaguchi-566”)
1008	U.S. Patent No. 6,769,319 to William G. McDonald et al. (filed July 9, 2001, issued August 3, 2004) (“McDonald”)
1009	WO/2020036859 to Sunjay Dodani and Andrew Wing-Hong (filed August 12, 2019, published February 20, 2020) (“Dodani-859”)
1011	U.S. Patent No. 7,009,506 to Paul Wilson et al. (filed July 9, 2002, issued March 7, 2006) (“Wilson-506”)
1013	U.S. Patent No. 8,373,551 to David Norman Laird et al. (filed July 29, 2009, issued February 12, 2013) (“Laird”)
1014	Patent Owner’s Supplemental Initial Infringement Contentions served on November 7, 2024 in <i>Cerebrum Sensor Techs., Inc. and Tire Stickers LLC v. Revvo Techs., Inc.</i> , C.A. No. 24-245 (JLH) (SRF) (D. Del.)
1015	Exhibit 3 to Patent Owner’s Supplemental Initial Infringement Contentions served on November 7, 2024 in <i>Cerebrum Sensor Techs., Inc. and Tire Stickers LLC v. Revvo Techs., Inc.</i> , C.A. No. 24-245 (JLH) (SRF) (D. Del.)

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Ex. No.	Description of Document
1016	Joint Claim Construction Chart (Dkt. No. 84), <i>Cerebrum Sensor Techs., Inc. and Tire Stickers LLC v. Revvo Techs., Inc.</i> , C.A. No. 24-245 (JLH) (SRF) (D. Del.)
1017	Exhibits A-J to Joint Claim Construction Chart (Dkt. No. 84-1), <i>Cerebrum Sensor Techs., Inc. and Tire Stickers LLC v. Revvo Techs., Inc.</i> , C.A. No. 24-245 (JLH) (SRF) (D. Del.)
1018	Listing of Challenged Claims
1019	PCT/JP2019/028506
1020	PCT/JP2019/028502
1021	U.S. Patent No. 10,836,222 to Stewart et al. (filed October 26, 2018, issued November 17, 2020) (“Stewart”)
1022	WO 2005/049339 to Zaroor et al. (filed November 18, 2004, published June 2, 2005) (“Zaroor”)

II. PERSON OF ORDINARY SKILL IN THE ART (“POSA”)

11. I understand that, under the patent laws in effect after the America Invents Act (“AIA”) of 2011, an assessment of claims of a patent filed after the AIA took effect should be undertaken from the perspective of a person of ordinary skill in the art (“POSA”) as of the “effective filing date” of the patent’s claimed inventions. I understand that because the ’421 patent (and each application to which it claims priority) was filed after the AIA came into effect, the ’421 patent is evaluated from a POSA’s perspective as of the patent’s effective filing date. I understand that the ’421 patent was filed on October 29, 2020. (*See* EX1001 (’421 patent), cover page.) I understand that the ’421 patent, as stated on its face is a

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“continuation-in-part application” of U.S. application No. 16/671,105 (the “’105 application”) [EX1004], filed on October 31, 2019. I express no opinion about the effective filing date for the ’421 patent and have assumed for purposes of my Declaration that it is October 31, 2019.

12. Counsel has advised me that to determine the appropriate level of one of ordinary skill in the art, I may consider the following factors: (a) the types of problems encountered by those working in the field and prior art solutions thereto; (b) sophistication of the technology in question, and the rapidity with which innovations occur in the field; (c) the educational level of active workers in the field; and (d) the educational level of the inventor.

13. The relevant technical field for the ’421 patent is sensor system design. Based on this, and the four factors above, in my opinion a POSA as of October 2019 would have had at least an B.S. in electrical engineering or mechanical engineering (or equivalent degree) and at least one-to-two years of experience in sensor design, such as tire pressure monitoring systems (“TPMS”) or related sensor technology. A person could also have qualified as a person of ordinary skill in the art with a combination of (1) more formal education (such as a doctoral degree) and less technical experience, or (2) less formal educational and more technical or professional experience.

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14. My opinions regarding the level of ordinary skill in the art are based on, among other things, my over twenty years of experience in the relevant areas, my understanding of the basic qualifications that would be relevant to an individual tasked with investigating the methods and devices in the relevant areas, and my familiarity with the backgrounds of researchers and practitioners in the related areas, including colleagues, students, employees, consultants and other individuals, both past and present, who work in these areas.

15. Although my qualifications and experience exceed those of the hypothetical person having ordinary skill in the art defined above, my analysis and opinions regarding the '421 patent have been based on the perspective of a person of ordinary skill in the art in October 2019.

16. My opinions herein regarding the understanding of a person of ordinary skill in the art and my other opinions set forth herein would remain the same if the person of ordinary skill in the art were determined to have somewhat more or less education and/or experience than I have identified above. Similarly, my opinions would remain unchanged for any particular claim if taken from the perspective of a person of ordinary skill in the art in October 2020, the filing date for the '421 patent.

III. STATEMENT OF LEGAL PRINCIPLES

A. Claim Construction

17. I understand that one purpose of claim construction is to determine what a person of ordinary skill in the art would have understood the claim terms to mean. I understand that under the legal principles, claim terms are generally given their ordinary and customary meaning, which is the meaning that the term would have to a person of ordinary skill in the art in question as of the critical date—here, the effective filing date of the patent application.

18. I understand that a person of ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification. I understand that the patent specification, under the legal principles, has been described as the single best guide to the meaning of a claim term, and is thus highly relevant to the interpretation of claim terms. And I understand for terms that do not have a customary meaning within the art, the specification usually supplies the best context to understand the meaning of those terms.

19. I further understand that other claims of the patent in question, both asserted and unasserted, can be valuable sources of information as to the meaning of a claim term. Because the claim terms are normally used consistently throughout

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the patent, the usage of a term in one claim can often illuminate the meaning of the same term in other claims. Differences among claims can also be a useful guide in understanding the meaning of particular claim terms.

20. I understand that the prosecution history can further inform the meaning of the claim language by demonstrating how the inventors understood the invention and whether the inventors limited the invention during prosecution, making the claim scope narrower than it otherwise would be. Extrinsic evidence, such as dictionaries, may also be consulted in construing the claim terms.

21. I understand that, in *Inter Partes* Review (“IPR”) proceedings, a claim of a patent shall be construed using the same claim construction standard that would be used to construe the claim in a civil action filed in a U.S. district court (which I understand is called the “*Phillips*” claim construction standard), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.

22. I have been instructed by counsel to apply the “*Phillips*” claim construction standard for purposes of interpreting the claims in this proceeding, to the extent they require an explicit construction. The description of the legal principles set forth above thus provides my understanding of the “*Phillips*” standard

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as provided to me by counsel.

B. Obviousness

23. I understand that a patent claim is obvious if, as of the critical date (i.e., the effective filing date (under AIA)), it would have been obvious to a person having ordinary skill in the field of the technology (the “art”) to which the claimed subject matter belongs.

24. I understand that the following factors should be considered in analyzing obviousness: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; and (3) the level of ordinary skill in the pertinent art. I also understand that, when present, evidence of “secondary considerations” of non-obviousness are to be considered. Such secondary considerations can include: copying, industry praise, commercial success, long-felt need, failure of others, skepticism, as well as other types of considerations. I am further informed that to support a finding of non-obviousness, the inventor must generally show a “nexus” between the secondary considerations and the features of the invention as claimed. For example, a secondary consideration such as commercial success is not relevant to non-obviousness unless the evidence shows that the commercial success was attributable to features of the claimed invention as opposed to attributable to features that already existed in the prior art.

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25. I understand that a reference qualifies as prior art for obviousness purposes when it is analogous to the claimed invention. The test for determining what art is analogous is: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor's endeavor, whether the reference is still reasonably pertinent to the particular problem with which the inventor is involved.

26. I understand that a person of ordinary skill in the art is assumed to have knowledge of all prior art. I understand that one skilled in the art can combine various prior art references based on the teachings of those prior art references, the general knowledge present in the art, or common sense. I understand that a motivation to combine references may be implicit in the prior art, and there is no requirement that there be an actual or explicit teaching to combine two references. Thus, one may take into account the inferences and creative steps that a person of ordinary skill in the art would employ to combine the known elements in the prior art in the manner claimed by the patent at issue. I understand that one should avoid "hindsight bias" and ex post reasoning in performing an obviousness analysis. However, this does not mean that a person of ordinary skill in the art for purposes of the obviousness inquiry does not have recourse to common sense.

27. I understand that when determining whether a patent claim is obvious

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in light of the prior art, neither the particular motivation for the patent nor the stated purpose of the patentee is controlling. The primary inquiry has to do with the objective reach of the claims, and that if those claims extend to something that is obvious, then the entire patent claim is invalid. By objective reach, I mean some portion of the claim clearly covers any subject matter that would be obvious from the prior art, even if the claims include other subject matter.

28. I understand one way that a patent can be found obvious is if there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. I understand that a motivation to combine various prior art references to solve a particular problem may come from a variety of sources, including market demand or scientific literature. I understand that a need or problem known in the field at the time of the invention can also provide a reason to combine prior art references and render a patent claim invalid for obviousness. I understand that familiar items may have obvious uses beyond their primary purpose, and that a person of ordinary skill in the art will be able to fit the teachings of multiple prior art references together like the pieces of a puzzle. I understand that a person of ordinary skill is also a person of at least ordinary creativity. I understand that when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person

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of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this finite number of predictable solutions leads to the anticipated success, I understand that the invention is likely the product of ordinary skill and common sense, and not of any sort of innovation. I understand that the fact that a combination was obvious to try might also show that it was obvious, and hence invalid, under the patent laws. I understand that if a patent claims a combination of familiar elements according to known methods, the combination is likely to be obvious when it does no more than yield predictable results. Thus, if a person of ordinary skill in the art can implement a predictable variation, an invention is likely obvious. I understand that combining embodiments disclosed near each other in a prior art reference would not ordinarily require a leap of inventiveness.

29. I understand that obviousness may be shown by demonstrating that it would have been obvious to modify what is taught in a single piece of prior art to create the patented invention. Obviousness may also be shown by demonstrating that it would have been obvious to combine the teachings of more than one item of prior art. I understand that a claimed invention may be obvious if some teaching, suggestion, or motivation exists that would have led a person of ordinary skill in the art to combine the invalidating references. I also understand that this suggestion or motivation may come from the knowledge of a person having ordinary skill in the

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art, or from sources such as explicit statements in the prior art. I understand that when there is a design need or market pressure, and there are a finite number of predictable solutions, a person of ordinary skill may be motivated to apply common sense and his skill to combine the known options to solve the problem.

30. I understand the following are examples of approaches and rationales that may be considered in determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of a person having ordinary skill in the art:

- (1) Some teaching, motivation, or suggestion in the prior art that would have led a person of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention;
- (2) Known work in one field of endeavor may prompt variations of it for use in the same field or a different field based on design incentives or other market forces if the variations would have been predictable to a person of ordinary skill in the art;
- (3) Combining prior art elements according to known methods to yield predictable results;
- (4) Applying a known technique to a known device, method, or product ready for improvement to yield predictable results;

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- (5) Applying a technique or approach that would have been “obvious to try” (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);
- (6) Simple substitution of one known element for another to obtain predictable results; or
- (7) Use of a known technique to improve similar products, devices, or methods in the same way.

31. I understand that, when determining whether a claimed combination is obvious, the correct analysis is not whether one of ordinary skill in the art, writing on a blank slate, would have chosen the particular combination of elements described in the claim. Instead, I understand the correct analysis considers whether one of ordinary skill, facing the wide range of needs created by developments in the field of endeavor, would have seen a benefit to selecting the combination claimed.

32. I understand that the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference. By *bodily incorporated*, I mean that the express combination of the disclosures of the prior art have already been combined in the manner that renders the claim invalid for obviousness. Rather, in other words, the test for obviousness is not whether the references could be physically combined without any modification

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from the disclosures therein, but whether the claimed inventions are rendered obvious by the teachings of the prior art as a whole.

33. I understand that a statement in the challenged patent that something is in the prior art is binding on the patentee for determinations of obviousness.

34. I have been informed that when a range disclosed in the prior art overlaps with a range in a patent claim that the overlap creates a presumption of obviousness. I have been informed that a patent owner can rebut this presumption of obviousness based on claiming an overlapping range with the prior art, such as where: (1) the claimed range differs from the prior art range in a manner that produces a new and unexpected result for the claimed invention which differs in kind and not merely in degree from that of the prior art; (2) the prior art taught away from the claimed range despite the overlap with the prior art; and (3) if the claimed parameter was not recognized as a result-effective parameter (but a recognition in the prior art that a property is affected by the variable is sufficient to find the variable result-effective); and (4) the prior art range is extremely broad such that it does not permit routine optimization.

IV. THE '421 PATENT

A. '421 Patent Specification

35. The '421 patent is directed toward “sensor assemblies and systems for

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monitoring dynamic objects” like vehicle tires. (’421, 8:28-30, 8:56-57.) “[I]n 2007 the U.S. government mandated use of direct tire-pressure monitoring systems (TPMS) technology in nearly all motor vehicles.” (*Id.*, 2:52-54.) According to the ’421 patent, then-existent TPMS solutions were “impractical or inadequate” due in relevant part to “[e]xcessive sizing and weight[,]” “[d]ifficulty of affixing to all tire inner surfaces,” and “[l]imited functionality and reporting of total tire performance parameters[.]” (*Id.*, 3:45-57.) The purported invention “seek[s] to fulfill the shortcomings of [] traditional TPMS systems[.]” (*Id.*, 8:57-58.)

36. To that end, the specification depicts various embodiments of sensor assemblies and systems, including the particular configuration below from FIG. 6.

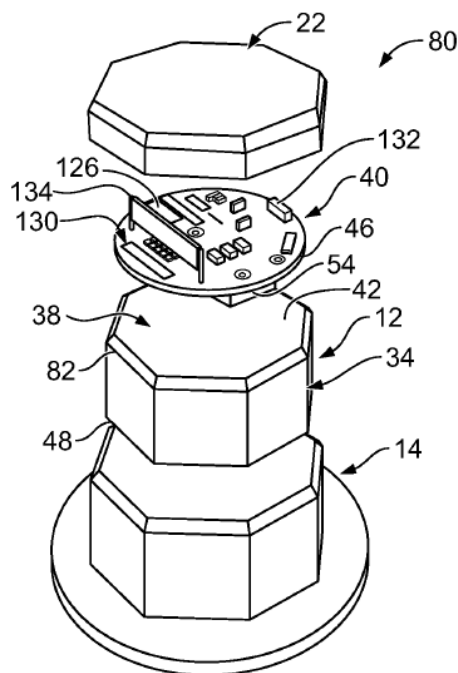


FIG. 6

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(’421, FIG. 6.) The specification describes a sensor assembly **80** comprised of a housing **12**, electrical sensor **40**, and retainer **14**. The housing **12** “comprises a wall structure **34** and bottom section **48** that is provided in an assembled state” and a “top cover **22** that is configured to attach over an opening **82** of [a] housing inside cavity **38**[.]” (*Id.*, 12:7-9, 12:22-24.) While not shown, the ’421 patent explains that inside cavity **38** “is configured having one or more surface features... that engage an underside of the electrical sensor device **40** peripheral edge **46** to fix axial displacement of electrical sensor device **40** within the inside cavity **38**[.]” such as “one or more ribs or tabs that project outwardly a distance from the wall structure inside surface **42**.” (*Id.*, 12:15-22.) In an example, sensor assembly **80** “is assembled by inserting the electrical sensor device **40** into the housing inside cavity **38** until the surface features engage the electrical sensor device **40** to fixedly limit its axial displacement therein.” (*Id.*, 12:25:29.)

37. The ’421 patent’s electrical sensor device “is configured to sense, transmit and/or receive information regarding surrounding conditions, orientation and/or location when the sensor assembly is attached with a dynamic object” like a tire. (’421, 4:34-38.) The specification notes that the sensor element within the device “is configured to sense one or more variables selected from the group consisting of air pressure, temperature, acceleration, or orientation or location of the

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environment[.]” (*Id.*, 4:34-41.)

B. Challenged Claims

38. This Declaration addresses claims 1, 2, 5, 7-12, 20-24, 28, 31-34, 41, 43, 44, 48, and 50-53 (the “Challenged Claims”). (See **EX1018** (Listing of Challenged Claims).) Claims 1, 28, and 41 are independent claims. Claims 2, 5, 7, 9-11, and 20 are dependent claims that depend from claim 1. Claim 8 is a dependent claim that depends from claim 7. Claim 12 is a dependent claim that depends from claim 11. Claims 21-24 are dependent claims that depend from claim 20. Claims 31-33 are dependent claims that depend from claim 28. Claim 34 is a dependent claim that depends from claim 33. Claims 43, 44, and 50-52 are dependent claims that depend from claim 41. Claim 48 is a dependent claim that depends from claim 44. Claim 53 is a dependent claim that depends from claim 52.

39. Independent claim 1 recites:

1[pre] A sensor assembly configured for attachment with an object that
is rotated in use, the sensory assembly comprising:

1[a] a housing comprising an outer surface and an internal cavity that
is enclosed within the housing;

1[b] an electrical sensor device that is disposed within the internal
cavity and attached therein to prevent movement of the device

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within the internal cavity,

1[c] wherein the internal cavity comprises an unfilled open space
above or below the electrical sensor device in the housing,

1[d] wherein the electrical sensor device is configured to sense,
transmit and/or receive information regarding surrounding
conditions, orientation and/or location when the sensor assembly
is attached with the object and the object is rotated in use; and

1[e] a retaining member that is configured to accommodate
attachment of the housing therewith, wherein the retaining
member has an outside surface configured for attachment to
rotate with the object when the object is rotated in use.

('421, cl. 1 (bracket annotations added).)

40. Independent claim 28 recites:

28[pre] A sensor assembly and sensing system for use with an object that
rotates in use comprising:

28[a] a housing comprising an outer structure that defines an open
internal cavity therein,

28[b] an electrical sensor device disposed within the internal cavity and
having a fixed placement therein by one or more surface features

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of the housing configured to contact the electrical sensor device,

28[c] wherein the electrical sensor device is configured to monitor and transmit and/or receive information regarding surrounding conditions, orientation and/or location,

28[d] wherein the electrical sensor device comprises: a portable power source; a sensor; and an antenna for transmitting and/or receiving information relating to the operating parameter being monitored by the sensor;

28[e] a retaining member having an outside surface configured for attaching with a surface of the object or an element connected with the object to rotate with the object in use, wherein the retaining member is configured to accommodate placement a portion of the housing therein to provide an attachment between the housing and the retaining member; and

28[f] a receiver external from the object that is configured to receive information from the electrical sensor device wirelessly.

('421, cl. 28 (bracket annotations added).)

41. Independent claim 41 recites:

41[pre] A method for using a sensor assembly and sensing system with

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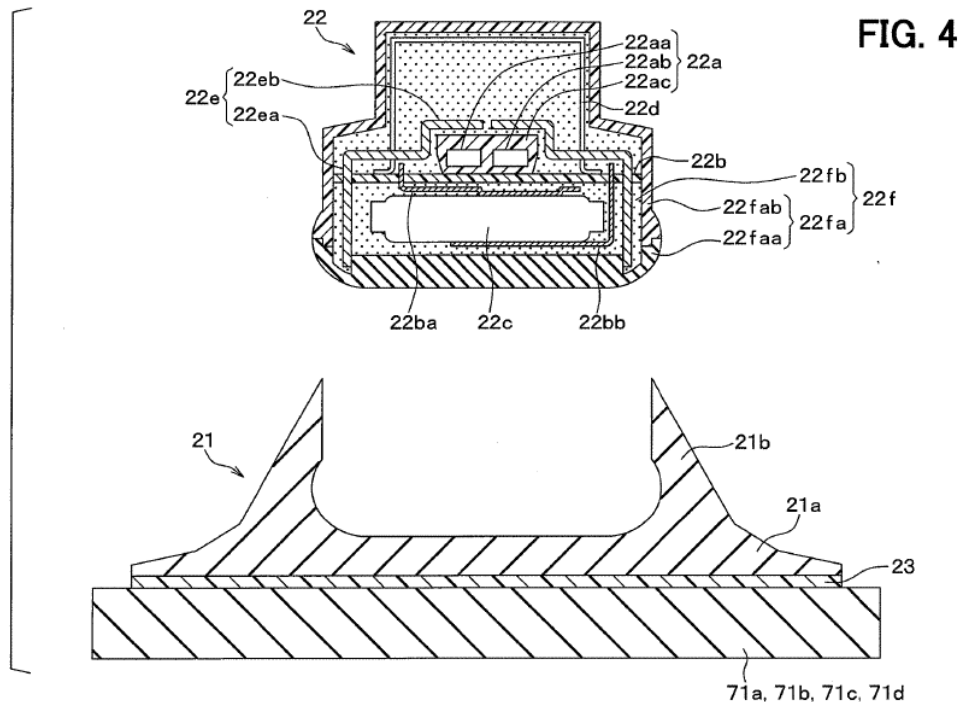
an object that rotates in use comprising the steps of:

- 41[a]** installing an electrical sensor device within an internal cavity of a housing, wherein the housing includes an outer structure that defines the internal cavity, and
- 41[b]** wherein the electrical sensor device comprises a sensor, a portable power source, an antenna, a printed circuit board, and related electrical circuitry,
- 41[c]** wherein the housing comprises an opening extending from an outer surface of the housing to the internal cavity;
- 41[d]** attaching the housing after the step of installing to a retaining member, wherein the retaining member is configured to accommodate attachment with the housing by mechanical or bonding technique, wherein the retaining member is connected with the object before or after formation of the object; and
- 41[e]** monitoring an operating parameter of the object through the use of the electrical sensing device, wherein information related to the operating parameter is wirelessly transmitted from the electrical sensing device to a receiver that is external from the sensor assembly.

(’421, cl. 41 (bracket annotations added).)

C. Relevant Prosecution History

42. During prosecution of the underlying application that matured into the issued ’421 patent, the applicant received a non-final rejection to its originally-drafted claims as anticipated by U.S. Patent Application No. 2019/0184773 to Saito (“Saito”) [EX1005]. (See EX1002, pp. 399-430 (November 23, 2022 Non-Final Rejection).) Saito describes a “tire-mounted sensor” to “be mounted to an inner wall surface of a tire” that includes an acceleration sensor integrated into a sensor chip mounted to a circuit board, along with an antenna for data transmission, the board being fully potted within a housing. (See, e.g., Saito, Abstract, [0003], [0015], [0029]-[0031], [0033], [0035], [0036], [0037], [0040], [0045], [0048], [0049], FIGs. 3, 4.) FIG. 4 depicts Saito’s fully potted acceleration sensor (22aa) in an accommodation structure (22f) of a housing (22), contoured to fit a corresponding rubber bracket (21) affixed to an inner wall surface of a tire.



(Saito, FIG. 4; *see also id.*, [0024]-[0026], [0029], [0030].)

43. In response to the Examiner’s rejection, the applicant amended independent claim 1 to specify that “the internal cavity comprises an unfilled open space above or below the electrical sensor device in the housing.” (EX1002, p. 251 (Applicant’s May 22, 2023 Claim Amendment).)

44. The applicant distinguished Saito’s fully potted accelerometer configuration from its claims, arguing that Saito “fails to expressly or implicitly disclose the feature that the housing internal cavity includes an unfilled open space above or below the electrical sensor device disposed inside the internal cavity”

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because Saito discloses that “the sensor components are encapsulated within the accommodation structure by the resin sealing portion.” (*Id.*, p. 266 (Applicant’s May 22, 2023 Remarks).)

45. The Examiner ultimately found the applicant’s amendments and corresponding arguments persuasive and allowed the claims over Saito. (*Id.*, pp. 65-68 (July 27, 2023 Notice of Allowance).)

46. I address the Challenged Claims further in my detailed analysis below.

V. CLAIM CONSTRUCTION

47. I am informed that in the underlying district court litigation between Petitioner and Patent Owner, the claim construction process is currently ongoing. I understand that Petitioner and Patent Owner have exchanged proposed claim constructions for certain terms in dispute, but that the district court has issued no opinion or order resolving the parties’ claim construction disputes.

48. In particular, I understand that in the underlying district court litigation, Patent Owner has proposed constructions for the following disputed terms within the claims of the ’421 patent, as follows:

Disputed Term	Patent Owner’s Construction
“(a) housing”	a protective cover
“internal cavity”	an open space inside of the housing

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Disputed Term	Patent Owner's Construction
“enclosed” / “enclosed within the housing”	surrounded within the housing
“unfilled open space” / “open space”	space without filling agents or materials
“surface feature[s]”	structure[s] on or of a surface
“fixed”/“having a fixed placement”	not displaceable in at least one direction
“the housing includes an outer structure that defines the internal cavity”	the space inside the housing structure is the internal cavity

(See EX1017, Exhibit A at 5-7, Exhibit B at 10.)

49. For the sole purpose of the opinions I express below in this proceeding, I have applied Patent Owner's proposed constructions for the disputed terms identified in the chart of the preceding paragraph.

50. It is also my understanding that the parties reserved additional terms for construction that may later require the Court's resolution, but the parties' disputes are not presently being resolved. (See EX1017, Exhibit B at 10-15.) I further understand that Patent Owner has taken the position that these remaining reserved terms should be accorded their plain meaning. (*Id.*) While I offer no opinion as to whether there is a plain meaning to these terms, or whether its application is appropriate in the context of the '421 patent claims, I nevertheless apply what I understand Patent Owner's positions to include based on my review of its

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infringement contentions.

51. I also understand that Patent Owner also served infringement contentions on Petitioner, the latest provided on November 7, 2024 [EX1014]-[EX1015], regarding one or more of Petitioner's products. I understand that Patent Owner's infringement allegations with respect to Petitioner's products may provide insight into Patent Owner's understanding of how Patent Owner is interpreting the scope of the claims in light of the recited language in the challenged claims of the '421 patent and in view of Patent Owner's proposed constructions for the above identified terms. I have reviewed Patent Owner's infringement contentions, including the implied and express constructions Patent Owner made through these contentions, in preparing my Declaration.

52. For purposes of applying the prior art to the claims in the present *inter partes* review, however, it is unnecessary to resolve the parties' disputes over the claim terms identified above, and I have not performed claim construction analysis to evaluate the parties' competing positions. My analysis below will show how the prior art satisfies each claim element under the constructions advanced in the pending litigation by Patent Owner.

53. To the extent that Patent Owner attempts to distinguish my mapping of the prior art to the claims based on claim interpretations that differ (either explicitly

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or implicitly) from the ones it advocated for in the underlying litigation (as identified above), I reserve the right to respond accordingly.

54. I further understand that as part of claim construction proceedings in the underlying district court litigation, Petitioner has asserted indefiniteness for several claim terms in dispute. I have been informed by counsel that the Board may not cancel claims for indefiniteness in IPR, and I have not included indefiniteness analyses that are unnecessary to my mapping of the prior art to the claim language for purposes of demonstrating obviousness under Patent Owner's proposed claim constructions.

VI. APPLICATION OF THE PRIOR ART TO CHALLENGED CLAIMS

55. I have reviewed and analyzed the prior art references and materials listed in Section I.B above. In my opinion, the claims of the '421 patent would have been obvious to a person of ordinary skill in the art based on the following combinations of the prior art.

Ground	Claim(s)	Basis for Challenge Under § 103
1	1, 2, 7-9, 11, 12, 20-24	Yamaguchi-727
2	5, 28, 31-33, 41, 43, 44, 48, 50, 51, 52	Yamaguchi-727 in view of Yamaguchi-566
3	34, 53	Yamaguchi-727 in view of Yamaguchi-566 in further view of Dodani-859
4	10	Yamaguchi-727 in view of McDonald

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56. I understand that each of the references cited in the grounds identified above qualifies as prior art to the challenged claims because each reference was effectively filed or published before the '421 patent's earliest possible effective filing date of October 29, 2019. I next provide a summary of these references before applying them to the claims.

A. Brief Summary of the Prior Art

1. Yamaguchi-727 [EX1006]

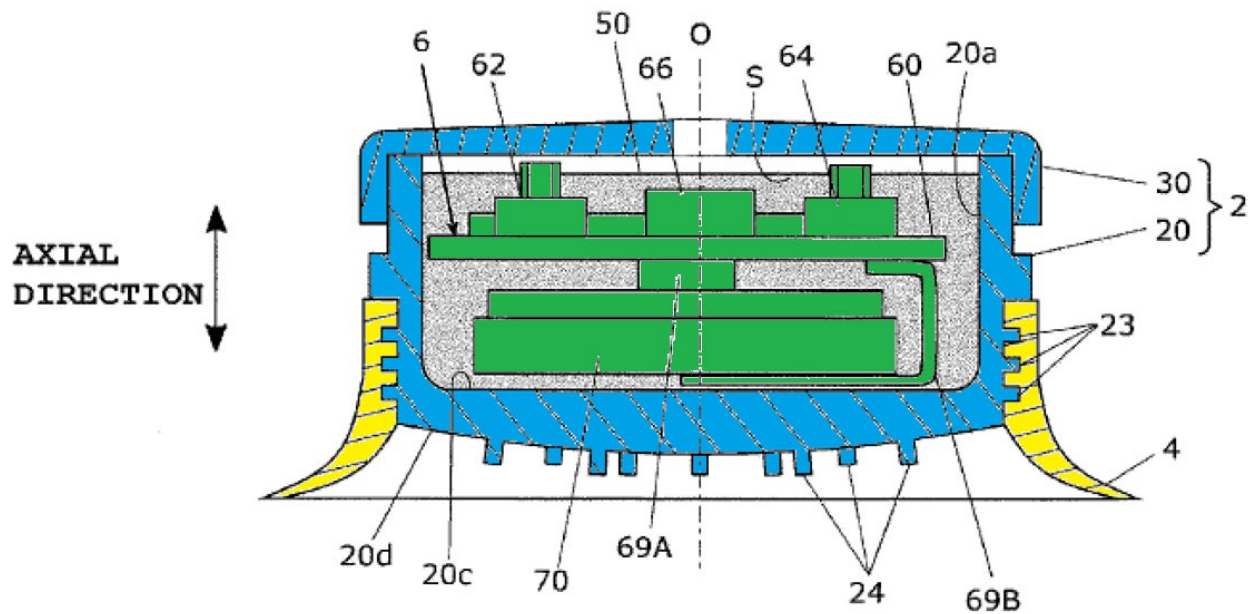
57. United States Patent Application Publication No. U.S. 2021/0370727 to Shigeru Yamaguchi ("Yamaguchi-727") [EX1006], entitled "Functional Component, Structure For Attaching Functional Component to Tire, and Tire," is a published patent application whose PCT application, PCT/JP2019/028506 [EX1019], was filed on July 19, 2019. Having been filed before the effective filing date for the '421 patent, I am informed that Yamaguchi-727 qualifies as prior art to the Challenged Claims.

58. Like the '421 patent, Yamaguchi-727 identifies several issues with pre-existing tire sensor assemblies, including weight that "tends to be high due to a size, a shape and an internal structure of the patch[.]" (Yamaguchi-727, [0004].) As a technical solution, Yamaguchi-727 proposes a similar design to the purported invention in the '421 patent, namely a "functional component in which an electronic

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component capable of acquiring information inside a tire is housed and which is attachable to an inner peripheral surface of the tire[.]” (*Id.*, [0006].)

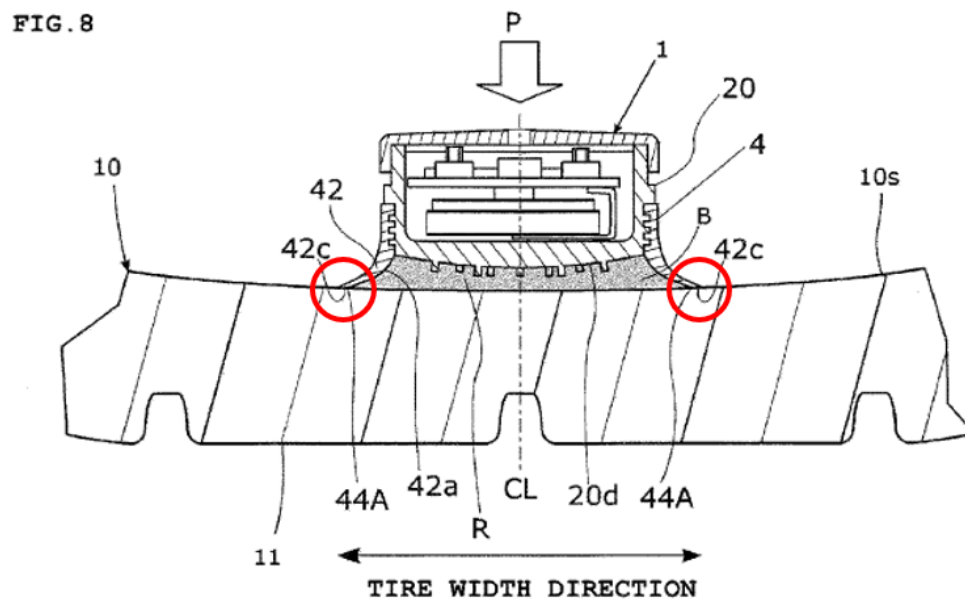
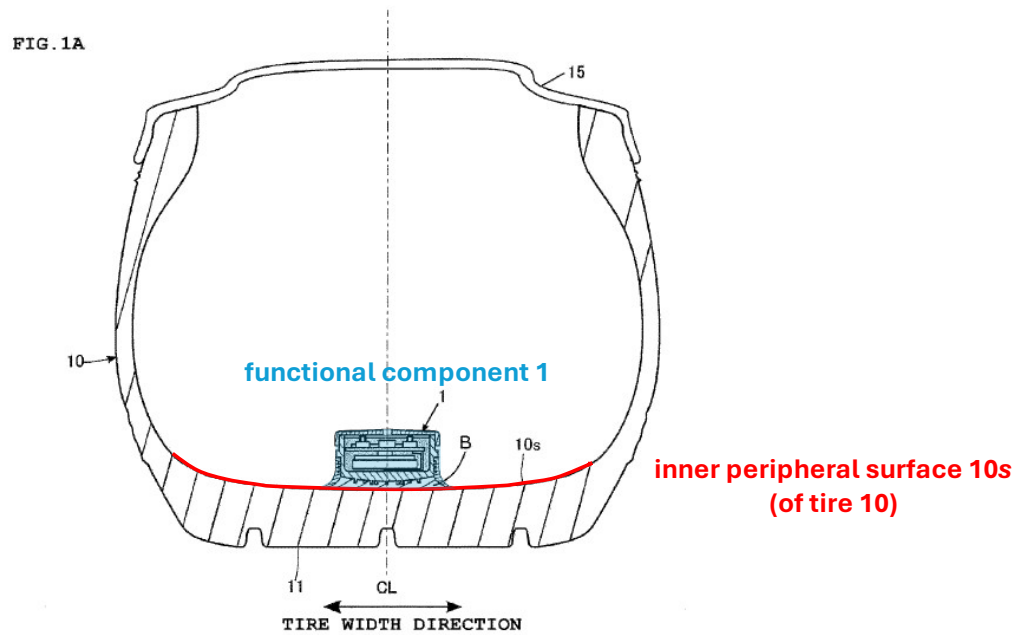
59. Yamaguchi-727 teaches a functional component **1** that includes: (1) a housing **2** comprising a housing cap **30** and housing case **20**; (2) a module **6** disposed within an internal housing space *S* of the housing **2** and comprising a circuit board **60** with various sensors (**62, 64, 66**) and other components, a battery **70**, and other related circuitry; and (3) a skirt **4** that attaches with housing **2** by complimentary features between the two structures (*i.e.*, annular recess **43** of skirt **4** with annular convex parts **23** of housing case **20**). (Yamaguchi-727, [0027], [0028], [0036], [0040]-[0048], FIGs. 3A, 3C, 4A, 4B, 4C, 5.) FIG. 5 below depicts an exemplary arrangement of these subcomponents of functional component **1**. For clarity and consistent with my analysis below, I have annotated housing **2** in blue, module **6** in green, and skirt **4** in yellow.



(*Id.*, FIG. 5 (annotated).)

60. Skirt **4** attaches functional component **1** to inner peripheral surface **10s** of a tire **10** at flat surface **42c** and through use of adhesive agent **B** that fills a cavity space **R** between skirt **4**, housing case **20**, and inner peripheral surface **10s**. (Yamaguchi-727, [0052]-[0054], FIGs. 1A, 7, 8.) FIGs. 1A and 8 depict this specific arrangement.

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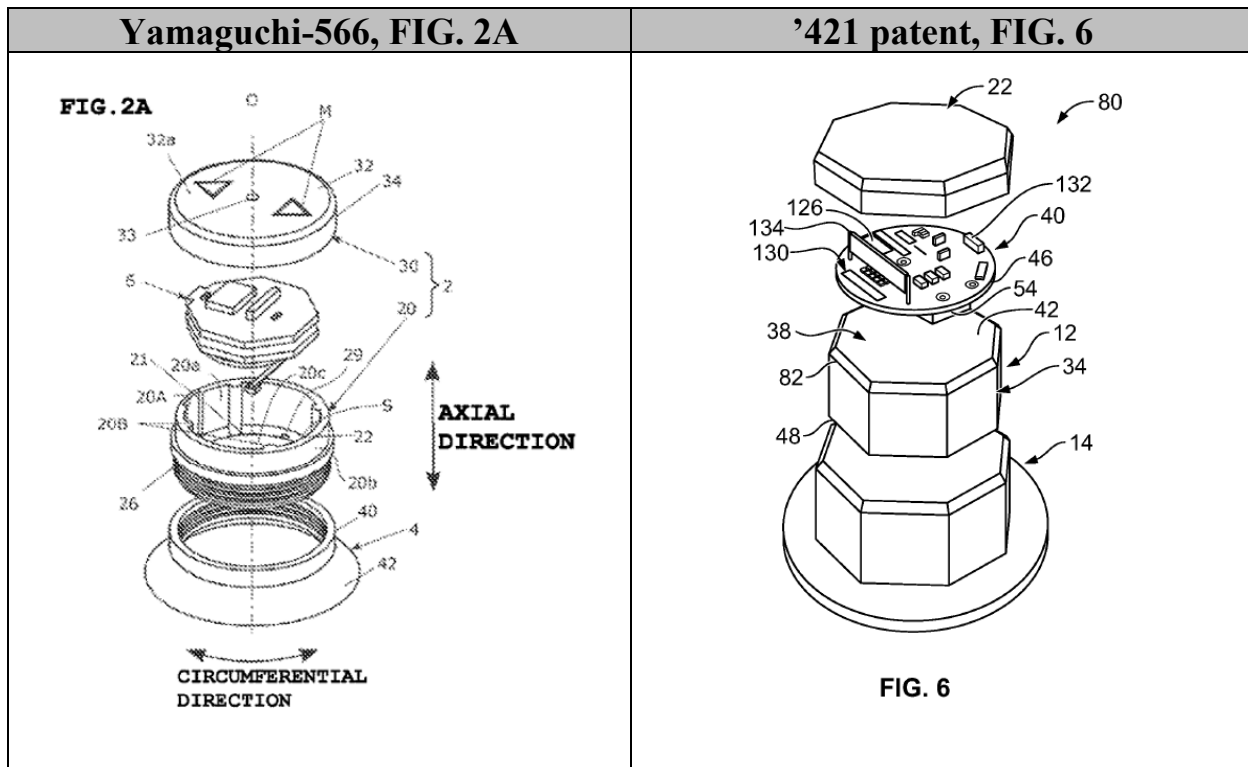
(*Id.*, FIGs. 1A, 8 (annotated).)

61. I discuss additional details from Yamaguchi-727 in my analysis below related to Grounds 1-4.

2. Yamaguchi-566 [EX1007]

62. United States Patent Application Publication No. U.S. 2021/0394566 to Shigeru Yamaguchi (“Yamaguchi-566”) [EX1007], entitled “Functional Component,” is a published patent application whose PCT application, PCT/JP2019/028502 [EX1020], was filed on July 19, 2019, the same day as Yamaguchi-727. Having been filed before the effective filing date for the ’421 patent, I am informed that Yamaguchi-566 qualifies as prior art to the Challenged Claims.

63. Yamaguchi-566 shares disclosures with Yamaguchi-727 in its disclosure of “[a] functional component to be attached inside a tire, for detecting a state of the tire as information.” (Yamaguchi-566, Abstract, [0006].) Like Yamaguchi-727, Yamaguchi-566 describes in detail that its functional component includes a housing **2** with a housing case **20** having a housing space *S* for the module **6** and enclosed by a housing cap **30**, attached to a skirt **4** that adheres to an inner peripheral surface of a tire. (*Id.*, [0017], [0018], [0020], [0024], [0027], FIGs., 1A, 2A, 2B.) Yamaguchi-566 also includes FIG. 2A that depicts an exploded view of its functional component that is near-identical to the sensor assembly disclosed in FIG. 6 of the ’421 patent:

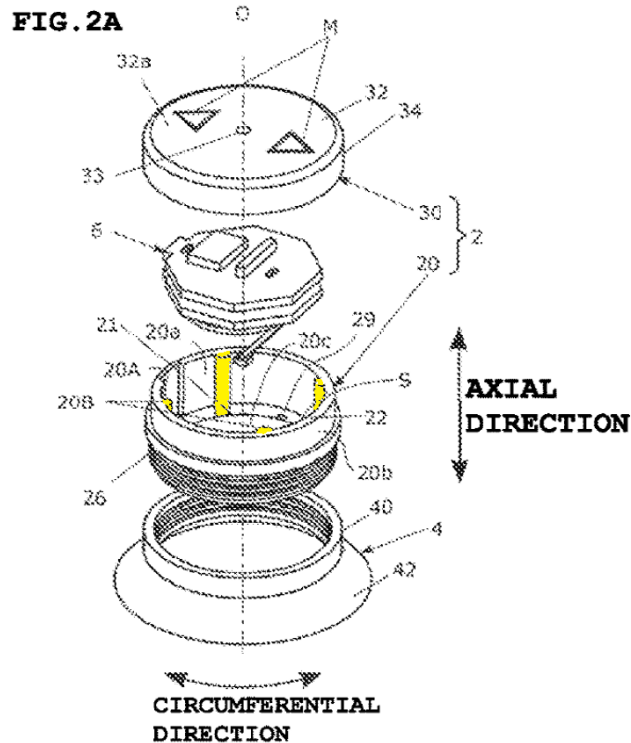


64. Yamaguchi-566 additionally teaches that the housing case **20** includes ribs and a groove on its inner peripheral wall surface to prevent axial movement of module **6** in the internal cavity of the housing:

On the inner peripheral surface **20a** of the peripheral wall part **22**, a concave part **20A** recessed outwardly in the radial direction relative to the axis O and a plurality of convex parts **20B** protruding toward the direction of the axis O and extending along the axis O are formed so as to position the module **6** housed in the housing space S at a predetermined position. The bottom part **21** of the housing case **20** is provided with a through hole **29** that penetrates from the inner bottom surface **20c** to an outer bottom surface **20d**. Furthermore, the inner bottom surface **20c** of the bottom part **21** is provided with a support means such as a protrusion, which is not shown in the figure, that supports the module **6** housed in the housing space S from a lower side.

(Yamaguchi-566, [0022] (underlining added).) These ribs, described as convex

parts **20B**, and the groove, described as concave part **20A**, are depicted in FIG. 2A with the “ribs” highlighted yellow.



(*Id.*, FIG. 2A (annotated).)

65. I rely on Yamaguchi-566’s teachings on convex parts **20B** and concave part **20A**, in addition to additional details related to module **6**, in my Grounds 2 and 3 analyses below.

3. Dodani-859 [EX1009]

66. WO 2020/036859 to Sunjay Dodani et al. (“Dodani-859”) [EX1009] is an international patent application entitled “Tire Sensor Device,” filed on August 12, 2019, and published on February 20, 2020. Having been filed and published

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before the effective filing date for the '421 patent, I am informed that Dodani-859 qualifies as prior art to the Challenged Claims.

67. Like Yamaguchi-727 and Yamaguchi-566, Dodani-859 also describes a tire sensor device “that is adapted to be mounted to a tire without invasive mounting requirements” and includes, *e.g.*, “a plurality of sensors beyond a TPMS, including, optionally, a high-frequency accelerometer, a microphone, and/or a temperature sensor.” (Dodani-859, [0024].) The tire sensor is “adapted to capture, measure, and analyze data from the tire using the plurality of sensors.” (*Id.*) Dodani-859 explains that “[b]y using a high-frequency accelerometer, for example, characteristics of individual rotations of each tire (*e.g.*, the tires ‘footprint’) can be determined.” (*Id.*; *see also id.*, [0034] (“[T]he accelerometer 108 is adapted to detect and/or measure changes in the motion of the tire, for example, as the tire is driven on a road surface.”).)

68. Dodani-859 provides multiple use cases for data generated from its accelerometer. An example includes sensing high-frequency vibrations in a tire, “to understand the road surface, and/or the friction between the tire and the road surface” by “using the data from the plurality of sensors acquired at the frequency greater than the frequency of rotation of the tire[.]” (*Id.*, [0081].) Another use includes “determining that the tire is mounted to a misaligned wheel includes detecting that

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data from the accelerometer include periodic motion of the tire along an axis of rotation of the tire (e.g., at the frequency of rotation of the tire).” (*Id.*, [0083].)

69. I rely on Dodani-859’s teachings regarding the use of accelerometer data in my analysis for Ground 3.

4. McDonald [EX1008]

70. United States Patent No. 6,769,319 to William G. McDonald et al. (“McDonald”) [EX1008], entitled “Component Having a Filter,” was filed on July 9, 2001 and issued on August 3, 2004. Having been filed and published before the effective filing date for the ’421 patent, I am informed that McDonald qualifies as prior art to the Challenged Claims.

71. McDonald, which was filed almost twenty years before Patent Owner filed the application maturing into the ’421 patent, teaches a commonly-used technique of using a filter in a tire-mounted sensor assembly. McDonald explains that a filter “can block potentially corrosive elements or media from the exterior environment while still permitting the unhindered transmission of pressure from the exterior environment to the sensor element inside the component.” (McDonald, 2:57-63; *see also id.*, 7:1-10 (describing efficacy of using a filter to protect against various corrosive compounds found or used with tires).) The specification describes multiple configurations for the filter within the sensor assembly, including a filter

345 (in yellow below) within housing **110** to cover a hole **551** that is in communication with a cavity **125** leading to a sensor element **105**. (*Id.*, 6:24-27.)

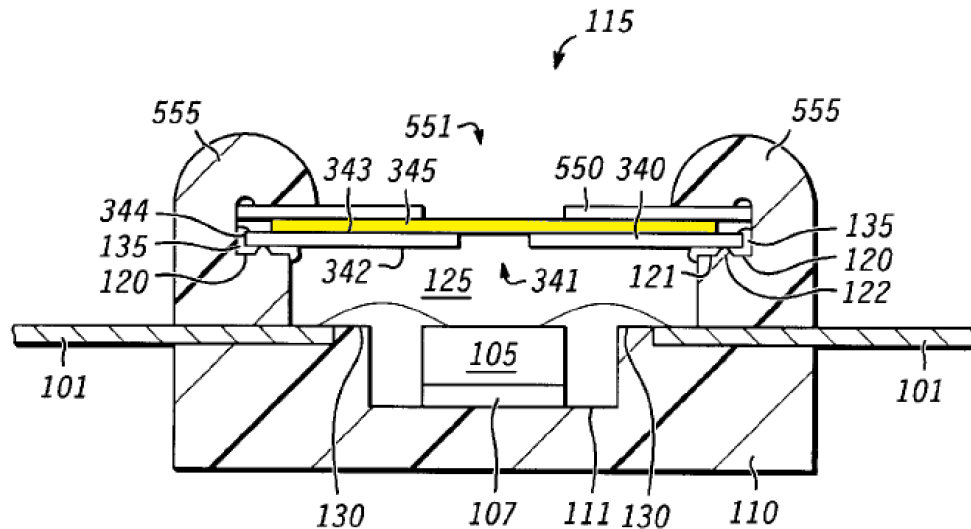


FIG. 6 100

(*Id.*, FIG. 6 (annotated).)

72. I rely on McDonald's filter teachings in my analysis for Ground 4.

B. Ground 1: Yamaguchi-727 Renders Obvious Claims 1, 2, 7-9, 11, 12, and 20-24

1. Independent Claim 1

(a) Claim 1[pre]: "A sensor assembly configured for attachment with an object that is rotated in use, the sensor assembly comprising:"

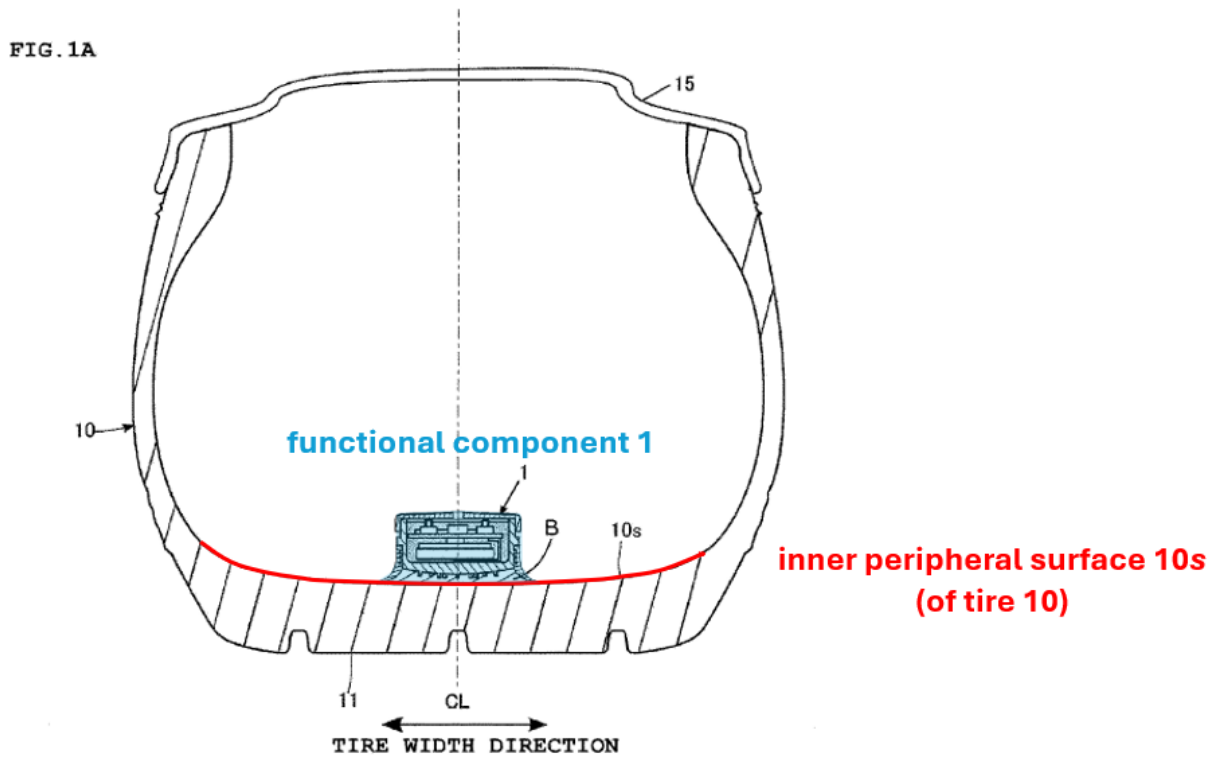
73. To the extent the preamble is limiting, in my opinion it is disclosed by Yamaguchi-727. Yamaguchi-727 teaches "[a] functional component [1] in which

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an electronic component capable of acquiring information inside a tire is housed and which is attachable to an inner peripheral surface of the tire[.]” (Yamaguchi-727, Abstract; *see also id.*, [0025]-[0027], [0040], FIG. 1A.)

74. The described functional component **1** is a “**sensor assembly**,” as it contains a module **6** that “is provided with a circuit board **60**” that “includes the electronic component which are, for example, a plurality of sensors... each of which functions as a state acquiring means that acquires a state inside the tire[.]” (*Id.*, [0040]; *see also id.*, FIG. 5 (depicting module **6** provided with circuit board **60** that includes sensors **62**, **64**, and **66**).)

75. Functional component **1** is also “**configured for attachment with an object that is rotated in use**.” Yamaguchi-727 describes how functional component **1** is attached to a tire **10**, which is an “**object that is rotated in use**,” as contemplated by the ’421 patent specification. (*See, e.g.*, ’421, 8:38-57.) Functional component **1** is “fixed by an adhesive agent B to an inner surface (inner peripheral surface **10s**) of the tire **10** and is disposed in the center in a width direction of the inner peripheral surface **10s** that is a back side of a tread **11**,” (Yamaguchi-727, [0026]), as shown in FIG. 1A below.

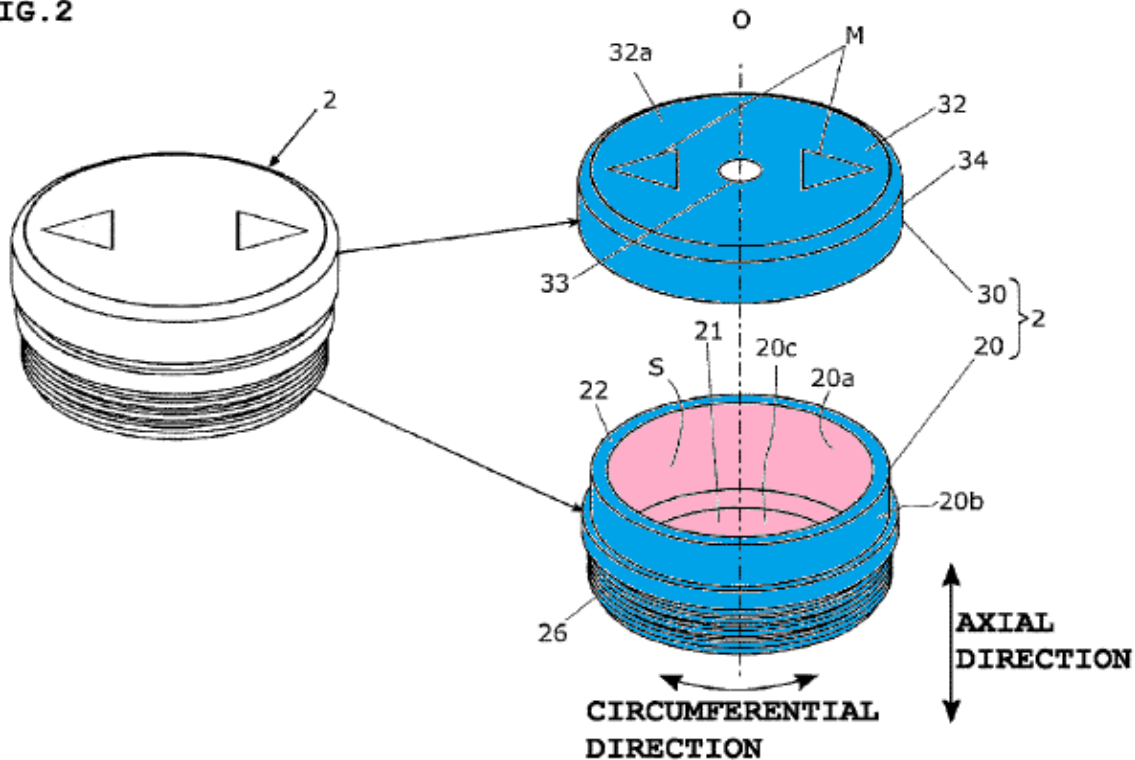


(*Id.*, FIG. 1A (annotated).)

(b) **Claim 1[a]: “a housing comprising an outer surface and an internal cavity that is enclosed within the housing;”**

76. Yamaguchi-727 discloses claim 1[a]. Yamaguchi-727 has a “**housing comprising an outer surface**” in housing 2, defined by housing case 20 and housing cap 30. (Yamaguchi-727, [0028].) Housing case 20 forms a housing space *S*, which is an “**internal cavity that is enclosed within the housing**” when housing cap 30 covers housing case 20. (*Id.*, [0029].) FIG. 2 below depicts housing 2 in an exploded view of housing case 20 and housing cap 30 (in blue) to show how housing case 20 forms a housing space *S* (in pink).

FIG. 2



(Yamaguchi-727, FIG. 2 (annotated).)

77. Yamaguchi-727 describes how housing case **20** is formed “by a circular bottom part **21** and a peripheral wall part **22** extending along the outer periphery from the outer peripheral edge of the bottom part **21** and rising annularly from the bottom part **21**.” (Yamaguchi-727, [0029].) Housing space *S* is an “**internal cavity that is enclosed within the housing**” defined by housing case **20** and housing cap **30**. It is “formed by an inner bottom surface **20c** of the bottom part **21** and an inner peripheral surface **20a** of the peripheral wall part **22**[,]” (*id.*), and a “cap **30** functioning as a lid member for the housing case **20**” (*id.*, [0028]), to enclose the

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internal cavity.

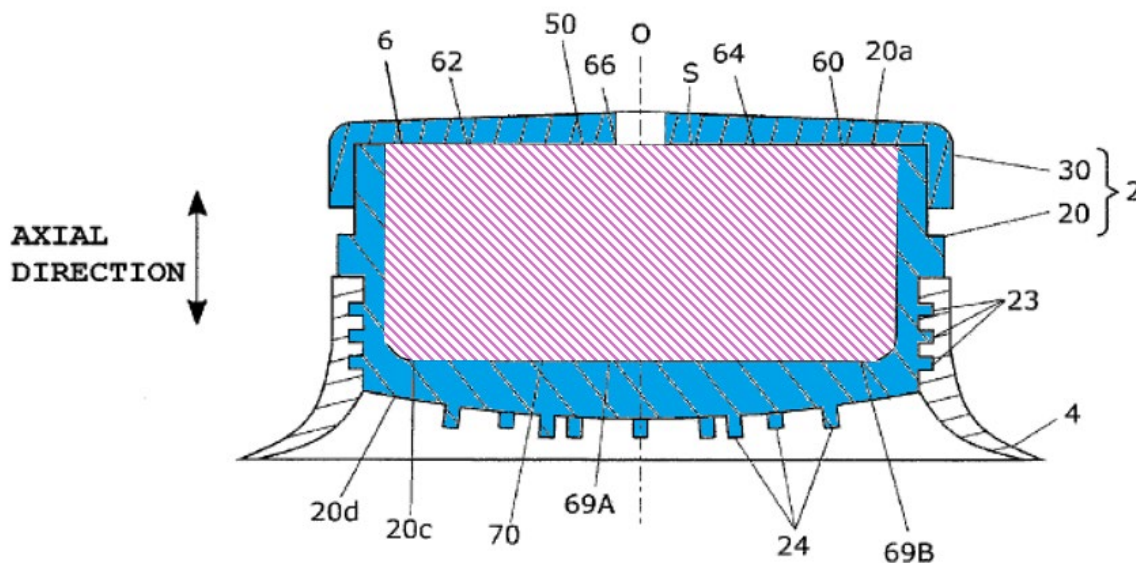
78. Yamaguchi-727 also discloses claim 1[a] under Patent Owner’s proposed constructions, as discussed further below.

79. **“housing”**: Patent Owner construes this term as “a protective cover.” (EX1017, Exhibit A at 5.) Yamaguchi-727’s housing **2** satisfies Patent Owner’s interpretation of “housing,” as housing case **20** and cap **30** act as a protective cover over module **6**, the electrical sensor device within functional component **1**. (*See, e.g.,* Yamaguchi-727, [0028] (“[t]he housing **2** includes the housing case **20** having a housing space S (housing part) for a module **6**, and a cap **30** functioning as a lid member for the housing case **20**, and is formed in a generally disk shape by combining the housing case **20** and the cap **30** together.”), [0029] (“In the housing case **20**, a housing space S that can housing the module **6** is formed...”), FIG. 5.)

80. **“internal cavity”**: Patent Owner claims the plain meaning for “internal cavity” is “an open space inside of the housing.” (EX1017, Exhibit A at 5-6.) Housing space *S* in Yamaguchi-727 discloses this interpretation of “internal cavity,” as it is an open space within housing case **20** and housing cap **30**. (*See, e.g.,* Yamaguchi-727, [0028], [0029], FIG. 2.)

81. **“enclosed within the housing”**: Patent Owner proposes that this term means “surrounded within the housing” (EX1017, Exhibit A at 6), which, as I have

stated, is present in Yamaguchi-727 when housing case **20** is covered by cap **30**. (See, e.g., Yamaguchi-727, [0028], [0029], FIG. 2.) As shown in my annotations to FIG. 5 below, the “**housing**” (in blue) discussed in Yamaguchi-727 surrounds the “**internal cavity**” (in pink crosshatch) on all sides.



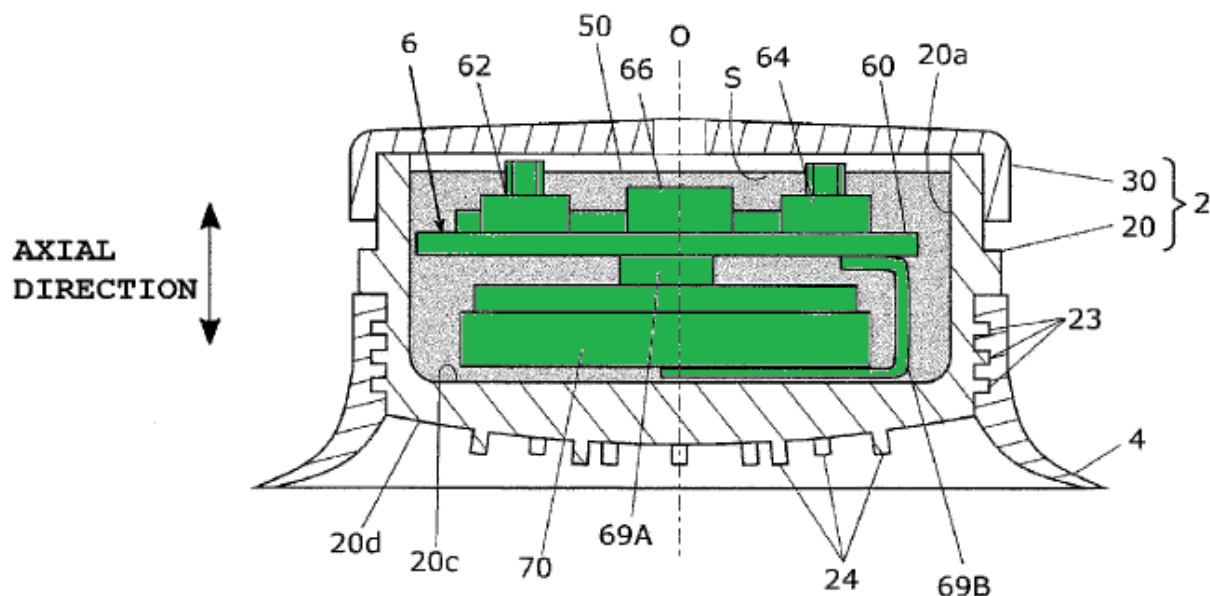
(*Id.*, FIG. 5 (annotated).) I use FIG. 5 below where practicable to guide my analysis for the remaining elements of claim 1.

- (c) **Claim 1[b]: “an electrical sensor device that is disposed within the internal cavity and attached therein to prevent movement of the device within the internal cavity,”**

82. Yamaguchi-727 discloses claim 1[b]. The “**electrical sensor device**” in Yamaguchi-727 is represented by module **6** and includes circuit board **60**. Circuit board **60** further includes “electronic components which are, for example, a plurality

of sensors such as a temperature sensor **62**, a pressure sensor **64** and an acceleration sensor **66** and the like...” (Yamaguchi-727, [0040] (underlining added).) Module **6** is annotated in green in FIG. 5 below, and clearly shown to be “**disposed within the internal cavity**” represented by housing space *S*.

FIG. 5



(*Id.*, FIG. 5 (annotated).)

83. Circuit board **60** is “**attached... to prevent movement of the device within the internal cavity.**” While not shown in its figures, Yamaguchi-727 teaches “circuit board **60** and the housing case **20** are provided with *a positioning means*, which is not shown in the figure, *that are mutually fitted with each other*. Whereby,

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a measurement direction of the acceleration sensor 66 relative to the housing case **20** is defined.” (Yamaguchi-727, [0042].) The “positioning means” that serves to “mutually fit” circuit board **60** and housing case **20** together ensures that the accelerometer on circuit board **60** is properly oriented within the housing and prevents at least radial movement about axis O within housing space *S*. (*Id.*, [0042].)

84. After the circuit board **60** is placed within housing space *S* using the mutually fitting “positioning means,” the housing space *S* is filled with a potting material **50**, shown in grey shading in FIG. 5 above. (*Id.*, [0048].) Potting material **50** “eliminate[s] a gap between the module **6** [containing circuit board **60**] and the inner bottom surface **20c** and the inner peripheral [surface] **20a** forming the housing space *S*” and further serves to attach the circuit board **60** within the housing’s internal cavity (*S*) to prevent movement of the module **6** and, in particular, circuit board **60**. (*Id.*, [0048].) As noted in Yamaguchi-727, “urethane-silicone resin or epoxy resin” are preferable materials for potting material **50**, such that they can retain the electrical components in place and “maintain sufficient resistance to forces received from the battery **70** and the circuitry board **60** even when the tire **10** is rotating, especially when the tire **10** is rotating at high speed.” (*Id.*) This further demonstrates that the potting material **50** is used to prevent movement of the components of module **6** (e.g., circuit board **60**) within the internal cavity of the housing case **20**. Additionally, the ’421

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patent further admits to this known use of potting material in automotive sensors which serves to prevent the movement of sensor boards used within the automotive industry, just like Yamaguchi-727: “A common technique used to assist in fixturing the electrical sensor device **40** known within the automotive industry is to fill the internal cavity with a coating material such as a neutral silicone or the like for purposes of retaining placement position.” (*See* ’421, 13:56-60.)

85. While sufficient to retain the placement of module **6** and circuit board **60**, Yamaguchi-727 discloses that potting material **50** does not completely fill housing space *S*. Rather, “even in the state of being filled with the potting material **50**, the communication between respective measurement parts of the temperature sensor **62** and the pressure sensor **64** and the tire air chamber is maintained” (Yamaguchi-727, [0048].), as indicated by the free path from the outside of the housing through the hole centered at “O” and passing into the housing space *S* above the top level of the potting material and with direct fluid communication with the temperature sensor **62**, and the pressure sensor **64** (and as depicted in orange in the image in the following claim element 1[c]).

(d) Claim 1[c]: “wherein the internal cavity comprises an unfilled open space above or below the electrical sensor device in the housing,”

86. Yamaguchi-727 discloses claim 1[c]. FIG. 5 depicts an “**internal**

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tire air chamber is maintained[.]” (Yamaguchi-727, [0048]; *see also id.*, [0043].)

88. Yamaguchi-727 further discloses claim 1[c] under Patent Owner’s proposed construction for “**unfilled open space**” as “**space without filling agents or materials.**” (EX1017, Exhibit A at 6.) The unfilled portion of housing space *S* (orange in FIG. 5 above) lacks any filling agents or materials in order to “maintain” communication between the protruding sensors **62** and **64** and the tire air chamber (via the opening in housing cap **30**).

(e) **Claim 1[d]: “wherein the electrical sensor device is configured to sense, transmit and/or receive information regarding surrounding conditions, orientation and/or location when the sensor assembly is attached with the object and the object is rotated in use; and”**

89. Yamaguchi-727 discloses claim 1[d]. Yamaguchi-727 describes an “electrical component capable of acquiring information inside a tire[.]” (Yamaguchi-727, [0006].) Module **6** is “**configured to sense, transmit and/or receive information**” related to the tire when functional component **1** is mounted to the interior peripheral surface **10s** of tire **10**.

90. Module **6** includes circuit board **60** with “electronic components which are, for example, a plurality of sensors such as a temperature sensor **62**, a pressure sensor **64** and an acceleration sensor **66** and the like...” (*Id.*, [0040].) Each sensor within circuit board **60** demonstrates that module **6** is configured to “**sense**” and

“receive information regarding surrounding conditions, orientation and/or location when the sensor assembly is attached” within the tire and the tire is rotated in use. Yamaguchi-727 teaches that its sensors **62**, **64**, and **66** “each ... function[] as a state acquiring means that acquires a state inside the tire[.]” (*Id.*) The specification further describes how “[t]he temperature sensor **62** and the pressure sensor **64** measure, ... a temperature and a pressure in the tire air chamber, respectively.” (*Id.*, [0043].) Measurements of temperature and pressure from sensors **62** and **64**, respectively, constitute **“information regarding surrounding conditions”** within the tire air chamber. Similarly, acceleration sensor **66** in Yamaguchi-727 is a “sensor capable of measuring acceleration in three axial directions, ... and is mounted so that each measurement direction faces a predetermined direction relative to the circuit board **60**.” (*Id.*, [0044].) The acceleration measurements constitute **“information regarding... orientation and/or location”** within the tire air chamber.

91. Module **6** is also configured to **“receive”** the information collected from the sensors. Yamaguchi-727 explains that circuit board **60** of module **6** includes “a memory means that stores histories of the detected values detected by each of the sensors **62**, **64**, and **66**[.]” (Yamaguchi-727, [0040]; *see also id.*, [0046] (“The memory means records the history of the temperature, the pressure and the

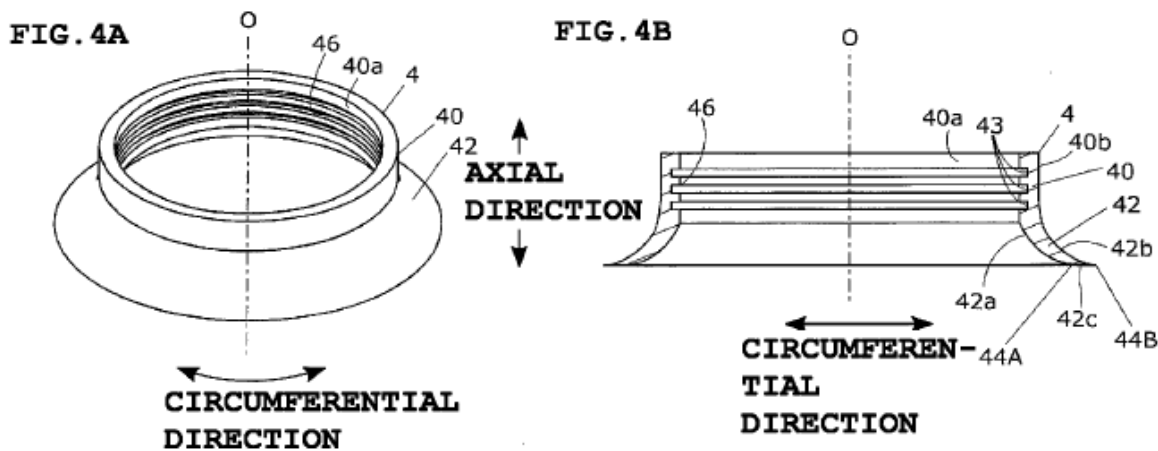
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acceleration inside the tire **10** detected by the temperature sensor **62**, the pressure sensor **64** and the acceleration sensor **66**, as well as manufacture information and quality information of the tire.”.)

92. Finally, module **6** is configured to “**transmit**” information its sensors collect from within the tire. Yamaguchi-727 describes how circuit board **60** within module **6** includes a transmitting means “for outputting detected values detected by each of the sensors **62**, **64** and **66** to the outside of the tire[.]” (Yamaguchi-727, [0040].) The transmitting means is “mounted on the circuit board as a transmitting circuit and transmits... to the outside of the tire via an antenna.” (*Id.*, [0045].)

- (f) **Claim 1[e]: “a retaining member that is configured to accommodate attachment of the housing therewith, wherein the retaining member has an outside surface configured for attachment to rotate with the object when the object is rotated in use.”**

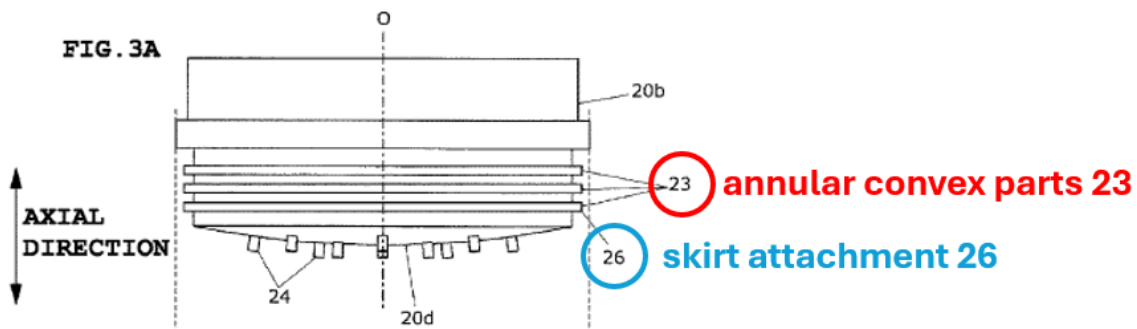
93. Yamaguchi-727 discloses claim 1[e]. The specification describes a “**retaining member**” in skirt **4** that “is attached to the [] skirt attachment part **26** formed in the housing case **20**, and extends from the outer bottom surface **20d** of the housing **2** toward the inner peripheral surface **10s** side of the tire **10**.” (Yamaguchi-727, [0035].) Skirt **4** is shown in FIGs. 4A and 4B below.



(*Id.*, FIGs. 4A, 4B; *see also id.*, [0035], [0037], [0038].)

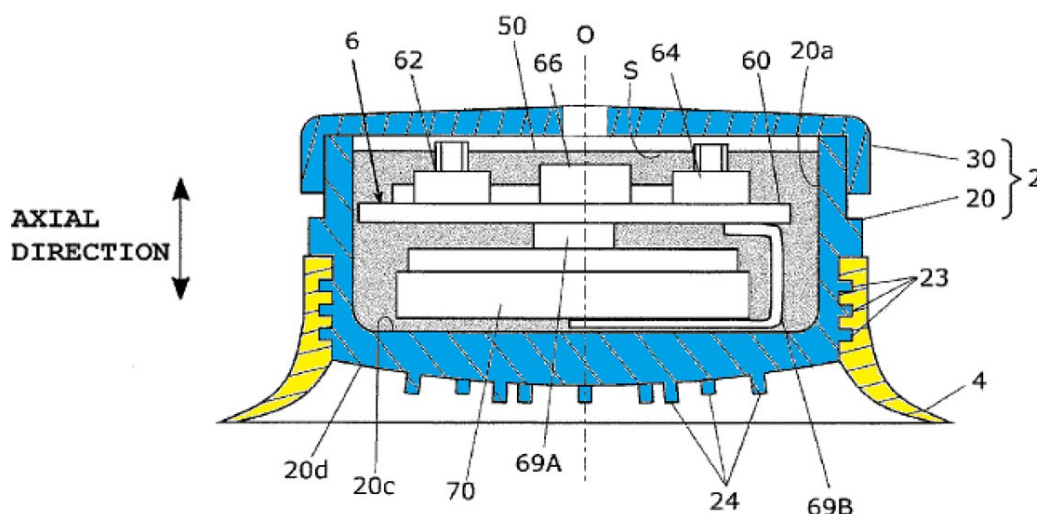
94. Skirt 4 includes annular recesses 43 that are “**configured to accommodate attachment**” of housing 2 through complimentary fitment with annular convex parts 23 of skirt attachment part 26 within housing case 20 (part of housing 2). The specification describes with reference to FIGs. 3A-3C how housing 2 includes “a skirt attachment part 26, to which a skirt 4 described later can be attached, is formed on an outer peripheral surface 20b of the peripheral wall part 22.” (Yamaguchi-727, [0030].) FIG. 3A shows how skirt attachment part 26 “is configured by a plurality of annular convex parts 23 formed on a lower half of the peripheral wall part 22.” (*Id.*)

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(*Id.*, FIG. 3A (annotated).)

95. Yamaguchi-727 teaches that the annular recesses **43** in skirt **4** “extend[] over the inner peripheral surface **40a** all the way around ... to be able to be mated with the annular convex part **23** provided in the housing case **20**.” (Yamaguchi-727, [0036]; *see also id.* (“In other words, the annular concave parts **43** are provided at intervals and in quantity corresponding to the annular convex parts **23**.”)). FIG. 5 depicts how the annular convex parts **23** in housing case **20** mate with the annular recesses **43** within skirt **4** to attach housing **2** (in blue) to skirt **4** (in yellow).



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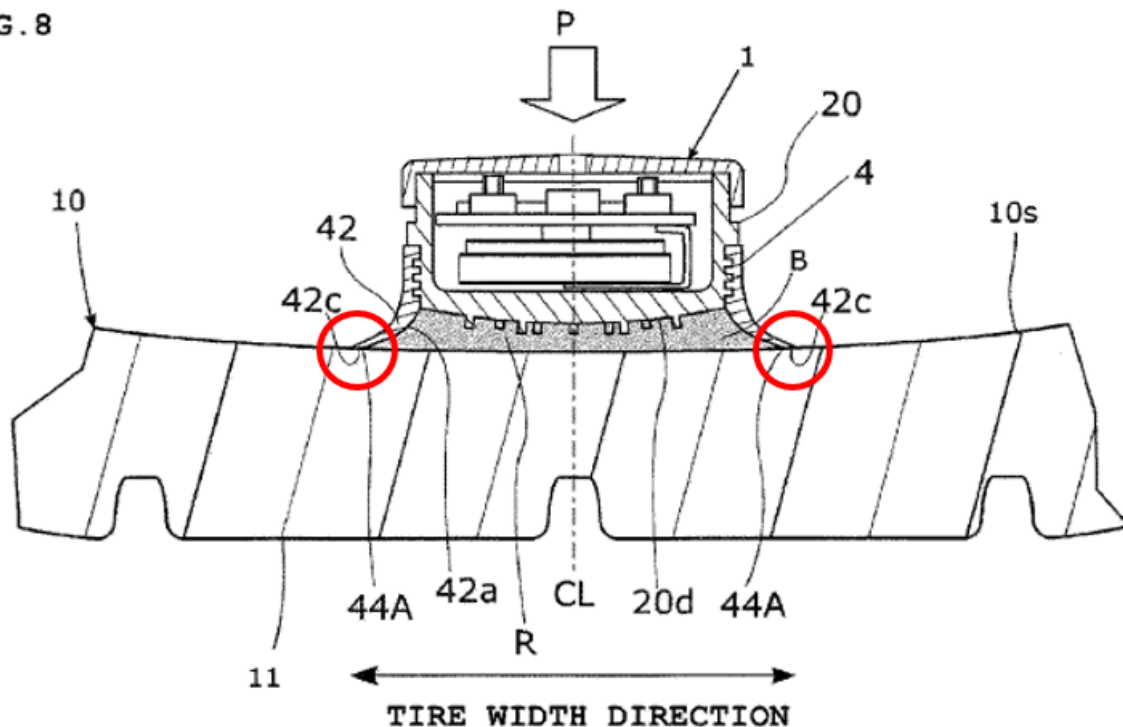
(Yamaguchi-727, FIG. 5 (annotated); *see id.*, FIG. 4C (depicting housing **2** attached to skirt **4**), [0035].)

96. Skirt **4** also **“has an outside surface configured for attachment to rotate with the object when the object is rotated in use.”** Yamaguchi-727 describes how functional component **1** is mounted to tire **10** through an adhesive agent **B** that fills a space defined by the peripheral surface **42** of skirt **4**:

As discussed above, the functional component **1** is configured to be attached in a state that the adhesive agent **B** is densely filled in the filling space R enclosed by the outer bottom surface **20d** facing the inner peripheral surface **10s** of the tire **10**, the inner peripheral surface **42a** of the skirt **4** that expands in diameter and extends in a tubular shape from the peripheral edge of the outer bottom surface **20d** toward the inner peripheral surface **10s**, and the inner peripheral surface **10s** of the tire **10**.

(Yamaguchi-727, [0054].) FIG. 8 depicts the above-configuration and how skirt **4** includes an **“outside surface configured for attachment”** at item **42c**, encircled in red below.

FIG. 8



(*Id.*, FIG. 8 (annotated).) The specification confirms the function of the outer surface at item **42c**, noting “there may be provided a structure for attaching, to a tire, the functional component described above, in which the end part of the tubular part is abutted against the inner peripheral surface of the tire, and an adhesive agent is filled in a filling space enclosed by an inner peripheral surface of the tubular part, the bottom surface of the housing and the inner peripheral surface of the tire.” (Yamaguchi-727, [0007] (underlining added); *see also id.*, [0008].)

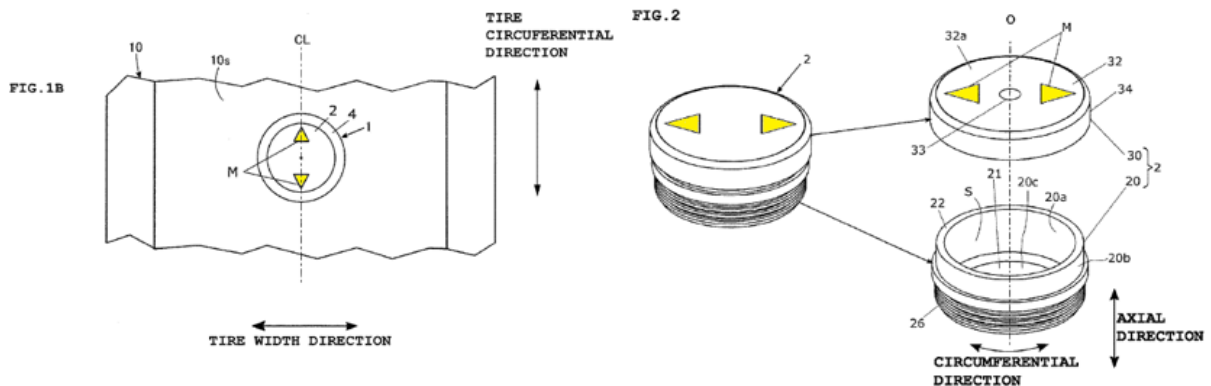
97. Yamaguchi-727 discloses how skirt 4, including its outside surface, is configured “**to rotate with the object when the object is rotated in use**” by being

mounted to the inner side **10s** of the tire. When tire **10** rotates while the vehicle is in use, so too would item **42c** of skirt **4**. It is an inherent feature of placement of functional component **1** within the inner peripheral surface of the tire. (*See, e.g.*, Yamaguchi-727, [0007], FIG. 1A.)

2. Dependent Claim 2

98. Claim 2 depends from claim 1 and recites “**wherein the housing outer surface includes one or more display features or indicia that are viewable to a user when the housing is attached with the retaining member.**” (’421, cl. 2.) Attachment marks on Yamaguchi-727’s housing cap **30** disclose claim 2.

99. Yamaguchi-727 describes how its housing cap **30** (part of housing **2**) has a circular ceiling part **32** that includes an outer side surface **32a** where “attachment marks M are formed to indicate a direction for attaching the functional component **1** to the tire **10**.” (Yamaguchi-727, [0034].) These attachment marks M “are indicated, for example, by engraving or printing” and “show that the functional component **1** is to be attached on the inner peripheral surface **10s** of the tire **10** in such a manner that the arrows are oriented in the tire circumferential direction.” (*Id.*) The attachment marks “M” are outwardly visible to a user from the face of the cap **30** as shown by the yellow arrows in FIGs. 1B and 2 below.



(Yamaguchi-727, FIGs. 1B, 2 (annotated).)

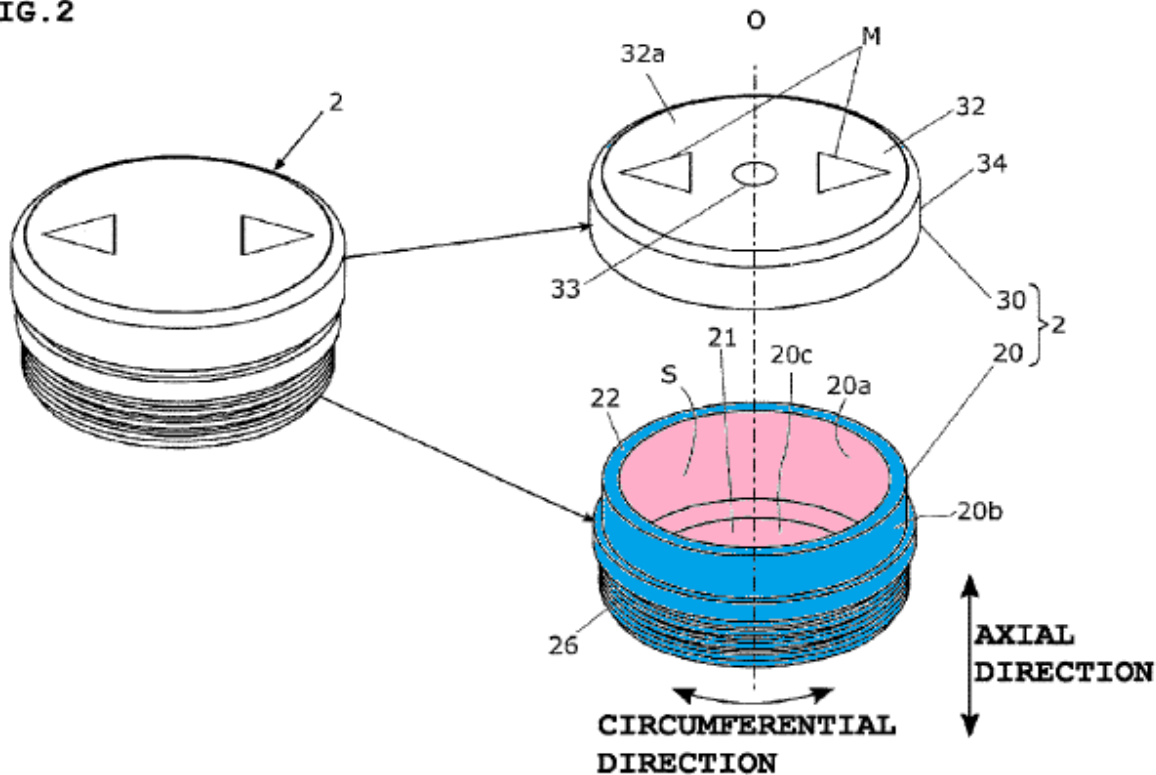
3. Dependent Claim 7

100. Claim 7 depends from claim 1 and recites “**wherein the housing and retaining member are configured having a complementary shape to facilitate attachment of the housing with the retaining member.**” (’421, cl. 7.)

Yamaguchi-727 discloses this claim element for the same reasons I described in my analysis for claim 1[e], incorporated here. Specifically, Yamaguchi-727 teaches that the annular recesses **43** in skirt **4** “extend[] over the inner peripheral surface **40a** all the way around ... to be able to be mated with the annular convex part **23** provided in the housing case **20**.” (Yamaguchi-727, [0036]; *see also id.* (“In other words, the annular concave parts **43** are provided at intervals and in quantity corresponding to the annular convex parts **23**.”).) The complementarily shaped features in housing case **20** and skirt **4** are depicted in FIG. 5 and demonstrate how they “**facilitate**

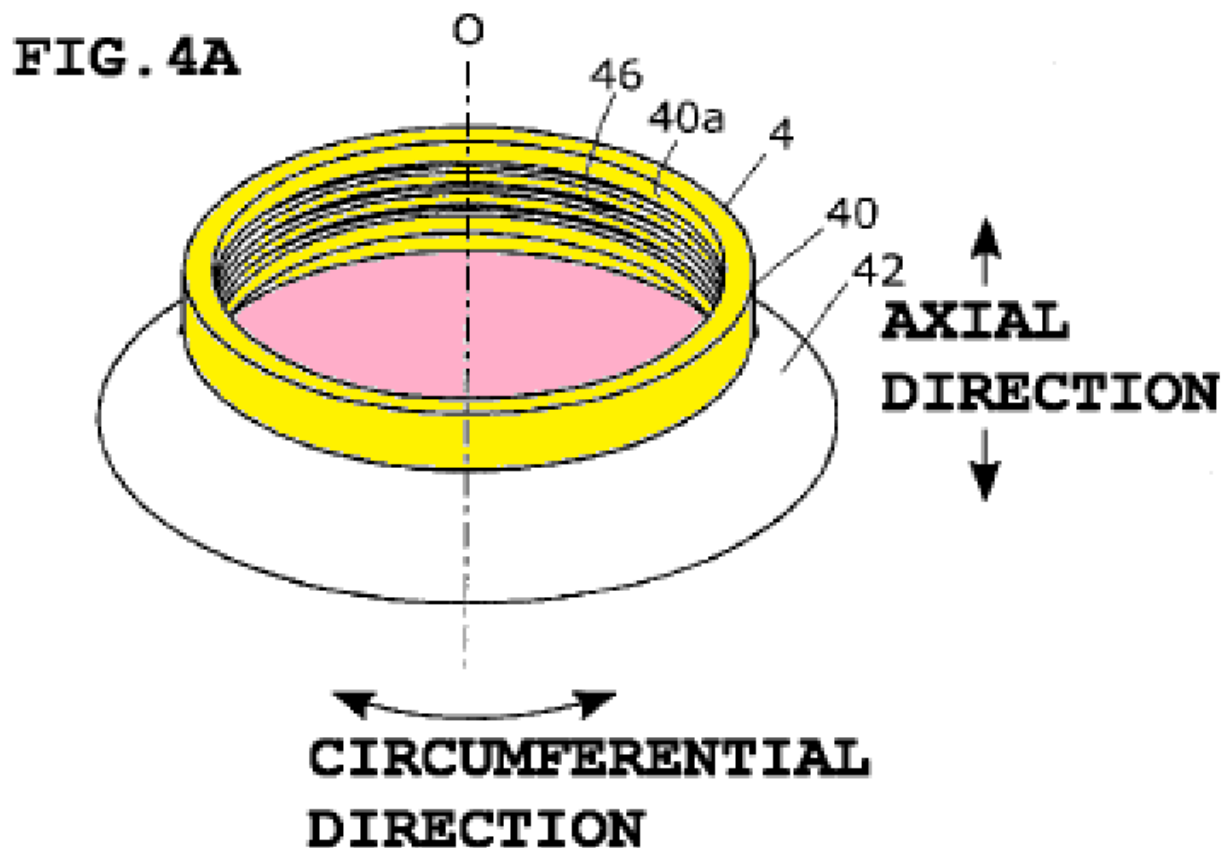
peripheral wall part 22 extending along the outer periphery from the outer peripheral edge of the bottom part 21 and rising annularly from the bottom part 21.” (*Id.*, [0029] (underlining added).) Wall part 22 “**surrounds the internal cavity**” represented by housing space *S*. (Yamaguchi-727, [0029] (“In the housing case 20, a housing space *S* that can house the module 6 is formed by an inner bottom surface 20c of the bottom part 21 and an inner peripheral surface 20a of the peripheral wall part 22.”).) FIG. 2 below depicts how wall part 22 of housing case 20 (in blue) surrounds housing space *S* (in pink).

FIG. 2



(*Id.*, FIG. 2 (annotated).)

103. Yamaguchi-727's skirt 4 (“retaining member”) also “comprises a wall structure having an open chamber that is configured to accommodate the housing wall structure therein to provide attachment therewith.” Skirt 4 “has an annular tubular part 40” that “is formed in a cylindrical shape enclosing the skirt attachment part 26” of housing case 20. (Yamaguchi-727, [0036]). That is, as shown in FIG. 4A below, tubular part 40 (in yellow) of skirt 4 forms a wall structure that includes an open chamber (in pink) that will accommodate the skirt attachment part 26.



(Yamaguchi-727, FIG. 4A (annotated).)

104. Yamaguchi-727 expressly teaches that the tubular part **40** of skirt **4** is **“configured to accommodate”** the skirt attachment part **26** that comprises part of wall part **22** in housing case **20**. As I discussed in my analysis for claim 1[e] above, Yamaguchi-727 teaches that the annular recesses **43** in tubular part **40** of skirt **4** **“extend[] over the inner peripheral surface 40a all the way around ... to be able to be mated with the annular convex part 23 provided in the housing case 20.”** (Yamaguchi-727, [0036]; *see also id.* (“In other words, the annular concave parts **43** are provided at intervals and in quantity corresponding to the annular convex parts **23**.”).)

5. Dependent Claim 9

105. Claim 9 depends from claim 1 and recites **“wherein the retaining member is formed from an elastomeric material that mitigates transmission of shock forces from the object to the housing when the retaining member is attached to the object and the housing is attached to the retaining member.”** (’421, cl. 9.) In my opinion, Yamaguchi-727 discloses claim 9.

106. Yamaguchi-727 describes how its skirt **4** is **“preferably made of an elastic material, for example, such as rubber or elastomer[.]”** (Yamaguchi-727, [0039].) Coupled with the description of the problem to be solved, **“...since tires**

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are repeatedly deformed when coming into contact with the road surface, simply adhering the housing may cause it to come off the inner surface of the tire, or the housing may crack due to the impact at the time of contacting the ground, or the electronic component inside the housing may be damaged. Therefore, in order to prevent these problems, it is necessary to bond the housing to the inner surface of the tire by the adhesive agent with a sufficient thickness.” (*Id.*, [0004.]) Yamaguchi-727 discloses a solution that specifically “**mitigates transmission of shock forces from the object to the housing when the retaining member is attached to the object and the housing is attached to the retaining member**” and a POSA would have understood that the skirt 4, being made of an elastic material such as rubber or an elastomer, inherently acts to provide this functionality.

107. Patent Owner confirmed a POSA’s understanding in statements made in its infringement contentions in the underlying district court litigation, noting with respect to its allegations for claim 9 that “[c]omprised of rubber, the [dock/case] in the Accused Revvo [Tire/Wheel] Sensor Products is elastomeric and mitigates transmission of shock forces from the [tire/wheel] to the housing when the [dock/case] retaining member is attached to the [tire/wheel] and the housing is attached to the [dock/case] retaining member.” (EX1015, pp. 56, 62.) Under Patent Owner’s own admission, Yamaguchi-727’s disclosures that skirt 4 can be made of

rubber or an elastomer satisfy the requirements for claim 9.

6. Dependent Claim 11

108. Claim 11 depends from claim 1 and recites “**wherein the sensing system comprises a receiver that is external from the object and that is configured to receive data from the electrical sensor device by wireless communication.**” (’421, cl. 11.) Yamaguchi-727 discloses claim 11.

109. As discussed, the electrical sensor device in Yamaguchi-727 is mounted within a tire, the “object” as recited in claim 11. Yamaguchi-727 also describes how circuit board **60** within its electronic sensor device includes a transmitting means “for outputting detected values detected by each of the sensors **62**, **64**, and **66** to the outside of the tire[.]” (Yamaguchi-727, [0040].) The transmitting means is “mounted on the circuit board as a transmitting circuit and transmits... to the outside of the tire via an antenna.... Signals... transmitted wirelessly from the transmitting means are received, for example, by a wireless circuit of a main unit provided in a vehicle.” (*Id.*, [0045] (underlining added).) The “wireless circuit of a main unit” described in Yamaguchi-727 is a “**receiver that is external from the object**” and receives the sensor data from the transmitting means of circuit board **60**.

7. Dependent Claim 12

110. Claim 12 further depends from claim 11 and recites “**wherein the electrical sensor device comprises an accelerometer sensor connected therewith and is configured to send data from the accelerometer sensor wirelessly to the external receiver.**” (’421, cl. 12.) In my opinion, Yamaguchi-727 discloses claim 12.

111. Yamaguchi-727 discloses that an acceleration sensor **66** is mounted to circuit board **60** within module **6**. (Yamaguchi-727, [0041].) A POSA would have understood that acceleration sensor **66** is an “**accelerometer sensor,**” as Yamaguchi-727 describes that acceleration sensor **66** is “a sensor capable of measuring acceleration in three axial directions[.]” (*Id.*, [0044].)

112. Circuit board **60** within module **6** is “**configured to send data from the accelerometer sensor wirelessly to the external receiver.**” Yamaguchi-727 discloses that circuit board **60** includes a “transmitting means, which is not shown in [FIG. 5], for outputting detected values detected by each of the sensors **62**, **64** and **66** to the outside of the tire[.]” (Yamaguchi-727, [0040].) The transmitting means is “mounted in the circuit board as a transmitting circuit and transmits the measured... acceleration... to the outside of the tire via an antenna.... Signals such as... the acceleration transmitted wirelessly from the transmitting means are

received, for example, by a wireless circuit of a main unit provided in a vehicle[.]” (*Id.*, [0045] (underlining added).) The wireless circuit described in Yamaguchi-727 is an “**external receiver**,” being external to the tire within which Yamaguchi-727’s electronic sensor device is mounted.

8. Dependent Claim 20

113. Claim 20 depends from claim 1 and recites “**wherein the electrical sensor device comprises: a printed circuit board comprising electrical circuitry; a portable power source for providing power to the electrical sensor device; at least one sensor element; and an antenna for receiving and/or transmitting information from the electrical sensor device.**” (’421, cl. 20.) I further divided claim 20 into its constituent requirements in my analysis below, but Yamaguchi-727 discloses the full scope of the claim.

114. “**a printed circuit board comprising electrical circuitry**”: Yamaguchi-727 expressly discloses how its module 6 “is provided with a circuit board 60 having electronic components mounted thereon[.]” (Yamaguchi-727, [0040].)

115. “**a portable power source providing power to the electrical sensor device**”: Yamaguchi-727 also discusses how module 6 also includes a “battery 70.” (Yamaguchi-727, [0040].) A POSA would have understood the purpose of battery

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70 to power the sensors within module **6**, as Yamaguchi-727 describes how battery **70** is “connected to the circuit board **60**[.]” (*Id.*, [0041], [0047].) This battery is a “**portable power source**,” as Yamaguchi-727 describes an exemplary form of battery **70** as “a so-called disk-shaped button battery[.]” (*Id.*, [0041].) The disk-shaped button battery disclosed in Yamaguchi-727 is consistent with the “**portable power source**” that Patent Owner points to in its infringement allegations against Petitioner’s products. (*See* EX1015, pp. 85-86.)

116. “**at least one sensor element**”: Yamaguchi-727 discloses that multiple sensor elements are mounted to circuit board **60**, “for example, a plurality of sensors such as a temperature sensor **62**, a pressure sensor **64** and an acceleration sensor **66** and the like[.]” (Yamaguchi-727, [0040].)

117. “**an antenna for receiving and/or transmitting information from the electrical sensor device**”: Yamaguchi-727 notes that its module **6** also includes a “transmitting means, ... for outputting detected values detected by each of the sensors **62**, **64** and **66** to the outside of the tire[.]” (Yamaguchi-727, [0040].) The transmitting means “is mounted on the circuit board as a transmitting circuit and transmits the measured temperature, the pressure, and the acceleration and so on to the outside of the tire via an antenna[.]” (*Id.*, [0045] (underlining added).)

9. Dependent Claim 21

118. Claim 21 depends from claim 20 and additionally recites “**wherein the electrical sensor device comprises one or both of a storage element and a processor.**” (’421, cl. 21.) Yamaguchi-727 discloses this claim element. With respect to its module 6, the specification notes that its circuit board 60 includes “a memory means that stores histories of the detected values detected by each of the sensors 62, 64 and 66[,]” that a POSA would have understood to constitute a “**storage element**” under claim 21. (Yamaguchi-727, [0040].) In addition, Yamaguchi-727 discloses that “[t]he control means is mounted on the circuit board 60 as a transmission circuit, and executes a predetermined program,” and a POSA would understand that a processor must exist in the control means to execute the program. (*Id.*, [0046].)

10. Dependent Claim 22

119. Claim 22 further depends from claim 20 and recites “**wherein the electrical sensor device comprises one or both of an accelerometer sensor and a global positioning device.**” (’421, cl. 22.) As described above, Yamaguchi-727 discloses that an acceleration sensor 66 is mounted to circuit board 60 within module 6. A POSA would have understood that acceleration sensor 66 is an “**accelerometer sensor,**” as Yamaguchi-727 describes that acceleration sensor 66 is “a sensor

capable of measuring acceleration in three axial directions[.]” (Yamaguchi-727, [0044].) In my opinion, this disclosure meets the requirements of claim 22.

11. Dependent Claim 23

120. Claim 23 further depends from claim 20 and recites “**wherein the sensor element is configured to sense one or more variables selected from the group consisting of air pressure, temperature, acceleration, and orientation or location of the environment, the sensor assembly, or the object.**” (’421, cl. 23.) Sensors mounted to Yamaguchi-727’s circuit board **60** disclose this claim element.

121. As noted above, the “**sensor element**” in Yamaguchi-727 comprises a temperature sensor **62**, pressure sensor **64**, or acceleration sensor **66** mounted to circuit board **60**. (Yamaguchi-727, [0040].) These sensors “**sense one or more variables,**” as Yamaguchi-727 notes that sensors **62**, **64**, and **66** “each ... function[] as a state acquiring means that acquires a state inside the tire[.]” (*Id.*)

122. The specification further describes how “[t]he temperature sensor **62** and the pressure sensor **64** measure, ... a temperature and a pressure in the tire air chamber, respectively.” (*Id.*, [0043].) Measurements of temperature and pressure from sensors **62** and **64**, respectively, are of the interior air tire chamber, which a POSA would have understood to be “**the environment**” under the claim language.

123. Similarly, acceleration sensor **66** in Yamaguchi-727 is a “sensor

capable of measuring acceleration in three axial directions, ... and is mounted so that each measurement direction faces a predetermined direction relative to the circuit board **60**.” (*Id.*, [0044].) The measured acceleration is of the “**sensor assembly**” under the claim language.

12. Dependent Claim 24

124. Claim 24 further depends from claim 20 and recites “**wherein the object is a vulcanized rubber vehicle tire, and wherein the retaining member is attached to an inside surface of the vehicle tire or an element attached with the tire that rotates with the tire.**” (’421, cl. 24.) In my opinion, Yamaguchi-727 discloses claim 24.

125. Yamaguchi-727 teaches that the “**object**” its functional component attaches to is a “**vehicle tire.**” (*E.g.*, Yamaguchi-727, FIGs. 1A, 1B, [0025] (“FIGs 1A and 1B are diagrams illustrating an attachment state of a functional component **1** attached to a tire **10**.”), [0026] (“As illustrated in FIGs. 1A and 1B, the functional component **1** is fixed by an adhesive agent B to an inner surface (inner peripheral surface **10s**) of the tire **10** and is disposed in the center in a width direction of the inner peripheral surface **10s** that is a back side of a tread **11**[.]”), [0027] (“[T]he functional component **1** is attached mainly to tires of automobiles...”), [0085].) The vehicle tires are composed of “**vulcanized rubber**” according to Yamaguchi-727’s

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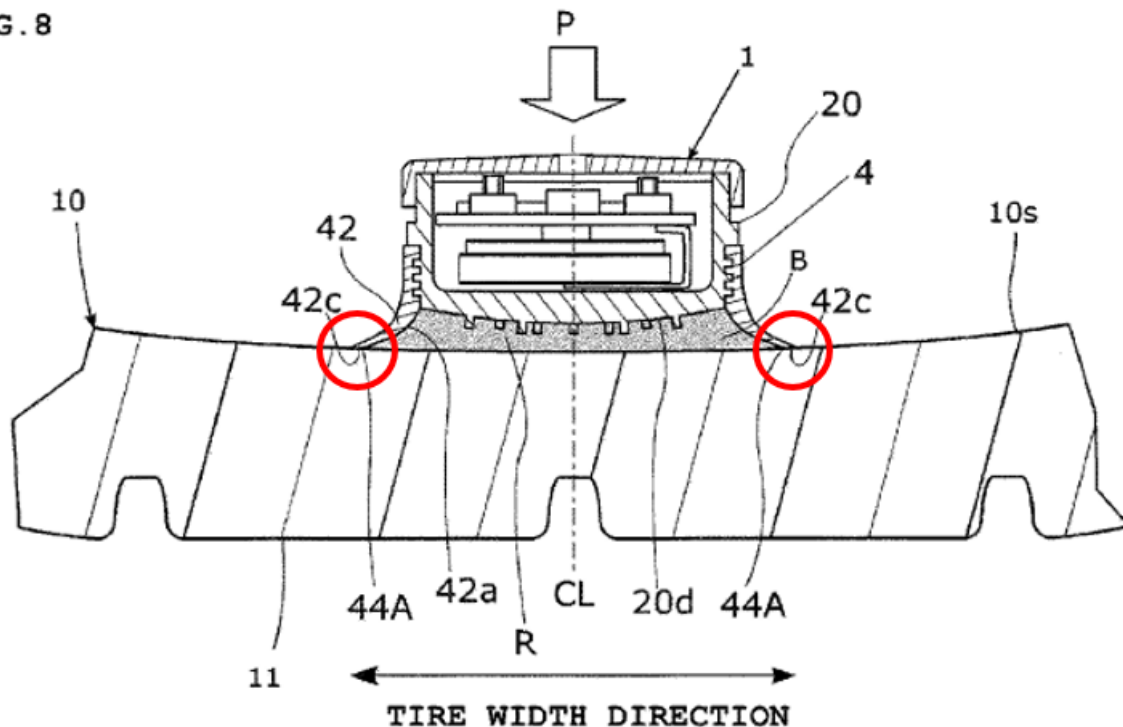
disclosures. (*Id.*, [0050] (“the inner peripheral surface of the tire has been vulcanized”), [0055] (tire “is made of a rubber-based material”), [0056] (same), [0057] (same).)

126. Yamaguchi-727 also discloses that “**the retaining member is attached to an inside surface of the vehicle tire.**” Yamaguchi-727 describes how functional component **1** is attached to inner peripheral surface **10s** of tire **10** through an adhesive agent **B** that fills a space defined by the peripheral surface **42** of skirt **4**:

As discussed above, the functional component **1** is configured to be attached in a state that the adhesive agent **B** is densely filled in the filling space R enclosed by the outer bottom surface **20d** facing the inner peripheral surface **10s** of the tire **10**, the inner peripheral surface **42a** of the skirt **4** that expands in diameter and extends in a tubular shape from the peripheral edge of the outer bottom surface **20d** toward the inner peripheral surface **10s**, and the inner peripheral surface **10s** of the tire **10**.

(Yamaguchi-727, [0054].) FIG. 8 depicts the above-configuration and how skirt **4** is attached to the inner peripheral surface **10s** of tire **10** at item **42c**, encircled in red below.

FIG. 8



(*Id.*, FIG. 8 (annotated).) The specification confirms the function of the outer surface at item 42c, noting “there may be provided a structure for attaching, to a tire, the functional component described above, in which the end part of the tubular part is abutted against the inner peripheral surface of the tire, and an adhesive agent is filled in a filling space enclosed by an inner peripheral surface of the tubular part, the bottom surface of the housing and the inner peripheral surface of the tire.” (*Id.*, [0007] (underlining added); *see also id.*, [0008].)

C. Ground 2: Claims 5, 28, 31-33, 41, 43, 44, 48, 50, 51, and 52 are Obvious Over Yamaguchi-727 in view of Yamaguchi-566

127. The Challenged Claims under Ground 2 each recite the housing surface

features requirement. Although, in my opinion, under Patent Owner's infringement allegations such surface features are clearly satisfied by the "positioning means" described as mutually fitted housing in Yamaguchi-727, Ground 2 further includes Yamaguchi-566's express teachings regarding exemplary surface features within the housing in the form of, for example "ribs" on the inside of the housing as the "positioning means," which I describe in more detail below. Additional implementation details about module 6, related to a communications unit to receive data from an external device, are provided by Yamaguchi-566 with respect to claim 51.

1. Motivation to Combine Yamaguchi-727 With Yamaguchi-566 and Reasonable Expectation of Success

128. A POSA would have found it obvious to combine Yamaguchi-727 with Yamaguchi-566's teachings regarding the use of convex parts, or ribs, on the inner peripheral surface of housing case 20 to constrain radial movement of its electrical sensor device (circuit board 60 of module 6) within the housing cavity. Yamaguchi-727 as modified by Yamaugchi-566 would have predictably resulted in the attachment of circuit board 60 of module 6 in Yamaguchi-727 to the inner peripheral wall of the housing case 20 through surface contact and mutual fitment between circuit board 60 of module 6 and convex parts 20B of peripheral wall part 22 of

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housing case **20**.

129. A POSA reviewing Yamaguchi-727 would have looked to Yamaguchi-566 to improve Yamaguchi-727's functional component **1**. Yamaguchi-727 and Yamaguchi-566 are analogous references in the same field of the alleged invention related to sensor design, particularly for the attachment of sensor assemblies to the inner wall of a tire to monitor tire conditions and other operating parameters. (*See, e.g.,* Yamaguchi-727, [0001], [0006]; Yamaguchi-566, [0001], [0006] (“As the configuration of a functional component for solving the above-mentioned problems, there is provided a functional component to be attached inside a tire, for detecting a state of the tire as information.”).) Yamaguchi-727 and Yamaguchi-566 share the same applicant, inventor, and assignee, and are partially coextensive (and complimentary) in their disclosures. (*Compare, e.g.,* Yamaguchi-727, item (71), item (72), item (73), FIGs. 1A, 1B, [0025]-[0029], [0034]-[0037], [0040], [0043], [0045], [0046], *with* Yamaguchi-566, item (71), item (72), item (73), FIGs. 1A, 1B, [0020], [0021], [0023]-[0029], [0032], [0033], [0035], [0037], [0040].) These two references were also filed at the same time and are directed to different aspects of the same invention. A POSA would have naturally consulted additional materials from Shigeru Yamaguchi to understand, and seek to improve, the functional component design in Yamaguchi-727.

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130. A POSA would have been motivated to combine Yamaguchi-727 with Yamaguchi-566 because Yamaguchi-566's teachings build upon and refine the functional component design in Yamaguchi-727. Yamaguchi-566 shares many disclosures with Yamaguchi-727 and provides additional details on the functionality of the functional component **1** not already present in Yamaguchi-727, including (1) use of ribs within the housing to position circuit board **60** of module **6** within the housing space *S* of housing case **20** (Yamaguchi-566, [0022], FIG. 2A); and (2) the capability for module **6** to include functionality to both transmit and receive data/instructions from a receiver external to functional component **1** (*id.*, [0034]-[0038], [0042]). A POSA would have modified Yamaguchi-727 with Yamaguchi-566 to take advantage of these additional features, as Yamaguchi-566 describes as its foundational technology a strikingly similar functional component design to that disclosed in Yamaguchi-727.

131. A POSA would have had a reasonable expectation that the combination would have been successful. The disclosures in Yamaguchi-727 and Yamaguchi-566 were conceived and reduced to practice by the same inventor, were commonly owned by Bridgestone, and as previously described, contain coextensive disclosures regarding the design, functionality, and operation of a tire sensor assembly mounted to the inner peripheral surface of a tire to monitor tire conditions and other operating

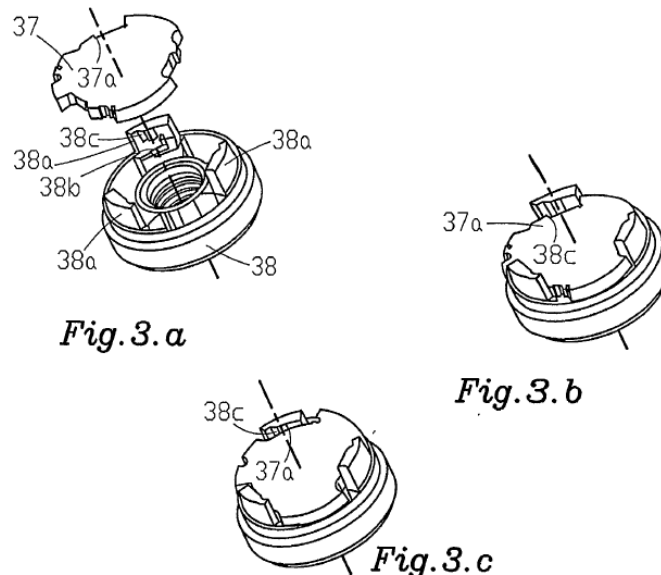
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parameters. These connections would have led a POSA to believe that Yamaguchi-566's more detailed teachings regarding use of convex parts on the inner surface of the housing case for attachment would naturally apply, and be combinable with, Yamaguchi-727. The combination would have entailed only the routine application of conventional fabrication techniques to integrate these convex parts into the inner peripheral surface of the housing case, particularly because Yamaguchi-727 *already* contemplates use of a positioning means to restrict radial movement of circuit board **60** of module **6** within housing space *S* of housing case **20**. (See Yamaguchi-727, [0042].) A POSA would have found it inherent to Yamaguchi-727 that some surface feature exists within housing case **20** that used complimentary fitment between housing case **20** and circuit board **60** to constrain radial movement of circuit board **60** about axis O. Yamaguchi-566 simply provides more granular details for the positioning means already expressly disclosed in Yamaguchi-727.

132. The convex parts, or ribs, described in Yamaguchi-566 are not novel surface features for the position and retention of sensor components within a housing. By October 2019, it was common industry practice to secure placement of sensor components within a housing assembly through mutually fitting and/or mechanically mated components. For example, U.S. Patent No. 10,836,222 to Stewart filed on October 26, 2018 [EX1021] describes using a “vertical rib or

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protrusion” within a sidewall of a sensor mount to accommodate and secure placement of an RFID chip within a sensor assembly. (Stewart, 4:50-65, 5:46-51, FIGs. 1A-1B, 4A-4C.) In another example in WO 2005/049339 to Zaroor filed on November 18, 2004 [EX1022], the specification teaches use of horizontal shelves in the housing of a sensor assembly that are aligned with mating tabs protruding outwardly from a circuit board assembly to fix and retain the position of the circuit board assembly within the housing. (Zaroor, [0028] (“Circuit board assembly **37** is then rotated clockwise until tabs **37a** are located between upper shelf **38c** and lower shelf **38b**, as shown in Fig. 3c. Shelves **38b** and **38c** hold assembly **37** in place...”), FIGs. 3a-3c.)



(Zaroor, FIGs. 3a-3c.)

2. Dependent Claim 5

133. Claim 5 depends from claim 1 and recites “**wherein the electrical sensor device is attached within the internal cavity by one or more surface features within the cavity that contact the electrical sensor device to retain its position therein.**” (’421, cl. 5.) It is my opinion that Yamaguchi-727 contains sufficient disclosure of this claim element. While not shown in any of its figures, Yamaguchi-727’s description of mutual fitment between circuit board **60** and housing case **20** requires that housing case **20** include surface features to ensure that the circuit board was appropriately positioned within the housing. (Yamaguchi-727, [0042].) The positioning means in Yamaguchi-727 assists with the function of permitting module **6** to “**retain its position**” within the internal cavity, as recited in dependent claim 5.

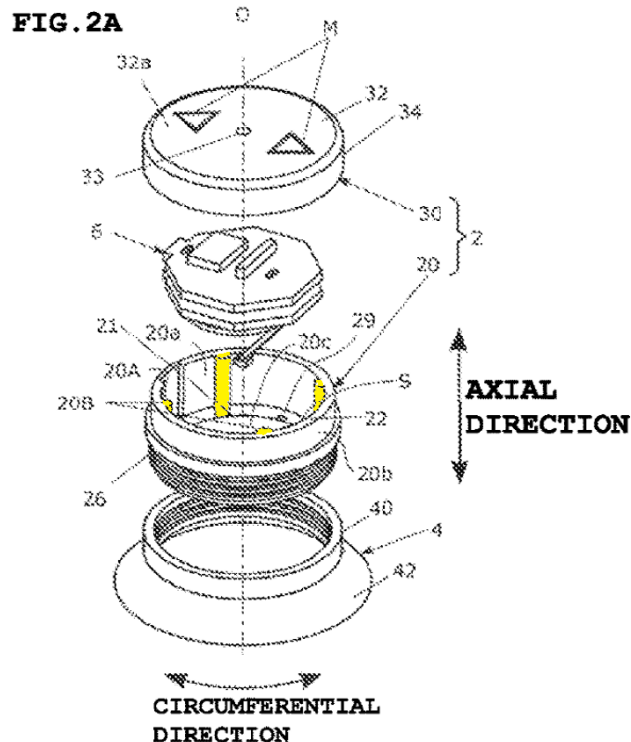
134. Yamaguchi-727 also discloses claim 5 under Patent Owner’s proposed construction for “**surface feature[s]**” as “**structure[s] on or of a surface.**” (EX1017, Ex. A at 6.) Yamaguchi-727 notes that housing case **20** is “*provided* with a positioning means” to ensure mutual fitment with circuit board **60**. (Yamaguchi-727, [0042] (emphasis added).) Achieving positioning for the circuit board **60** through mutual fitment requires that housing case **20** have a structure on or of its surface for the circuit board **60** to fit with/into.

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135. Patent Owner may argue that a more particularized description of “**one or more surface features**” is necessary. While I disagree, in my opinion the requirements for claim 5 are also rendered obvious by Yamaguchi-727 in view of Yamaguchi-566. Yamaguchi-566 teaches that housing case **20** includes ribs and a groove on its inner peripheral wall surface to prevent radial movement of module **6** in housing space *S*, the internal cavity formed in part by housing case **20**:

On the inner peripheral surface **20a** of the peripheral wall part **22**, a concave part **20A** recessed outwardly in the radial direction relative to the axis *O* and a plurality of convex parts **20B** protruding toward the direction of the axis *O* and extending along the axis *O* are formed so as to position the module **6** housed in the housing space *S* at a predetermined position. The bottom part **21** of the housing case **20** is provided with a through hole **29** that penetrates from the inner bottom surface **20c** to an outer bottom surface **20d**. Furthermore, the inner bottom surface **20c** of the bottom part **21** is provided with a support means such as a protrusion, which is not shown in the figure, that supports the module **6** housed in the housing space *S* from a lower side.

(Yamaguchi-566, [0022] (underlining added).) These ribs and groove, described as convex parts **20B** and concave part **20A**, are depicted in FIG. 2A below with the “ribs” highlighted yellow.



(*Id.*, FIG. 2A (annotated).)

136. A POSA would have understood convex parts **20B** are “**one or more surface features within the cavity.**” Yamaguchi-566 expressly recognizes that convex parts **20B** and concave parts **20A** are “[o]n the inner peripheral surface **20a** of the peripheral wall part **22**[.]” (Yamaguchi-566, [0022] (underlining added).)

137. Yamaguchi-566 further discloses that its convex parts **20B** “**contact the electrical sensor device to retain its position therein.**” Yamaguchi-566 explains that substrates in module **6** “are formed in a roughly octagonal shape, for example, so as to correspond to the concave part **20A** and the plurality of convex parts **20B** provided in the housing case **20**[.]” (Yamaguchi-566, [0030].) The

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specification continues by explaining that this shape allows module **6** “to be housed in the housing case **20** by bringing the peripheral edges of the substrates **60** and **80** into contact with the convex portions **20B**, and making protruding pieces **60z** and **80z** each protruding from a part of each of the peripheral edges to coincide with the concave portion **20A**.” (*Id.*, [0030].)

138. My mapping of “**surface features**” to the convex portions, or ribs, and concave portions or groove in Yamaguchi-566 is consistent with examples of surface features contemplated by the ’421 patent specification. While FIG. 3 in the ’421 patent depicts a recessed groove in the housing as a surface feature, the written description further provides that “rather than a recessed groove, the surface feature can be provided in the form [of] ribs or tabs or the like that extend radially outwardly a distance from the wall structure inside surface **42** and that are positioned and configured to engage the electrical sensor device **40** peripheral edge **46** to secure placement of the electrical sensor device **40** within the housing internal cavity **38**.” (’421, 10:40-46 (underlining added).)

139. The combination of Yamaguchi-727 and Yamaguchi-566 in the manner I have articulated discloses the requirements of claim 5 because it would have resulted in the inclusion of convex or concave surface features being designed into the inner peripheral surface of housing case **20** that mutually fitted with circuit board

60 of module **6** and fixed radial movement of circuit board **60** within housing space *S* of housing case **20**, relative to axis *O*.

13. Independent Claim 28

(a) **Claim 28[pre]: “A sensor assembly and sensing system for use with an object that rotates in use comprising:”**

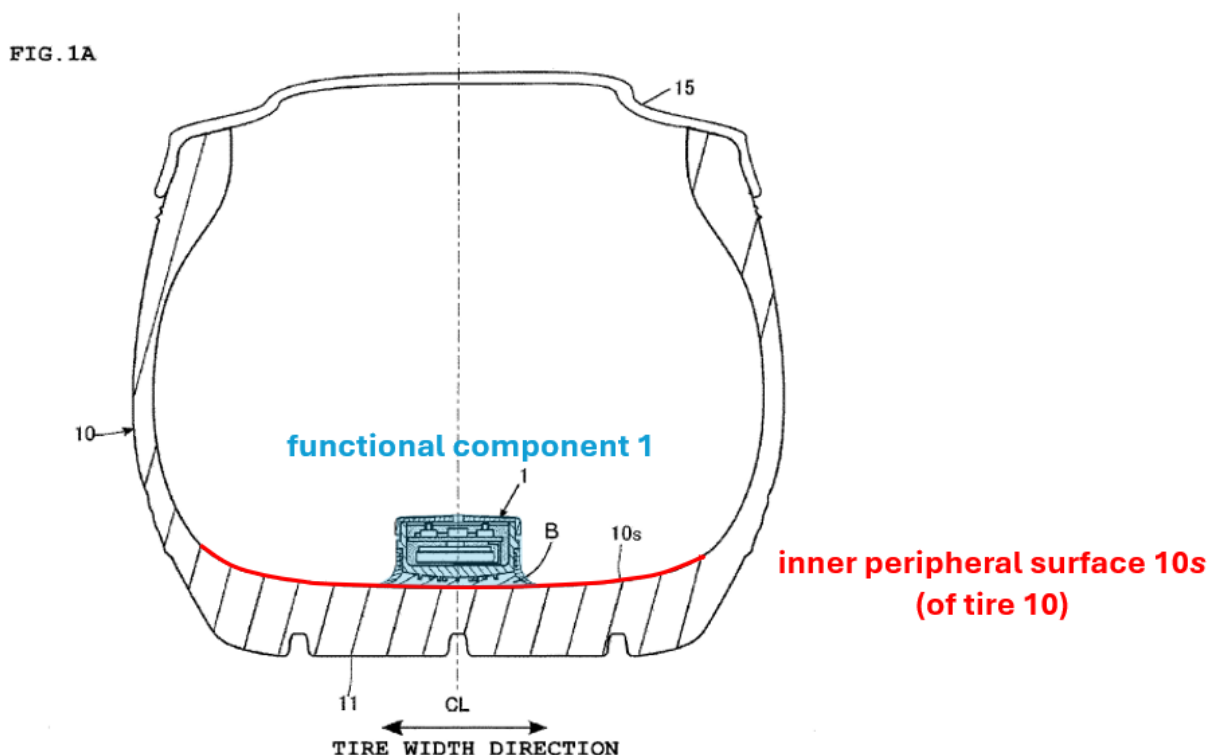
140. To the extent the preamble is limiting, in my opinion it is disclosed by Yamaguchi-727. Yamaguchi-727 teaches “[a] functional component [**1**] in which an electronic component capable of acquiring information inside a tire is housed and which is attachable to an inner peripheral surface of the tire[.]” (Yamaguchi-727, Abstract; *see also id.*, [0025]-[0027], [0040], FIG. 1A.) The information acquired by functional component **1** from within the tire is wirelessly transmitted to a wireless circuit disposed in the main unit of a vehicle, outside of the tire.

141. The described functional component **1** is a “**sensor assembly**,” as it contains a module **6** that “is provided with a circuit board **60**” that “includes the electronic component which are, for example, a plurality of sensors... each of which functions as a state acquiring means that acquires a state inside the tire.” (Yamaguchi-727, [0040]; *see also id.*, FIG. 5 (depicting module **6** provided with circuit board **60** that includes sensors **62**, **64**, and **66**.) Functional component **1** is also a “**sensing system**” as contemplated by the ’421 patent (*see* ’421, 22:23-40), as its module **6** includes a transmission means that wirelessly transmits information

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about the states of the tire collected from its sensors to “a wireless circuit of a main unit provided in a vehicle,” external to the tire. (Yamaguchi-727, [0045].)

142. Functional component **1** is “**for use with an object that rotates in use.**” Yamaguchi-727 describes how functional component **1** is attached to a tire **10**, which is an “**object that rotates in use.**” (*See, e.g.,* Yamaguchi-727, 8:38-57.) Functional component **1** is “fixed by an adhesive agent B to an inner surface (inner peripheral surface **10s**) of the tire **10** and is disposed in the center in a width direction of the inner peripheral surface **10s** that is a back side of a tread **11**,” (Yamaguchi-727, [0026]), as shown in FIG. 1A below.

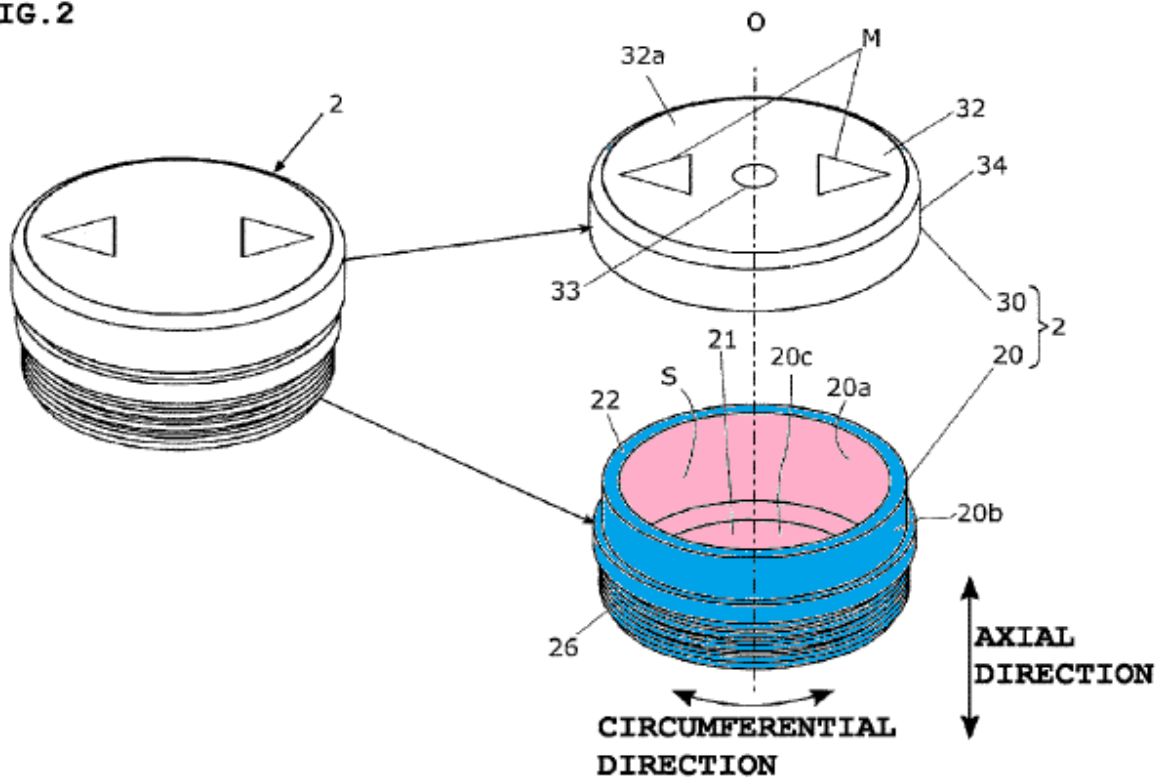


(*Id.*, FIG. 1A (annotated).)

(b) **Claim 28[a]: “a housing comprising an outer structure that defines an open internal cavity therein,”**

143. Yamaguchi-727 discloses the elements of claim 28[a] for the same reasons I described in my analysis for claim 1[a], incorporated here. Specifically, housing **2** includes a housing case **20** (“**a housing comprising an outer structure**”) “having a housing space *S* (housing part) for a module **6**[.]” (Yamaguchi-727, [0028].) Yamaguchi-727 teaches this housing case **20** “**defines an open internal cavity therein,**” explaining that “[i]n the housing case **20**, a housing space *S* that can house the module **6** is formed by an inner bottom surface **20c** of the bottom part **21** and an inner peripheral surface **20a** of the peripheral wall part **22**.” (*Id.*, [0029].) FIG. 2 below depicts how housing case **20** is an outer structure (in blue) that defines the open internal cavity of housing space *S* (in pink).

FIG. 2



(*Id.*, FIG. 2 (annotated).)

- (c) **Claim 28[b]: “an electrical sensor device disposed within the internal cavity and having a fixed placement therein by one or more surface features of the housing configured to contact the electrical sensor device”**

144. The combination of Yamaguchi-727 and Yamaguchi-566 discloses and renders obvious claim 28[b]. To start, Yamaguchi-727 discloses the element of “**an electrical sensor device disposed within the internal cavity**” recited in claim 28[b] for the same reasons I described in my analysis for claim 1[b] in Ground 1, incorporated here.

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145. Yamaguchi-727 also teaches that its module **6** (“**electrical sensor device**”) has a “**fixed placement therein by one or more surface features of the housing configured to contact the electrical sensor device.**” I understand that Patent Owner has (1) proposed a construction in the reserved disputed terms list for “**fixed placement**” as “**not displaceable in at least one direction**” (EX1017, Exhibit B at 10); and (2) taken the position in its infringement contentions that holes in a printed circuit board of a sensor assembly that align with posts in the housing are sufficient to satisfy this limitation. (*See* EX1015, pp. 111-113.) I express no opinion about whether such posts would satisfy the “**fixed placement**” requirement but, applying Patent Owner’s own interpretation of the claim language, it is my opinion that Yamaguchi-727 renders obvious claim 28[b], alone or in combination with Yamaguchi-566.

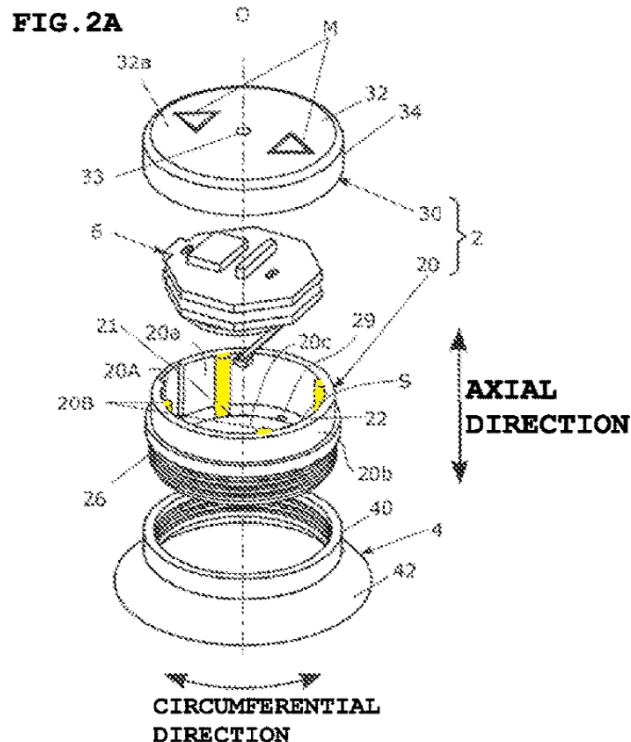
146. Yamaguchi-727 describes how “circuit board **60** and the housing case **20** are provided with a positioning means, ..., that are mutually fitted with each other.” (Yamaguchi-727, [0042].) This positioning means fixes module **6** radially about axis O within housing space *S*. (*See id.*, FIG. 2.) While not shown in any of its figures, use of one or more surface features of the housing (via housing case **20**) would be inherent to Yamaguchi-727’s disclosures of a positioning means. The inherent disclosures from Yamaguchi-727 are confirmed by express teachings from

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Yamaguchi-566 that disclose the use of ribs and a groove on the inner surface of housing case **20** to position the circuit board.

147. Yamaguchi-566 expressly teaches the use of ribs and a groove on the inner peripheral wall surface of housing case **20** to “fix placement” of module **6** within housing space *S* and restricting its radial movement about axis *O*. (Yamaguchi-566, [0022] (describing “a concave part **20A** recessed outwardly in the radial direction relative to the axis *O* and a plurality of convex parts **20B** protruding toward the direction of the axis *O* and extending along the axis *O* are formed so as to position the module **6** housed in the housing space *S* at a predetermined position.”), FIG. 2A.)

148. As discussed for claim 5 above, these ribs, described as convex parts **20B**, and the groove, described as concave part **20A**, are depicted in FIG. 2A below with the “ribs” highlighted yellow.



(*Id.*, FIG. 2A (annotated).)

149. A POSA would have understood convex parts **20B** are “**one or more surface features of the housing.**” Yamaguchi-566 expressly recognizes that convex parts **20B** are “[o]n the inner peripheral surface **20a** of the peripheral wall part **22**[.]” (Yamaguchi-566, [0022] (underlining added).)

150. Yamaguchi-566 further discloses that its convex parts **20B** and concave part **20A** cause the electrical sensor device to have a “**fixed position**” by being “**configured to contact the electrical sensor device.**” Yamaguchi-566 explains that substrates in module **6** “are formed in a roughly octagonal shape, for example, so as to correspond to the concave part **20A** and the plurality of convex parts **20B**”

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provided in the housing case **20**[.]” (Yamaguchi-566, [0030].) The specification continues by explaining that this shape allows module **6** “to be housed in the housing case **20** by bringing the peripheral edges of the substrates **60** and **80** into contact with the convex portions **20B**, and making protruding pieces **60z** and **80z** each protruding from a part of each of the peripheral edges to coincide with the concave portion **20A**.” (*Id.*, [0030].)

151. My mapping of “**surface features**” to the convex portions, or ribs, and concave portion, or groove, in Yamaguchi-566 is consistent with examples of surface features contemplated by the ’421 patent specification. While FIG. 3 in the ’421 patent depicts a recessed groove in the housing as a surface feature, the written description further provides that “rather than a recessed groove, the surface feature can be provided in the form [of] ribs or tabs or the like that extend radially outwardly a distance from the wall structure inside surface **42** and that are positioned and configured to engage the electrical sensor device **40** peripheral edge **46** to secure placement of the electrical sensor device **40** within the housing internal cavity **38**.” (’421, 10:40-46 (underlining added).)

152. Patent Owner points in its infringement contentions to positioning posts in a housing as the “**one or more surface features**” enabling fixed placement of the sensor board. (*See* EX1015, pp. 111-113.) That Yamaguchi-566 discloses this claim

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is confirmed by Patent Owner's understanding of its scope. The ribs and groove in Yamaguchi-566 are not functionally different than the positioning posts identified in Patent Owner's infringement contentions, preventing radial displacement of module 6 about axis O. (See Yamaguchi-566, [0022], FIG. 2A.)

- (d) **Claim 28[c]: “wherein the electrical sensor device is configured to monitor and transmit and/or receive information regarding surrounding conditions, orientation and/or location”**

153. The combination of Yamaguchi-727 and Yamaguchi-566 disclose the elements of claim 28[c] for the same reasons I described in my analysis with respect to Yamaguchi-727 for claim 1[d] in Ground 1, incorporated here.

- (e) **Claim 28[d]: “wherein the electrical sensor device comprises: a portable power source; a sensor; and an antenna for transmitting and/or receiving information relating to the operating parameter being monitored by the sensor;”**

154. The combination of Yamaguchi-727 and Yamaguchi-566 disclose the elements of claim 28[d] for the same reasons I described in my analysis with respect to Yamaguchi-727 for claim 20 in Ground 1, incorporated here.

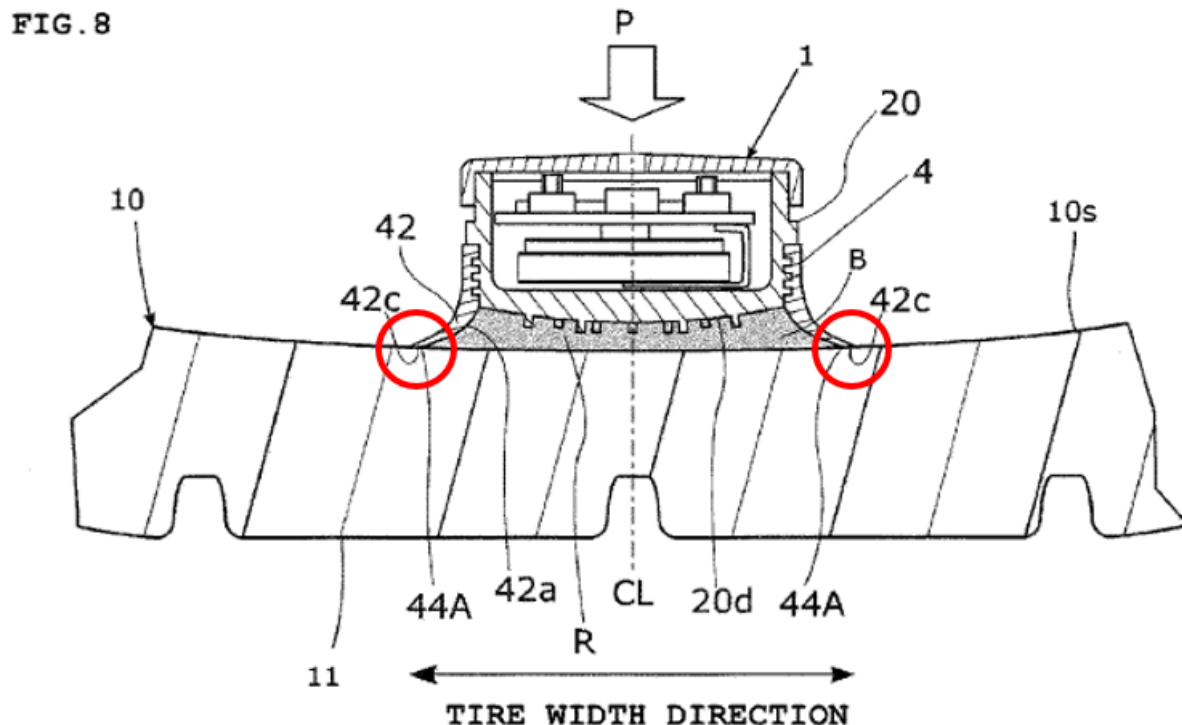
- (f) **Claim 28[e]: “a retaining member having an outside surface configured for attaching with a surface of the object or an element connected with the object to rotate with the object in use, wherein the retaining member is configured to accommodate placement a portion of the housing therein to provide an attachment between the housing and the retaining member; and”**

155. The combination of Yamaguchi-727 and Yamaguchi-566 disclose claim 28[e]. As noted in my analysis for claim 1[e] in Ground 1, the Yamaguchi-727 specification describes a “**retaining member**” in skirt **4** that “is attached to the [] skirt attachment part **26** formed in the housing case **20**, and extends from the outer bottom surface **20d** of the housing **2** toward the inner peripheral surface **10s** side of the tire **10**[.]” (Yamaguchi-727, [0035].) Skirt **4** has “**an outside surface configured for attaching with a surface of the object or an element connected with the object to rotate with the object in use.**” Yamaguchi-727 describes how functional component **1** is mounted to tire **10** through an adhesive agent **B** that fills a space defined by the peripheral surface **42** of skirt **4**:

As discussed above, the functional component **1** is configured to be attached in a state that the adhesive agent **B** is densely filled in the filling space R enclosed by the outer bottom surface **20d** facing the inner peripheral surface **10s** of the tire **10**, the inner peripheral surface **42a** of the skirt **4** that expands in diameter and extends in a tubular shape from the peripheral edge of the outer bottom surface **20d** toward the inner peripheral surface **10s**, and the inner peripheral surface **10s** of the tire **10**.

(Yamaguchi-727, [0054].) FIG. 8 depicts the above-configuration and how skirt **4**

includes an “**outside surface configured for attaching**” at item **42c**, encircled in red below.

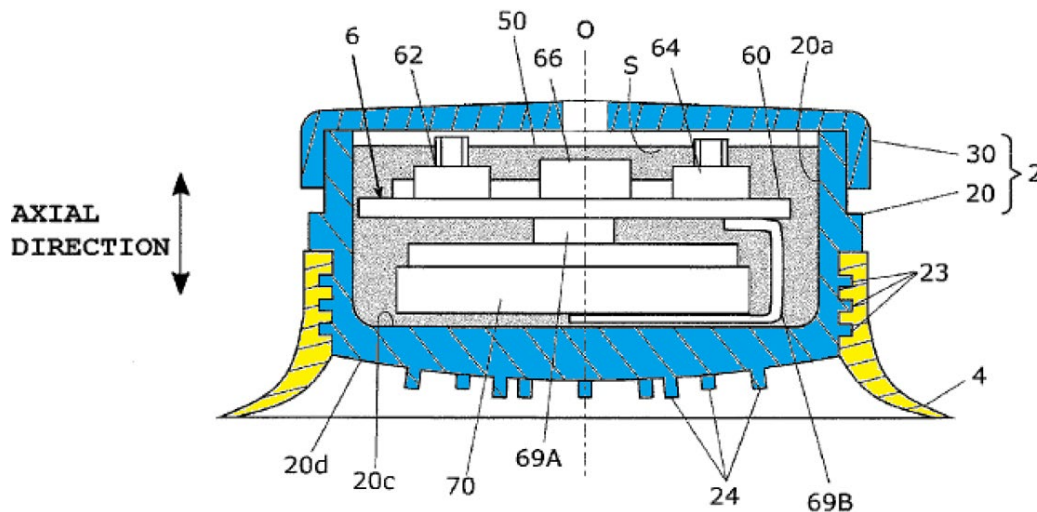


(*Id.*, FIG. 8 (annotated).) The specification confirms the function of the outer surface at item **42c**, noting “there may be provided a structure for attaching, to a tire, the functional component described above, in which the end part of the tubular part is abutted against the inner peripheral surface of the tire, and an adhesive agent is filled in a filling space enclosed by an inner peripheral surface of the tubular part, the bottom surface of the housing and the inner peripheral surface of the tire.” (*Id.*, [0007] (underlining added); *see also id.*, [0008].)

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156. Yamaguchi-727 discloses how skirt **4**, including its outside surface, is configured **“to rotate with the object in use”** by being mounted to the inner side **10s** of the tire. When tire **10** rotates while the vehicle is in use, so too would item **42c** of skirt **4**. It is an inherent feature of the placement of functional component **1** within the inner peripheral surface of the tire. (*See, e.g.,* Yamaguchi-727, [0007], FIG. 1A.)

157. Skirt **4** is also **“configured to accommodate placement [of] a portion of the housing therein to provide an attachment between the housing and the retaining member.”** As described in my analysis for claim 1[e], Yamaguchi-727 teaches that the annular recesses **43** in skirt **4** **“extend[] over the inner peripheral surface 40a all the way around ... to be able to be mated with the annular convex part 23 provided in the housing case 20.”** (Yamaguchi-727, [0036]; *see also id.* (“In other words, the annular concave parts **43** are provided at intervals and in quantity corresponding to the annular convex parts **23**.”). FIG. 5 below depicts how the annular convex parts **23** in housing case **20** mate with the annular recesses **43** within skirt **4** to attach housing **2** (in blue) to skirt **4** (in yellow).



(Yamaguchi-727, FIG. 5 (annotated); *see id.*, FIG. 4C (depicting housing 2 attached to skirt 4), [0035].)

(g) **Claim 28[f]: “a receiver external from the object that is configured to receive information from the electrical sensor device wirelessly.”**

158. The combination of Yamaguchi-727 and Yamaguchi-566 disclose the elements of claim 28[f] for the same reasons I described in my analysis with respect to Yamaguchi-727 for claim 11 in Ground 1, incorporated here.

14. Dependent Claim 31

159. Claim 31 depends from claim 28 and recites “**wherein the internal cavity comprises an open space above or below the electrical sensor device disposed within the internal cavity.**” (’421, cl. 31.) The combination of Yamaguchi-727 and Yamaguchi-566 disclose the elements of claim 31 for the same

reasons I described in my analysis with respect to Yamaguchi-727 for claim 1[c] in Ground 1, incorporated here.

15. Dependent Claim 32

160. Claim 32 depends from claim 28 and recites “**wherein the retaining member is formed from an elastomeric material that mitigates transmission of shock forces received from the object when attached to the object before reaching the housing attached with the retaining member.**” (’421, cl. 32.) The combination of Yamaguchi-727 and Yamaguchi-566 disclose the elements of claim 32 for the same reasons I described in my analysis with respect to Yamaguchi-727 for claim 9 in Ground 1, incorporated here.

16. Dependent Claim 33

161. Claim 33 depends from claim 28 and recites “**wherein the electrical sensor device comprises an accelerometer sensor and is configured to send data from the accelerometer sensor wirelessly to the external receiver.**” (’421, cl. 33.) The combination of Yamaguchi-727 and Yamaguchi-566 disclose the elements of claim 33 for the same reasons I described in my analysis with respect to Yamaguchi-727 for claim 12 in Ground 1, incorporated here.

17. Independent Claim 41

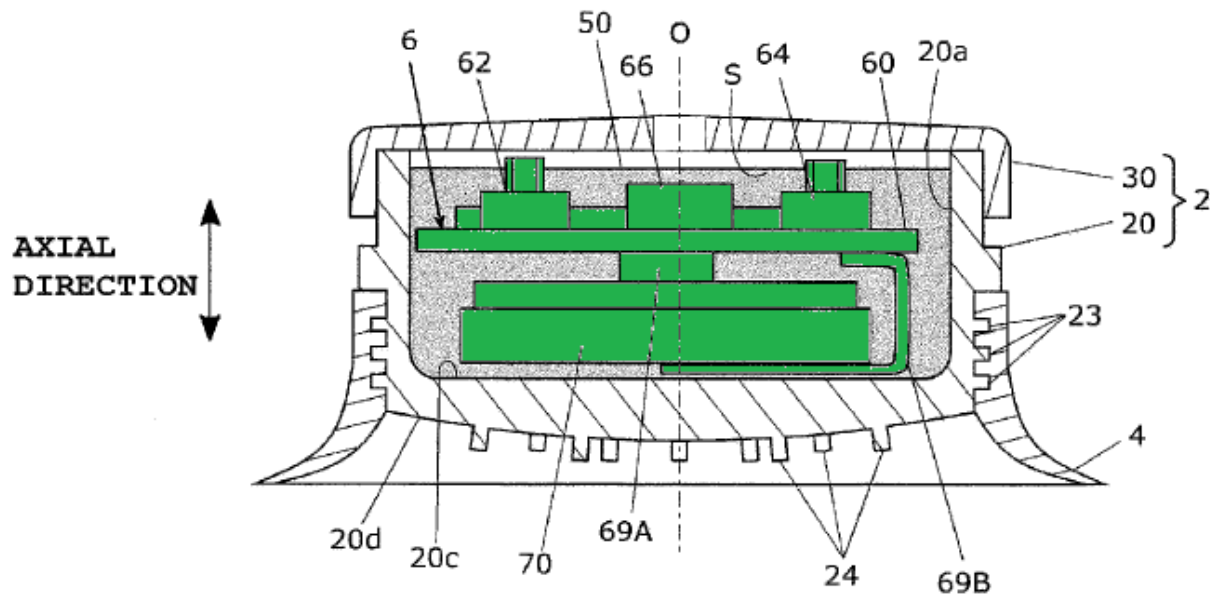
- (a) **Claim 41[pre]: “A method for using a sensor assembly and sensing system with an object that rotates in use comprising the steps of:”**

162. To the extent the preamble is limiting, the combination of Yamaguchi-727 and Yamaguchi-566 discloses it for the same reasons I described in my analysis for claim 28[pre] for Ground 2, incorporated here.

- (b) **Claim 41[a]: “installing an electrical sensor device within an internal cavity of a housing, wherein the housing includes an outer structure that defines the internal cavity, and”**

163. The combination of Yamaguchi-727 and Yamaguchi-566 discloses **“installing an electrical sensor device within an internal cavity of a housing.”** As discussed for claim 1[b] for Ground 1, the **“electrical sensor device”** in Yamaguchi-727 is represented by module **6** that includes circuit board **60**. Circuit board **60** further includes “electronic components which are, for example, a plurality of sensors such as a temperature sensor **62**, a pressure sensor **64** and an acceleration sensor **66** and the like...” (Yamaguchi-727, [0040] (underlining added).) This electrical sensor device (in green below) is installed within an internal cavity of a housing based on its placement within housing space *S* in FIG. 5 below.

FIG. 5

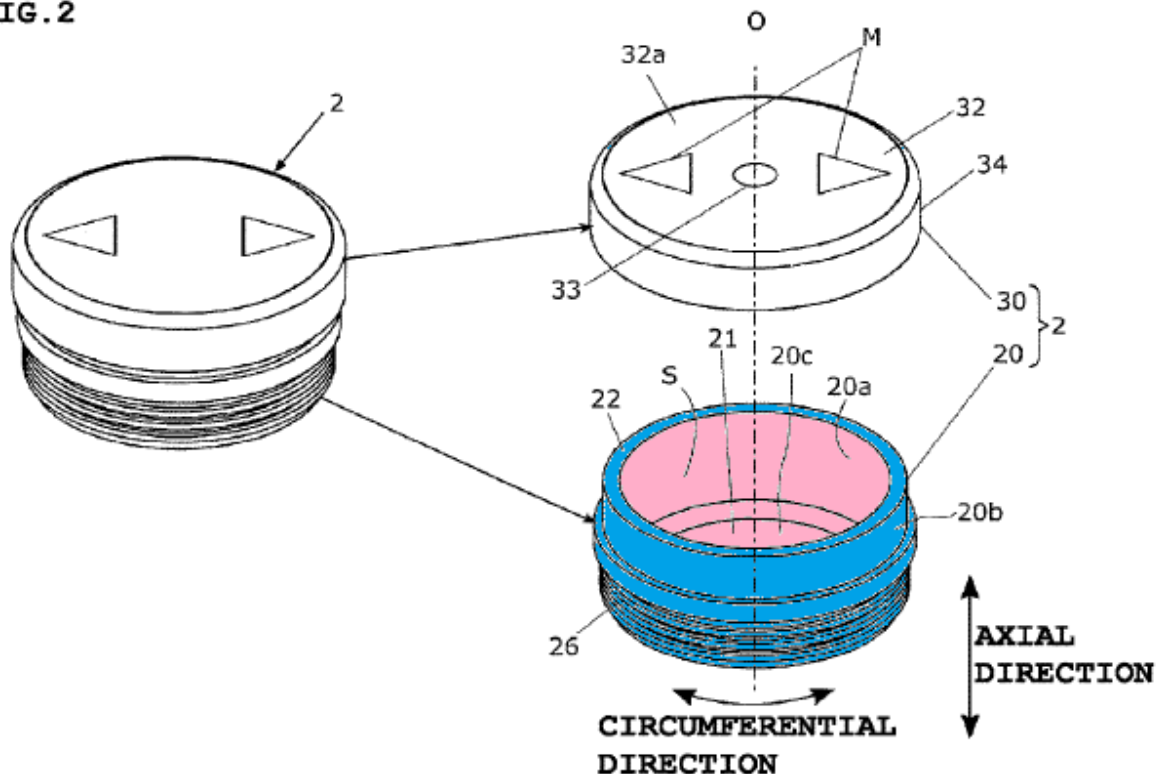


(Yamaguchi-727, FIG. 5 (annotated).) Installation of module 6 within the internal cavity of the housing is inherent to Yamaguchi-727’s device, as Yamaguchi-727 explains that “module 6 is configured to be able to be housed in the housing space S of the above-mentioned housing case 20.” (*Id.*, [0040] (underlining added).)

164. The combination of Yamaguchi-727 and Yamaguchi-566 also discloses that “**the housing includes an outer structure that defines the internal cavity**” for the same reasons I described in my analysis for claim 28[a], incorporated here. To summarize, housing 2 includes a housing case 20 (“**outer structure**”) “having a housing space *S* (housing part) for a module 6[.]” (Yamaguchi-727, [0028].)

Yamaguchi-727 teaches this housing case **20** “defines the internal cavity,” explaining that “[i]n the housing case **20**, a housing space S that can house the module **6** is formed by an inner bottom surface **20c** of the bottom part **21** and an inner peripheral surface **20a** of the peripheral wall part **22**.” (*Id.*, [0029].) FIG. 2 below depicts how housing case **20** is an outer structure (in blue) that defines the internal cavity of housing space S (in pink).

FIG. 2



(*Id.*, FIG. 2 (annotated).)

165. Yamaguchi-727's disclosures satisfy Patent Owner's proposed construction for **"the housing includes an outer structure that defines the**

internal cavity” that clarifies that “**the space inside of the housing structure is the internal cavity[.]**” (EX1017, Exhibit B at 10.) Yamaguchi-727 teaches that its housing space *S* is a “**space inside of the housing structure**” of housing case **20** for the reasons stated above. (Yamaguchi-727, [0028], [0029], FIG. 2.)

(c) **Claim 41[b]: “wherein the electrical sensor device comprises a sensor, a portable power source, an antenna, a printed circuit board, and related electrical circuitry,”**

166. The combination of Yamaguchi-727 and Yamaguchi-566 discloses the elements of claim 41[b] for the same reasons I described in my analysis with respect to Yamaguchi-727 for claim 20 in Ground 1, incorporated here. I have substantially reproduced that analysis below for clarity.

167. “**a sensor**”: Yamaguchi-727 discloses that multiple sensor elements are mounted to circuit board **60**, “for example, a plurality of sensors such as a temperature sensor **62**, a pressure sensor **64** and an acceleration sensor **66** and the like[.]” (Yamaguchi-727, [0040].)

168. “**a portable power source**”: Yamaguchi-727 also discusses how module **6** also includes a “battery **70**.” (Yamaguchi-727, [0040].) This battery is a “**portable power source**,” as Yamaguchi-727 describes an exemplary form of battery **70** as “a so-called disk-shaped button battery[.]” (*Id.*, [0041].)

169. “**an antenna**”: Yamaguchi-727 notes that its module **6** also includes a

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“transmitting means, ... for outputting detected values detected by each of the sensors **62**, **64** and **66** to the outside of the tire[.]” (Yamaguchi-727, [0040].) The transmitting means “is mounted on the circuit board as a transmitting circuit and transmits the measured temperature, the pressure, and the acceleration and so on to the outside of the tire via an antenna[.]” (*Id.*, [0045] (underlining added).)

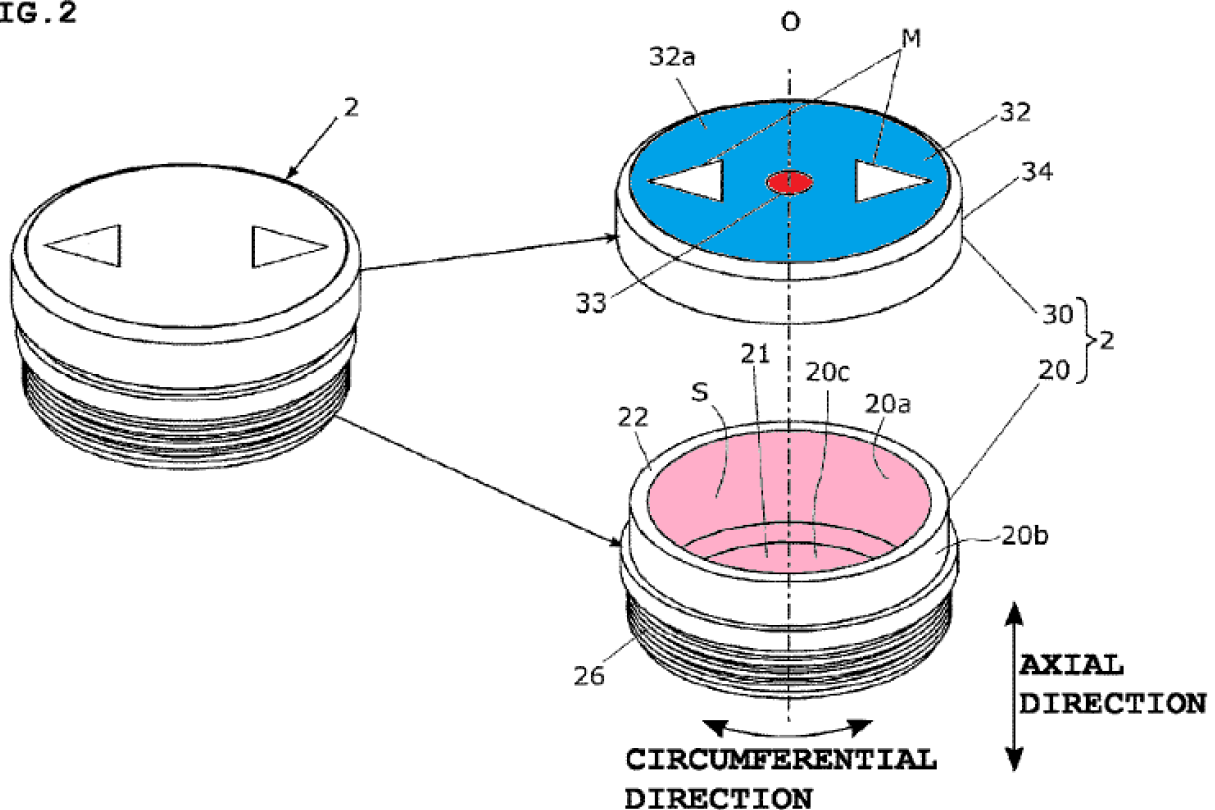
170. **“a printed circuit board, and related electrical circuitry”**: Yamaguchi-727 expressly discloses how its module **6** “is provided with a circuit board **60** having electronic components mounted thereon[.]” (Yamaguchi-727, [0040].) The circuit board includes, beyond its mounted sensors, a transmission means, a control means, a memory means, and metal terminals **69A** and **69B** for supplying power from the battery **70** to the electrical components on the circuit board. (*Id.*, [0040].)

(d) **Claim 41[c]: “wherein the housing comprises an opening extending from an outer surface of the housing to the internal cavity;”**

171. The combination of Yamaguchi-727 and Yamaguchi-566 disclose the elements of claim 41[c]. Yamaguchi-727 describes how its housing cap **30** has a circular ceiling part **32** that includes side surface **32a** forming **“an outer surface of the housing.”** (Yamaguchi-727, [0034].) A “hole **33** penetrating in the axis O direction is formed in the ceiling part **32**” and “allows for communication between

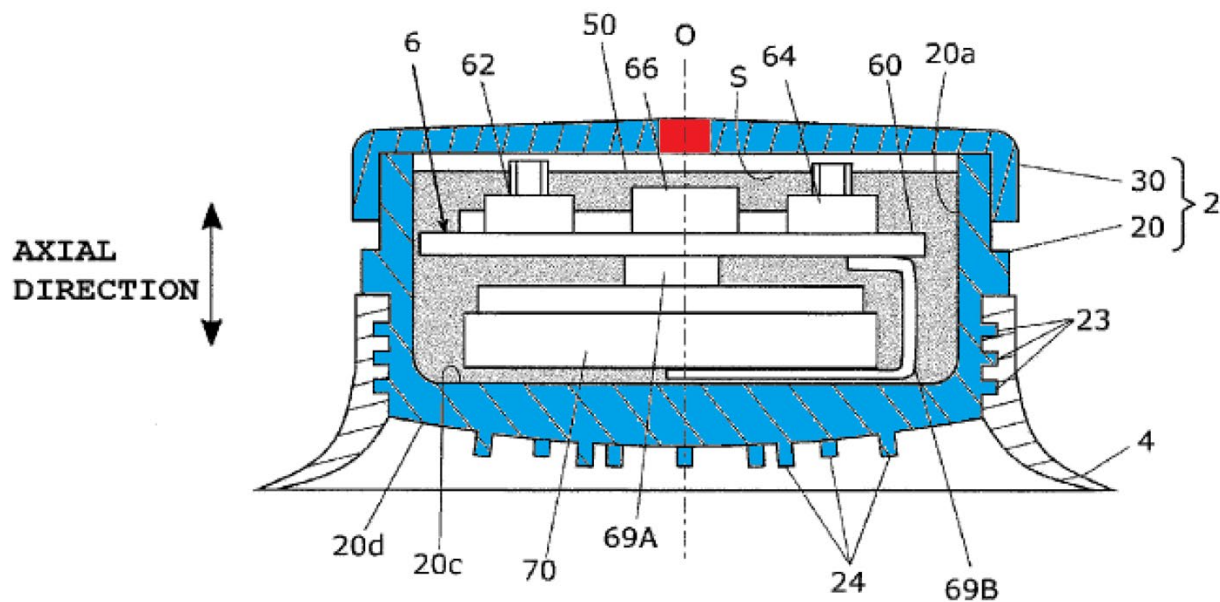
housing space *S* of the housing case **20** and the outside when the opening of the housing case **20** is closed by the cap **30**.” (Yamaguchi-727, [0034].) FIG. 2 below depicts hole **30** (“**an opening**” – in red) that extends from side surface **32a** of housing cap **30** (in blue) to the housing space *S* (“**internal cavity**” – in pink).

FIG. 2



(*Id.*, FIG. 2 (annotated).)

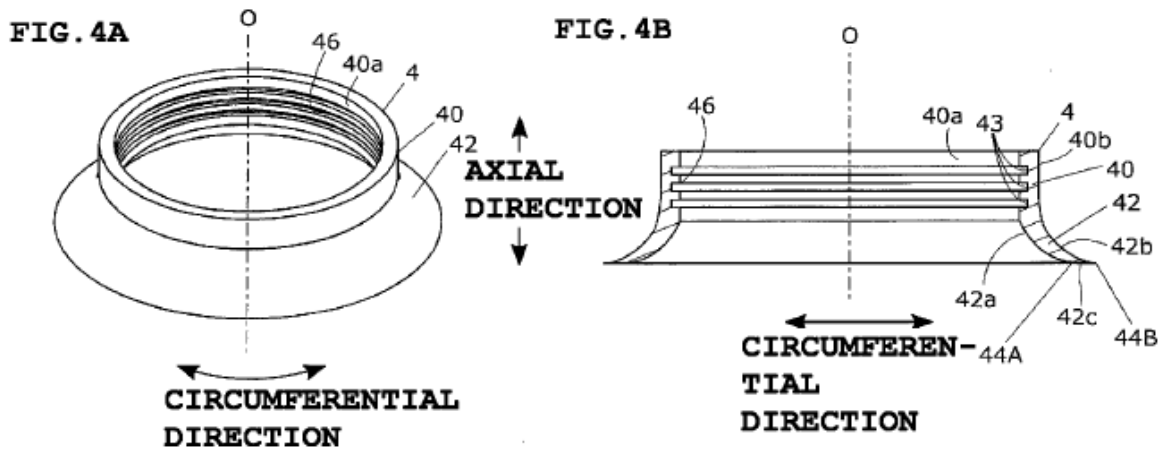
172. FIG. 5 below provides a cross-sectional view that depicts how hole **30** (in red) of housing cap **32** extends from the outer surface of housing **2** (in blue) to the internal cavity of housing space *S*.



(Yamaguchi-727, FIG. 5 (annotated).)

- (e) **Claim 41[d]: “attaching the housing after the step of installing to a retaining member, wherein the retaining member is configured to accommodate attachment with the housing by mechanical or bonding technique, wherein the retaining member is connected with the object before or after formation of the object; and”**

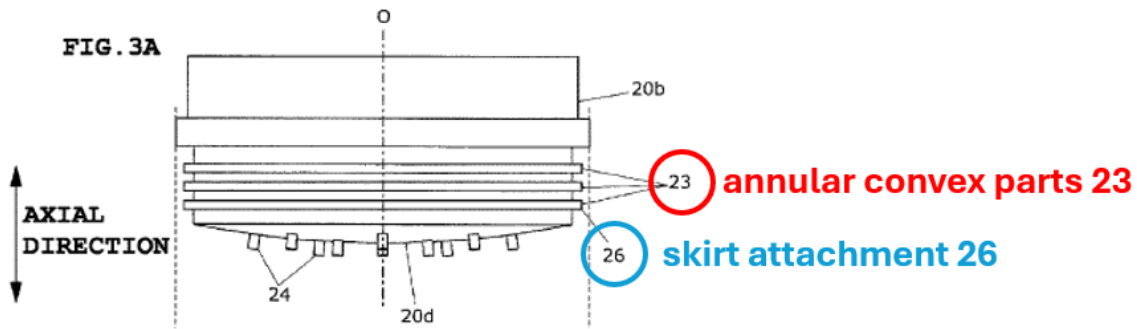
173. The combination Yamaguchi-727 and Yamaguchi-566 discloses claim 41[d]. The specification describes a “**retaining member**” in skirt 4 that “is attached to the [] skirt attachment part 26 formed in the housing case 20, and extends from the outer bottom surface 20d of the housing 2 toward the inner peripheral surface 10s side of the tire 10.” (Yamaguchi-727, [0035].) Skirt 4 is shown in FIGs 4A and 4B below.



(*Id.*, FIGs. 4A, 4B; *see also id.*, [0035], [0037], [0038].)

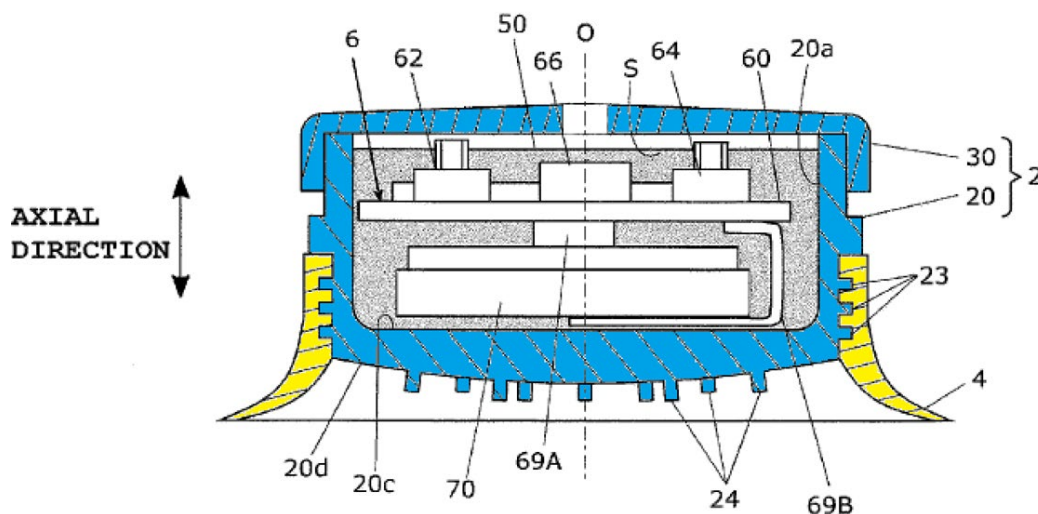
174. Skirt 4 includes annular recesses 43 that are “**configured to accommodate attachment with the housing by mechanical ... technique,**” namely through complimentary fitment with annular convex parts 23 of skirt attachment part 26 within housing case 20 (part of housing 2). The specification describes with reference to FIGs. 3A-3C how housing 2 includes “a skirt attachment part 26, to which a skirt 4 described later can be attached, is formed on an outer peripheral surface 20b of the peripheral wall part 22.” (Yamaguchi-727, [0030].) FIG. 3A below shows how skirt attachment part 26 “is configured by a plurality of annular convex parts 23 formed on a lower half of the peripheral wall part 22.” (*Id.*)

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(*Id.*, FIG. 3A (annotated).)

175. Yamaguchi-727 teaches that the annular recesses **43** in skirt **4** “extend[] over the inner peripheral surface **40a** all the way around ... to be able to be mated with the annular convex part **23** provided in the housing case **20**.” (Yamaguchi-727, [0036]; *see also id.* (“In other words, the annular concave parts **43** are provided at intervals and in quantity corresponding to the annular convex parts **23**.”)). FIG. 5 below depicts how the annular convex parts **23** in housing case **20** mate with the annular recesses **43** within skirt **4** to attach housing **2** (in blue) to skirt **4** (in yellow).



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(Yamaguchi-727, FIG. 5 (annotated); *see id.*, FIG. 4C (depicting housing **2** attached to skirt **4**), [0035].)

176. Yamaguchi-727 discloses “**attaching the housing after the step of installing to a retaining member attached.**” FIG. 6A describes “attachment processing” as coming *after* “functional component preparation processing” by virtue of the arrowhead in the process step description. “Attachment processing” in Yamaguchi-727 includes the “attaching the housing” step in claim 41[d], whereas the “functional component preparation processing” includes the “installing” step in claim 41[d], where the step of installing refers to installing the electrical sensing device into the housing. (*See* Yamaguchi-727, FIG.6A; *id.* [0052] (describing the “functional component preparation process” in FIG. 7 where the electrical sensing device is already installed in the housing).) Yamaguchi-727 also discloses how “**the retaining member is connected with the object ... after formation of the object.**” To start, Yamaguchi-727 describes a process for attaching its functional component **1** that occurs *after* the tire (“**object**”) has been formed. (*See* Yamaguchi-727, [0049].) FIG. 6A is a work process diagram that demonstrates that the attachment process for functional component **1** (including skirt **4**—the “**retaining member**”) occurs after tire pretreatment. Per FIG. 6B, tire pretreatment additionally includes a mold release agent removal process, a ridge treatment process, and a cleaning

process that prepare the inner peripheral surface of the tire for attachment and occurs after “**formation**” of the tire.

FIG. 6A

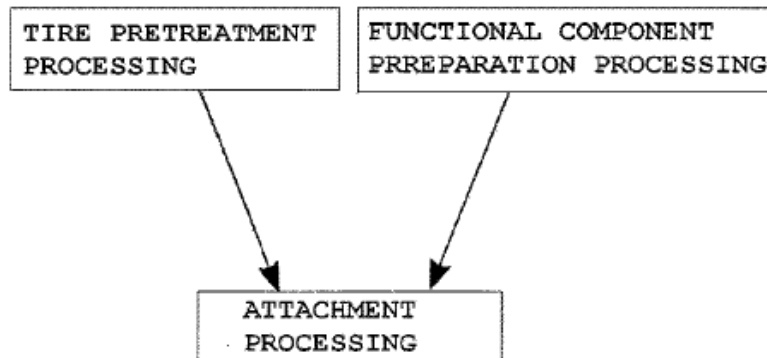
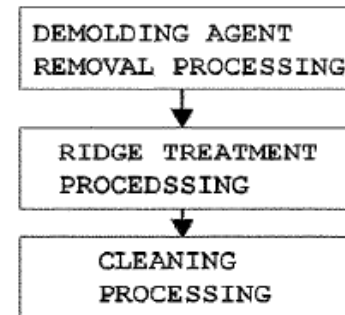


FIG. 6B



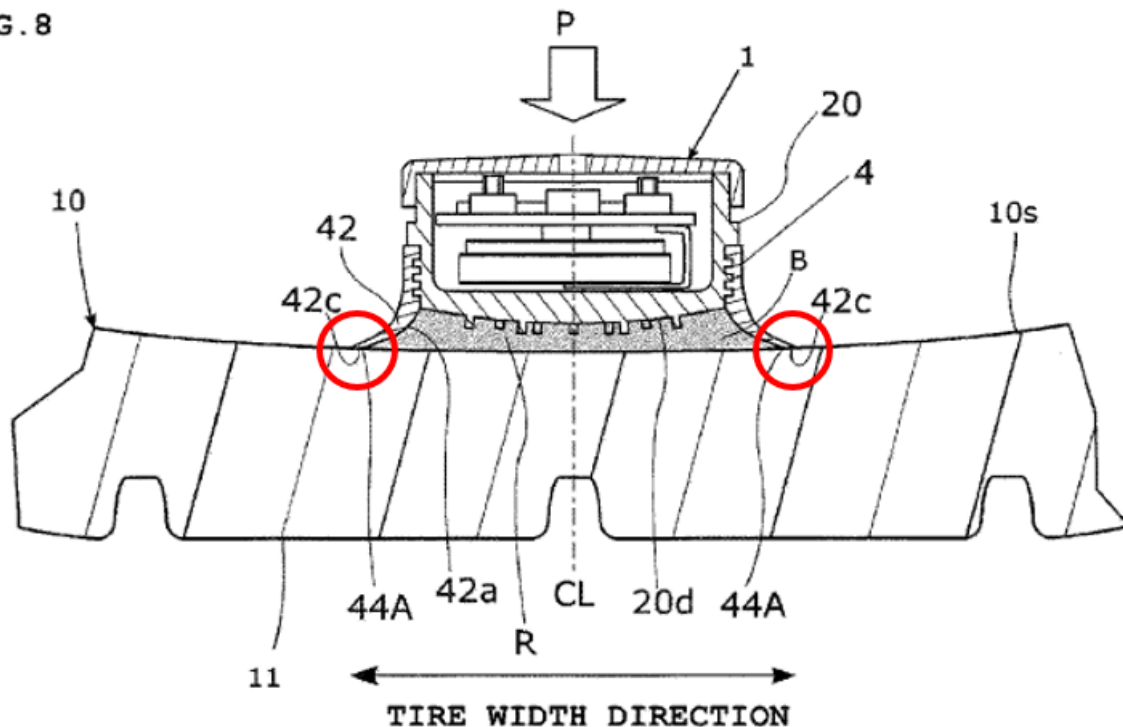
(*Id.*, FIGs. 6A, 6B.)

177. Yamaguchi-727 describes an attachment process where functional component **1** is mounted to tire **10** through an adhesive agent **B** that fills a space defined by the peripheral surface **42** of skirt **4**:

As discussed above, the functional component **1** is configured to be attached in a state that the adhesive agent **B** is densely filled in the filling space R enclosed by the outer bottom surface **20d** facing the inner peripheral surface **10s** of the tire **10**, the inner peripheral surface **42a** of the skirt **4** that expands in diameter and extends in a tubular shape from the peripheral edge of the outer bottom surface **20d** toward the inner peripheral surface **10s**, and the inner peripheral surface **10s** of the tire **10**.

(Yamaguchi-727, [0054].) FIG. 8 below depicts how skirt **4** is connected at item **42c** (encircled in red) with inner peripheral surface **10s** of tire **10**.

FIG. 8



(*Id.*, FIG. 8 (annotated).) The specification confirms connection between inner peripheral surface 10s of tire 10 and item 42c of skirt 4, providing “there may be provided a structure for attaching, to a tire, the functional component described above, in which the end part of the tubular part is abutted against the inner peripheral surface of the tire, and an adhesive agent is filled in a filling space enclosed by an inner peripheral surface of the tubular part, the bottom surface of the housing and the inner peripheral surface of the tire.” (*Id.*, [0007] (underlining added); *see also id.*, [0008].)

- (f) **Claim 41[e]: “monitoring an operating parameter of the object through the use of the electrical sensing device, wherein information related to the operating parameter is wirelessly transmitted from the electrical sensing device to a receiver that is external from the sensor assembly.”**

178. The combination of Yamaguchi-727 and Yamaguchi-566 discloses claim 41[e] through the use of sensors, control means, memory means, and transmission means mounted to the circuit board **60** of module **6** (“**electrical sensing device**”).

179. Yamaguchi-727 describes how module **6** “**monitor[s] an operating parameter of the object**” through multiple sensors (*e.g.*, temperature, pressure, acceleration), “each of which functions as a state acquiring means that acquires a state inside the tire[.]” (Yamaguchi-727, [0040].) The memory means “records the history” of measurements from the sensors. (*Id.*, [0046].) The control means “executes a predetermined program” based on the basis of information on the state inside the tire measured by the sensors, and then “controls the operation of the transmitting means” that transmits that information outside of the sensor assembly. (*Id.*)

180. The “**information related to the operating parameter**” collected from Yamaguchi-727’s sensors is “**wirelessly transmitted**” from module **6** to “**a receiver that is external from the sensor assembly.**” Yamaguchi-727 describes

how circuit board **60** includes a transmitting means “for outputting detected values detected by each of the sensors **62**, **64** and **66** to the outside of the tire[.]” (Yamaguchi-727, [0040].) The transmitting means is “mounted on the circuit board as a transmitting circuit and transmits... to the outside of the tire via an antenna.... Signals... transmitted wirelessly from the transmitting means are received, for example, by a wireless circuit of a main unit provided in a vehicle[.]” (*Id.*, [0045] (underlining added).) The “wireless circuit of a main unit” described in Yamaguchi-727 is a “**receiver that is external from the sensor assembly**” and receives sensor data from the transmitting means of circuit board **60**.

18. Dependent Claim 43

181. Claim 43 depends from claim 41 and recites “**wherein during the step of installing, the electrical sensor device is attached in place within the internal cavity by contact between the electrical sensor device and one or more surface features in the internal cavity.**” (’421, cl. 43.) The combination of Yamaguchi-727 and Yamaguchi-566 discloses and renders obvious the elements of claim 43 for the same reasons I described in my analysis for claim 5, incorporated here.

19. Dependent Claim 44

182. Claim 44 depends from claim 41 and recites “**wherein the object is [] made from vulcanized rubber, and before the step of attaching, the retaining**

member is attached with the object or an element that rotates with the object before or after the object has been formed.” In my opinion, the combination of Yamaguchi-727 and Yamaguchi-566 renders obvious the elements of claim 44.

183. While Yamaguchi-727 discusses in its attachment of the skirt to the tire process that one would fill a cavity space **R** with adhesive agent **B** to adhere the functional component to the tire, it does not require that the adhesive agent fill the cavity space after skirt **4** has been fixed to housing **2**. A POSA would have understood that, during the attachment process, skirt **4** could be placed in the inner peripheral surface of the tire, adhesive agent fill the internal cavity of the skirt, and then housing **2** be placed within the cavity to fix to skirt **4** while also pressing base of housing case **20** to the adhesive agent. This method was well-known by the 2019 time period, especially where, as here, curing occurs at relatively lower temperatures. (*Compare* Yamaguchi-727, [0057] (describing how “it is preferable that the adhesive agent B is cured by heating with a dryer at a heating temperature of 60° C or higher for one minute or more”) *with* Wilson-506 [EX1011], 4:23-25 (curing at 45° C), 5:11-16 (known in the field that attachment of housing to retaining member can occur after retaining member attached to tire).) A POSA would have further identified this method as advantageous over what is disclosed in Yamaguchi-727, as Yamaguchi-727 itself cautions with respect to its technique that “care should

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be taken to avoid overflow of the adhesive more than necessary due to too much of the pressing force” when affixing the functional component **1** with skirt **4** to the inner peripheral surface of the tire. (Yamaguchi-727, [0053].) Such concerns would be circumscribed by first placing and curing skirt **4** to the inner peripheral surface of the tire. Moreover, it would have been obvious to try, as there are finite and known options for attaching these components to the inner tire through use of adhesive or other bonding agents. It was well-established in the art that attachment in either order is acceptable at lower-cure temperatures. (*See, e.g.*, Wilson-506, 5:11-16 (“Since the rubber patch assembly can be attached to the tire using an air cure or low temperature cure, it is understood that the sequence of assembling the tag assembly into the rubber patch housing may be accomplished either before or after the rubber patch is attached to the tire innerliner.”).) The ’421 patent confirms such elementary understanding that one may reverse the order of the steps for attaching the housing to the retaining member and step of attaching the retaining member to the object or tire, explaining that “a desired feature of the retainer 14 and housing 12 mechanical attachment configuration illustrated in FIGS. 1, 6 and 7 is that such permits the removal of the housing 12 from the retainer 14.” (’421, 18:41-44.)

184. The remaining elements of claim 44 are disclosed in Yamaguchi-727, as discussed in my analysis for claim 24 for Ground 1, incorporated here.

20. Dependent Claim 48

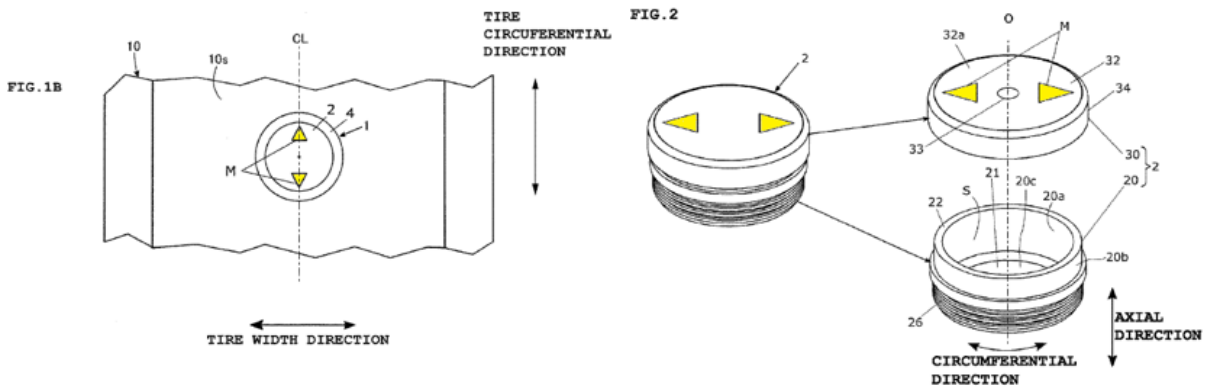
185. Claim 48 further depends from claim 44 and recites “**wherein the object is a vehicle tire, and wherein the retaining member is attached to a surface that is inside of the vehicle tire.**” (’421, cl. 48.) The combination of Yamaguchi-727 and Yamaguchi-566 discloses and renders obvious the elements of claim 48 for the same reasons I described in my analysis with respect to Yamaguchi-727 for claim 24 in Ground 1, incorporated here.

21. Dependent Claim 50

186. Claim 50 depends from claim 41 and recites “**wherein during the step of attaching, the housing is positioned relative to the retaining member according to a display feature that is positioned on the housing.**” (’421, cl. 50.) Attachment marks M on Yamaguchi-727’s housing cap **30** disclose claim 50. The combination of attachment marks M on housing cap **30** and annular convex parts **23** of skirt attachment part **26** for housing **2** also disclose this claim.

187. Yamaguchi-727 describes how its housing cap **30** (part of housing **2**) has a circular ceiling part **32** that includes an outer side surface **32a** where “attachment marks M are formed to indicate a direction for attaching the functional component **1** to the tire **10.**” (Yamaguchi-727, [0034].) As shown in FIG. 1B and FIG. 2 below, attachment marks M (in yellow) are a “**display feature that is**

positioned on the housing.” They “are indicated, for example, by engraving or printing” of the surface of housing cap **30**. (*Id.*)



(*Id.*, FIGs. 1B, 2 (annotated).)

188. These attachment marks M direct how the housing ought to be “**positioned relative to the retaining member,**” as Yamaguchi-727 explains that they “show that the functional component 1 is to be attached on the inner peripheral surface 10s of the tire 10 in such a manner that the arrows are oriented in the tire circumferential direction.” (Yamaguchi-727, [0034].) A POSA would have understood (1) that the retaining member would be placed in a fixed position relative to the inner peripheral surface of the tire; and (2) that the attachment marks M provide a specific orientation for the housing when fitted to the retaining member to ensure components like its acceleration sensor are properly oriented within the tire to collect accurate tire information. (*See id.* (“The direction indicated by the

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attachment marks **M** may be set appropriately in accordance with a detection direction of the module **6**.”).)

189. Patent Owner may argue that Yamaguchi-727 fails to disclose how the attachment marks **M** indicate that the housing should be positioned relative to the retaining member but instead indicate how the housing should be positioned relative to the inner peripheral surface of the tire. In my view, this distinction is without a difference because the relative positioning of housing to retaining member is the same as functional component to tire surface—the purpose is to ensure the sensor assembly is disposed in an orientation that permits accurate measurements of tire information. While Yamaguchi-727 discusses in its attachment process that one would fill a cavity **R** with adhesive agent **B** to adhere the functional component to the tire, it does not require that the adhesive agent fill the cavity after skirt **4** has been fixed to housing **2**.

190. A POSA would have understood that, during the attachment process, skirt **4** could be placed in the inner peripheral surface of the tire, adhesive agent could fill the internal cavity of the skirt, and then housing **2** could be placed within the cavity to fix to skirt **4** while also pressing base of housing case **20** to the adhesive agent. This method was well-known by the 2019 time period, especially where, as here, curing occurs at relatively lower temperatures. (*Compare* Yamaguchi-727,

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[0057] (describing how “it is preferable that the adhesive agent B is cured by heating with a dryer at a heating temperature of 60° C or higher for one minute or more”) *with* Wilson-506, 4:23-25 (curing at 45° C), 5:11-16 (known in the field that attachment of housing to retaining member can occur after retaining member attached to tire).) A POSA would have further identified this method as advantageous over what is disclosed in Yamaguchi-727, as Yamaguchi-727 itself cautions with respect to its technique that “care should be taken to avoid overflow of the adhesive more than necessary due to too much of the pressing force” when affixing the functional component 1 with skirt 4 to the inner peripheral surface of the tire. (Yamaguchi-727, [0053].) Such concerns would be circumscribed by first placing and curing skirt 4 to the inner peripheral surface of the tire. Moreover, it would have been obvious to try, as there are finite and known options for attaching these components to the inner tire through use of adhesive or other bonding agents. It was well-established in the art that attachment in either order is acceptable at lower-cure temperatures. (*See, e.g.*, Wilson-506, 5:11-16 (“Since the rubber patch assembly can be attached to the tire using an air cure or low temperature cure, it is understood that the sequence of assembling the tag assembly into the rubber patch housing may be accomplished either before or after the rubber patch is attached to the tire innerliner.”).)

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191. Attachment marks M, along with annular convex parts **23** of skirt attachment part **26** on housing **2**, are also display features that describe how the housing should be “**positioned relative to the retaining member**” in a top-to-bottom orientation. As attachment marks M are etched on the top of the housing, and annular convex parts **23** are a structural component visible to the outer surface of housing **2**, they each are a “**display feature that is positioned on the housing.**” Both provide to the user an indication of the top-to-bottom orientation of housing **2** relative to skirt **4**—attachment marks M should be on the top of the housing, skirt attachment part **26** should be directionally at the bottom for attachment to the skirt via annular convex parts **23**. That is, a POSA would have understood by Yamaguchi-727’s teachings for these two display features that, during the attachment step that housing **2** should be positioned with the skirt attachment part **26** to be inserted into the cavity of skirt **4** such that its annular convex parts **23** mate with annular recesses **43** of skirt **4**. (Yamaguchi-727, [0030], [0036], FIGs. 3A, 5.)

192. My mapping of attachment marks M and/or annular convex parts **23** to the recited “**display feature**” is consistent with the ’421 patent’s specification. The ’421 patent describes how a “display feature” “may be provide[d] in the form of different shapes, objects, signs, figures and the like” and that “it is to be understood that the display feature [] may be positioned at different locations on the housing[]

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that is viewable by a user and that all such other placement positions are intended to be within the scope[.]” (’421, 9:54-56, 10:3-8.)

193. In addition, my mapping of annular convex parts **23** as a “**display feature**” is also consistent with Patent Owner’s interpretation of the scope of claim 50. In its infringement contentions, Patent Owner points to an “empty notch space on the bottom of the Sensor” as a “**display feature**” that can be positioned relative to the retaining member.



(EX1015, p. 244.) In my opinion, Yamaguchi-727’s annular convex parts **23** are

materially indistinct from the “empty notch space” as a housing display feature.

22. Dependent Claim 51

194. Claim 51 depends from claim 41 and recites “**wherein during the step of monitoring, the sensor monitors operating parameters comprising one or more of operating conditions, orientation, and location and transmits by use of the antenna information related to the monitored operating parameter to the receiver, and wherein the electrical device is configured to receive information transmitted from an external device to change one or more feature of the electrical sensor device.**” (’421, cl. 51.) The combination of Yamaguchi-727 and Yamaguchi-566 discloses that its “**sensor monitors operating parameters**” for the reasons discussed in my analysis for claim 41[e], incorporated here.

195. Patent Owner has taken the position in its infringement contentions that data accumulated from an accelerometer and pressure sensor is sufficient to satisfy this claim element, noting that Petitioner’s products “include an accelerometer and a pressure sensor inside the yellow housing which senses air pressure from through a pressure hole.” (EX1015, p. 245.) Based on Patent Owner’s interpretation of claim 51’s scope, Yamaguchi-727’s functional component 1 discloses sensors that monitor “**one or more of operating conditions, orientation, and location.**” As I have discussed, module 6 includes a circuit board 60 that comprises a temperature sensor

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62, pressure sensor **64**, or acceleration sensor **66** mounted to circuit board **60**. (Yamaguchi-727, [0040].) Sensors **62**, **64**, and **66** “each ... functions as a state acquiring means that acquires a state inside the tire,” *i.e.*, “**operating conditions**” for the tire. (*Id.*; *see also id.*, [0043], [0044].)

196. The sensor data containing information on the operating conditions of the tire is “**transmit[ted] by use of the antenna information related to the monitored operating parameter to the receiver.**” As discussed for claim 41[e], Yamaguchi-727 describes how circuit board **60** includes a transmitting means “for outputting detected values detected by each of the sensors **62**, **64** and **66** to the outside of the tire[.]” (Yamaguchi-727, [0040].) The transmitting means is “mounted on the circuit board as a transmitting circuit and transmits ... to the outside of the tire via an antenna.... Signals ... transmitted wirelessly from the transmitting means are received, for example, by a wireless circuit of a main unit provided in a vehicle[.]” (*Id.*, [0045] (underlining added).)

197. Yamaguchi-566 teaches that the “**electrical device is configured to receive information transmitted from an external device to change one or more features of the electrical sensor device.**” Yamaguchi-566’s module **6** includes a reception section **69** that consists of a reception circuit **69A** and a reception antenna **69B**. (Yamaguchi-566, [0034], FIG. 4B.) Reception section **69**, “when a

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predetermined radio wave is input to the reception antenna **69B** from a functional component management device, ... judges that the reception circuit **69A** has received the radio wave, opens a communication circuit from the outside to the control processing unit **70**, and outputs the input information to the control processing unit 70.” (*Id.*, [0036] (underlining added).) The described process discloses that the reception circuit **69A** “**receive[s] information transmitted from an external device,**” the functional component management device that is outside of the functional component.

198. The information received at the reception circuit **69A** is meant to “**change one or more features of the electrical sensor device.**” Yamaguchi-566 describes how “[t]he control processing unit **70**, when the communication circuit to the reception section **69** is opened, outputs, updates, or adds the information stored in the memory means **72** on the basis of commands input by means of radio waves from the functional component management device... that manages the functional component **1.**” (Yamaguchi-566, [0042] (underlining added).) Memory means **72** includes “a memory in which programs or the like are stored,” (*id.*, 0037]) such that a POSA would have understood that information received at the reception section **69** to update and/or add information to what is stored in the memory means would change feature(s) of the functional component **1**. This is made plain by Yamaguchi-

566's specific disclosures of the information contained within memory means 72:

The memory means 72 stores, for example, a unique identification number set in the basic substrate 60, a program for controlling the operations of the temperature sensor 62 and the pressure sensor 64, a program for causing the communication unit 67 to operate, a program for executing processing when a signal is input from the outside to the reception section 69 of the communication unit 67, and a program for controlling the expansion substrate 80, and so on.

(*Id.*, [0038] (underlining added).)

199. The rationale and motivation to combine Yamaguchi-727 and Yamaguchi-566 that I provided in connection with claim 5 applies here.

23. Dependent Claim 52

200. Claim 52 depends from claim 41 and recites “**wherein the sensor assembly electrical sensor device comprises an accelerometer sensor.**” (’421, cl. 52.) The combination of Yamaguchi-727 and Yamaguchi-566 discloses and renders obvious the elements of claim 52 for the same reasons I described in my analysis with respect to Yamaguchi-727 for claim 12 in Ground 1, incorporated here.

D. Ground 3: Claims 34 and 53 are Obvious Over Yamaguchi-727 and Yamaguchi-566 in further view of Dodani-859

201. In my opinion, the combination of Yamaguchi-727 and Yamaguchi-566 disclose and/or renders obvious almost all Challenged Claims except those related to the use of accelerometer sensor data at the external receiver, *i.e.*, claims 34 and 53. But use of accelerometer data in tire sensor assemblies in the manner

claimed by the '421 patent was well-known by October 2019. In Ground 3, I incorporate my analysis from Ground 2 and discuss how the main unit from Yamaguchi-727 may be further adapted from Dodani-859's teachings to process the accelerometer sensor data it receives from functional components mounted in the tires and then determine certain operating parameters and/or conditions of the vehicle tire.

**1. Motivation to Combine Yamaguchi-727 and Yamaguchi-566
With Dodani-859 and Reasonable Expectation of Success**

202. A POSA would have been motivated to combine Yamaguchi-727 and Yamaguchi-566 with the teachings of Dodani-859 discussed above regarding the use of sensor data to determine various tire operating parameters. In particular, the "main unit provided in a vehicle" in Yamaguchi-727 would be able to process sensor data obtained from the accelerometer and use it to calculate road conditions and vehicle camber and/or toe alignment in accord with Dodani-859's disclosures.

203. A POSA would have regarded the teachings of Dodani-859 as naturally combinable with the sensor system discussed in Yamaguchi-727 as modified by Yamaguchi-566. Yamaguchi-727, Yamaguchi-566, and Dodani-859 are analogous references in the same field as the alleged invention related to sensor design and implementation within automotive applications, particularly for the attachment of

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sensor assemblies to the inner wall of a tire to monitor tire conditions and other operating parameters. (*See, e.g.*, Yamaguchi-727, [0001], [0006]; Yamaguchi-566, [0001], [0006]; Dodani-859, [0002] (“The disclosed embodiments relate generally to a tire sensor device for determining driving conditions and tire degradation, and more specifically to a tire sensor device adapted to be disposed on the inner surface of a tire tread.”), [0005] (“The present disclosure provides a tire sensor device for monitoring a condition of a tire.”).) Yamaguchi-727, Yamaguchi-566, and Dodani-859 are reasonably pertinent to the problem faced by the inventor of providing a tire monitoring system with enhanced functionality and reporting of total tire performance parameters that indicates when to initiate proper tire maintenance for safety. (*See* Yamaguchi-727, Abstract (“A functional component in which an electronic component capable of acquiring information inside a tire is housed...”), [0040] (describing “circuit board **60** includes the electronic components which are, for example, a plurality of sensors ... each of which functions as a state acquiring means that acquires a state inside the tire, a transmitting means, ... for outputting detected values detected by each of the sensors ... to the outside of the tire[.]”), [0045] (describing a “wireless circuit of a main unit provided in a vehicle” that receives sensor information about states of the tire and displays to the user); Yamaguchi-566, Abstract, [0031]-[0033], [0035] (describing transmission of a

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“predetermined signal” to a “main unit installed in a vehicle”), [0041] (“predetermined signal” comprising sensor data information); Dodani-859 ([0003] (“Tire wear and maintenance are critical aspects of vehicle safety.”), [0007] (“[T]he present disclosure provides a method of alerting a user to changes in tire characteristics. The method includes receiving data from a plurality of sensors disposed within a tire.”), [0079], [0081] (accelerometer to determine road conditions), [0082] (accelerometer to determine rubber decay in tire), [0083] (accelerometer to determine wheel misalignment), [0084]-[0085] (pressure sensors to determine slow leaks and/or punctures in the tire), [0086] (using pressure data to determine excess load), [0087] (counting revolutions to determine tire mileage limit), [0090]-[0093] (user alerts indicating abnormal tire conditions), [0098]-[0099] (same).)

204. A POSA would have been motivated to combine Yamaguchi-727 and Yamaguchi-566 with Dodani-859. While Yamaguchi-727’s disclosures are more particularly directed towards effective attachment of a sensor assembly to the inner peripheral surface of a tire, the purpose of that functional component is nevertheless to obtain state information about tire operating conditions and/or parameters and transmit that information outside of the tire to a “main unit provided in the vehicle” for display to a user. (Yamaguchi-727, [0045]; *see also* Yamaguchi-566, [0035].)

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Whereas Yamaguchi-727 and Yamaguchi-566 teach that sensor data can be sent from the functional component to another unit outside of the tire for a user to interface with, Dodani-859's teachings on how that data can be used would have provided a POSA with a deeper understanding of how specific information collected from particular sensors may be processed to determine specific conditions related to a tire's operation. (Dodani-859, [0079], [0081]-[0087].) A POSA would have been motivated to incorporate Dodani-859's teachings on sensor data processing into the capabilities of Yamaguchi-727's main unit to enhance a user's capabilities to monitor various aspects of the vehicle's tire conditions.

205. A POSA would have had a reasonable expectation that the combination would have been successful. Dodani-859 teaches that its disclosures "are not intended to be exhaustive" and that "[m]any modifications and variations are possible in view of" its teachings. (Dodani-859, [00104].) The embodiments chosen and described were meant "to best explain the principles and their practical applications" and "enable others skilled in the art to best utilize the embodiments and various embodiments with various modifications as are suited to the particular use contemplated." (*Id.*) Here, a POSA would have not perceived any teaching from Yamaguchi-727 or Yamaguchi-566 that would discourage incorporation of Dodani-859's principles on the use of accelerometer sensor data from the tire sensor(s)

attached to the inside tire tread(s). Rather, the combination would have entailed only the routine application of conventional software programming techniques to integrate the processing functionality for the accelerometer sensor data into Yamaguchi-727's main unit to determine road conditions and vehicle camber and/or toe alignment for the tire(s).

2. Dependent Claim 34

206. Claim 34 further depends from claim 33 and recites “**wherein the object is a vehicle tire and the system is configured to determine one or more parameters consisting of a tire diameter, slip, strain, road conditions or soil conditions, a tire tread depth, a tire radial load, and vehicle camber and/or toe alignment from the accelerometer sensor data.**” (’421, cl. 34.) A POSA would have known that the collected accelerometer data from the combination of Yamaguchi-727 and Yamaguchi-566, while transmitted to an outside receiver, would be used in some manner to analyze the state of the tire but the Yamaguchi references do not detail specifically how the accelerometer data may be used. For that implementation detail, a POSA would have looked to Dodani-859’s teachings that such data can be used to “**determine**” at least “**road conditions**” and “**vehicle camber and/or toe alignment.**”

207. Generally, Dodani-859 describes how its accelerometer is “adapted to

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detect and/or measure changes in the motion of the tire, for example, as the tire is driven on a road surface.” (Dodani-859, [0034].) The accelerometer data can be used to determine “**road conditions**” by sensing high-frequency vibrations in a tire. (*Id.*, [0081].) These vibrations “can be used to understand the road surface, and/or the friction between the tire and the road surface” by “using the data from the plurality of sensors acquired at the frequency greater than the frequency of rotation of the tire[.]” (*Id.* (underlining added).)

208. Dodani-859 also describes how “**vehicle camber and/or toe alignment**” may be determined from the accelerometer data. A POSA would have understood vehicle camber and/or toe alignment to generally describe the alignment (or misalignment) of a vehicle’s wheel and tire relative to the road surface. Dodani-859 notes that “determining that the tire is mounted to a misaligned wheel includes analyzing motion (e.g., wobble) of the tire as determined by data from the accelerometer...” (Dodani-859, [0083].) Discussing a three-axis accelerometer similar to that present in Yamaguchi-727 and Yamaguchi-566, Dodani-859 provides that “determining that the tire is mounted to a misaligned wheel includes detecting that data from the accelerometer include periodic motion of the tire along an axis of rotation of the tire (e.g., at the frequency of rotation of the tire).” (*Id.* (underlining added).)

209. The combination of Yamaguchi-727 and Yamaguchi-566 with Dodani-859 in the manner I articulated discloses a **“system [] configured to determine one or more parameters consisting of ... road conditions or soil conditions, ... and vehicle camber and/or toe alignment from the accelerometer sensor data”** because Yamaguchi-727 and Yamaguchi-566 as modified by Dodani-859 would have resulted in the main unit in the vehicle being able to calculate additional state information based on the accelerometer data received at the wireless circuit from Yamaguchi-727’s functional components in the tires.

3. Dependent Claim 53

210. Claim 53 further depends from claim 52 and recites **“wherein the object is a vehicle tire, and wherein during the step of monitoring, one or more of a tire outside diameter, a tire tread depth, slip, strain, road or soil conditions, a tire radial load, and a vehicle camber and/or toe alignment parameter is determined from information sent wirelessly from the sensor assembly.”** (’421, cl. 53.) The combination of Yamaguchi-727, Yamaguchi-566, and Dodani-859 render obvious claim 53 for the same reasons I described in my analysis for claim 34, incorporated here.

E. Ground 4: Claim 10 is Obvious Over Yamaguchi-727 in View of McDonald

211. Ground 4 builds off Ground 1, incorporated here, and is directed to the only claim reciting use of a filter within an opening from the housing to the internal cavity. Such filters were well-known solutions to a POSA by 2019 for keeping contaminants (*e.g.*, corrosive media) out of passages that lead to sensors within a cavity, as explained below, and I rely on the teachings of McDonald to demonstrate that it would have been obvious to a POSA to modify the passage within hole **33** in Yamaguchi-727 to incorporate a filter to achieve this benefit.

1. Motivation to Combine Yamaguchi-727 With McDonald and Reasonable Expectation of Success

212. It would have been obvious to a POSA to combine Yamaguchi-727 with McDonald, predictably resulting in the use of a filter within the hole **33** to filter air from outside of housing **2** into housing space *S*, in communication with sensors **62** and **64**. This combination would involve the straightforward incorporation of a filter within opening **30** of functional component **1** to filter air passing from outside the housing into the internal cavity of the housing, thereby preventing the sensors from being exposed to corrosive media.

213. Yamaguchi-727 and McDonald are analogous references in the same field as the alleged invention related to sensor design and implementation within

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automotive applications, particularly for the attachment of sensor assemblies to the inner wall of a tire to monitor tire conditions and other operating parameters. (*See, e.g., Yamaguchi-727*, [0001] (“The present invention relates to a functional component or the like that can be attached to a tire.”), [0006] (“As the functional component for solving the above mentioned problems, there is provided a functional component in which an electronic component capable of acquiring information inside a tire is housed and which is attachable to an inner peripheral surface of the tire, the functional component including a housing having a housing part for housing the electronic component and a bottom surface facing the inner peripheral surface of the tire, and a tubular part extending from a peripheral edge of the bottom surface toward the inner peripheral surface.”); *McDonald*, 2:61-65 (“As an example, the component can be used in pressure sensing applications such as a tire pressure monitor. In this embodiment, the component can be wheel-mounted, rim-mounted, tire-valve mounted, or tire-mounted.”).)

214. A POSA would have been motivated to combine *Yamaguchi-727* with *McDonald* because, as noted, use of a filter or permeable membrane to maintain fluid communication between sensors and the outside environment of the sensor assembly was well-known since the 1990s. *McDonald* notes that physical sensor components used in automotive applications had to be protected from “the

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potentially corrosive environments in which the pressure sensors operate.” (McDonald, 1:20-26.) A “common failure mechanism” for pressure sensors occurs where interfacing with these hostile environments causes the pressure sensor to “corrode from the direct exposure to the corrosive media.” (*Id.*, 1:35-40.) A POSA would have understood, as one of only a limited number of potential solutions, that a filter could be used to “protect[] a sensor element from corrosion in various potentially corrosive environments such as, for example, tire mounting paste, tire mounting and general purpose lubricants, tire de-mounting fluid, brake fluid, degreaser, wheel cleaner, and mineral oil.” (*Id.*, 7:5-10.) These substances have long been used in the mounting, maintenance, and de-mounting of tires, and a POSA would have known that any tire-mounted sensor assembly would have to include a solution to protect sensors from exposure to such corrosive material. It would have been obvious to try using a filter, among other limited solutions available to prevent exposure of sensors to corrosive material. (See McDonald, 1:20-30 (describing use of elastic gels, polymers, diaphragms, membranes, and other protective coatings or encapsulants to protect pressure sensors from corrosive materials); Laird [EX1013], FIG. 2 (pressure transducer 104 used to measure pressure in compartment 112 through conduit 116), 5:54-6:9 (use of diaphragm with pressure transducer 104, along with epoxy encasement).)

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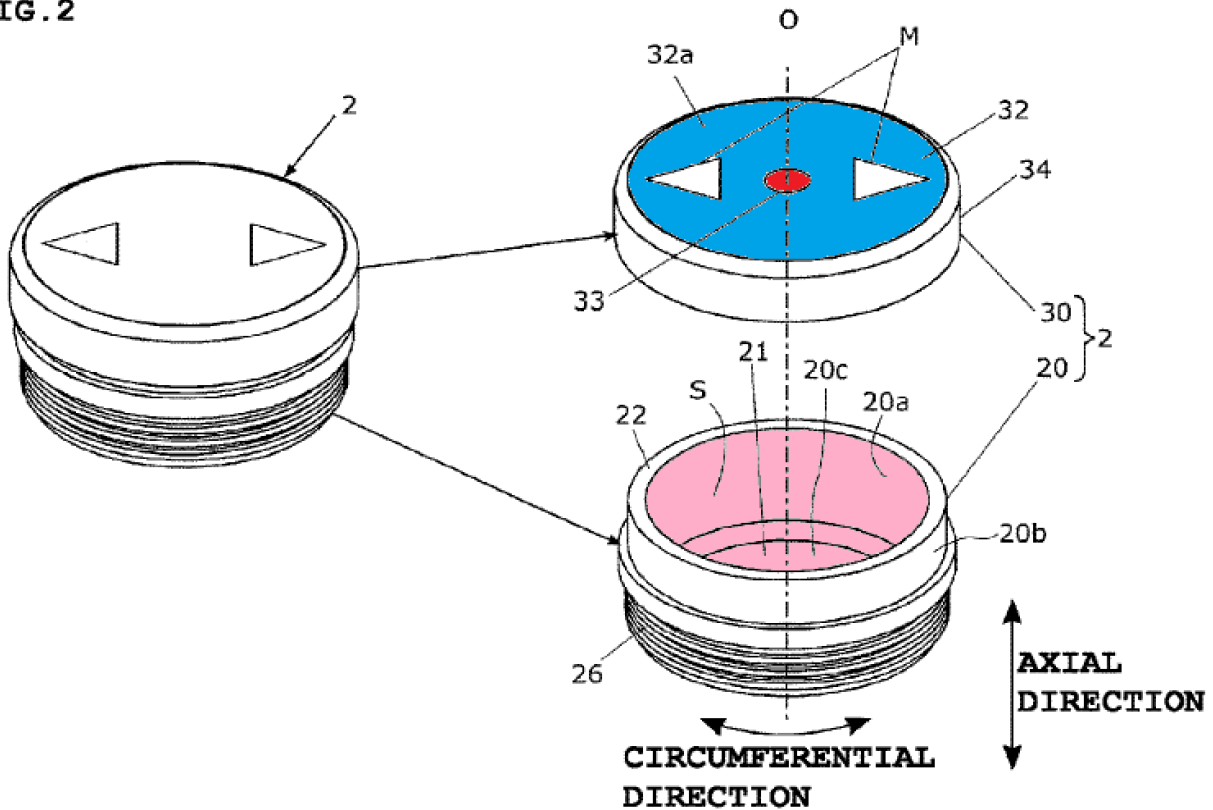
215. A POSA would have also had a reasonable expectation of success. The filter described in McDonald on which I rely discloses a standard structure used in TPMS systems that would have been part of a POSA's background knowledge. (See, e.g., Laird, 1:36-44 (“To protect against corrosion..., some tire pressure sensors have a housing for encasing the sensor electronic components and circuitry. An opening is provided in the housing and a filter covers the opening.”).) McDonald also notes the adaptability of its filter teachings, noting that “it will be understood by those skilled in the art that various changes may be made without departing from the spirit or scope of the invention.” (McDonald, 11:20-22; see also *id.*, 11:22-31 (providing examples of potential modifications and applications), 11:45-47.) A POSA would have found the disclosures in Yamaguchi-727 and McDonald sufficiently detailed to implement the filter that I cite in my Declaration, *supra*, without undue experimentation.

2. Claim 10

216. Claim 10 depends from claim 1 and recites “**wherein the housing includes an opening through the outside surface to the internal cavity, and further includes a filter that is positioned to filter air passing into the internal cavity before reaching the electrical sensor device.**” (’421, cl. 10.) Yamaguchi-727 discloses that the “**housing includes an opening through the outside surface**

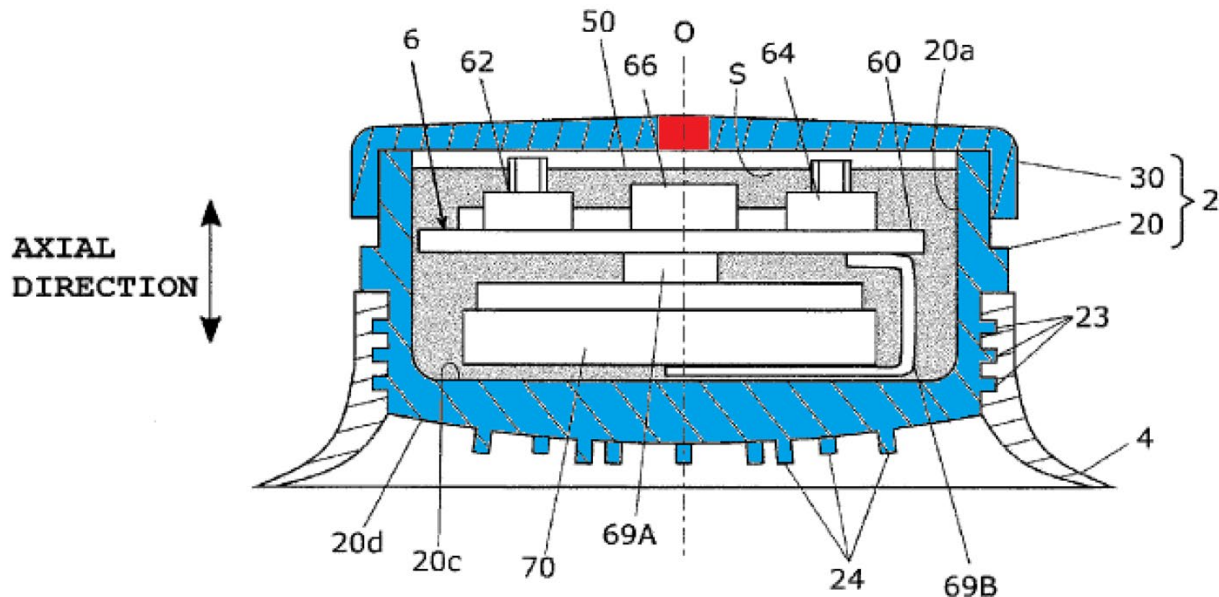
to the internal cavity,” by describing how its housing cap **30** has a circular ceiling part **32** that includes side surface **32a** and a “hole **33** penetrating in the axis **O** direction is formed in the ceiling part **32**” and “allows for communication between the housing space *S* of the housing case **20** and the outside when the opening of the housing case **20** is closed by the cap **30**.” (Yamaguchi-727, [0034].) FIG. 2 below depicts hole **30** (“an opening” – in red) that extends from side surface **32a** of housing cap **30** (in blue) to the housing space *S* (“internal cavity” – in pink).

FIG. 2



(*Id.*, FIG. 2 (annotated).) FIG. 5 below provides a cross-sectional view that depicts how hole **30** (in red) of housing cap **32** extends from the outer surface of housing **2**

(in blue) to the internal cavity of housing space *S*.



(Yamaguchi-727, FIG. 5 (annotated).) Yamaguchi-727 does not appear to expressly disclose use of “a filter ... to filter air passing into the internal cavity” before reaching the sensors on its circuit board. But this structure would have been a trivial addition that was well-known to a POSA.

217. Use of a filter in this manner is disclosed by McDonald, which like Yamaguchi-727, describes physical sensor components used in automotive applications, including tire-mounted TPMS sensor assemblies. (McDonald, 1:20-22, 2:61-65.) McDonald explains that a filter “can block potentially corrosive elements or media from the exterior environment while still permitting the unhindered transmission of pressure from the exterior environment to the sensor

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element inside the component.” (McDonald, 2:57-63; *see also id.*, 7:1-10 (describing efficacy of using a filter to protect against various corrosive compounds found or used with tires).) The specification describes multiple configurations for the filter within the sensor assembly, including a filter **345** (in yellow) within housing **110** to cover a hole **551** that is in communication with a cavity **125** leading to a sensor element **105**. (*Id.*, 6:24-27.)

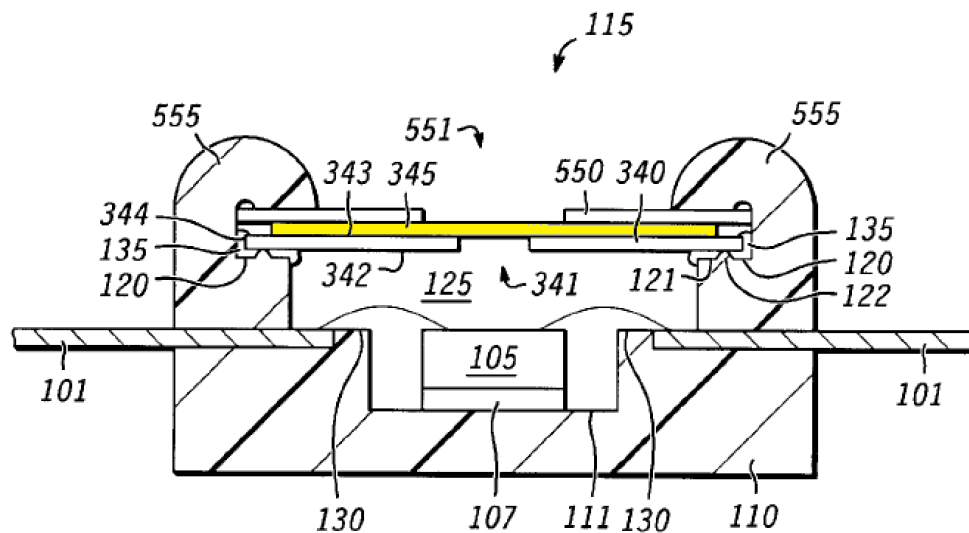


FIG. 6 100

(*Id.*, FIG. 6 (annotated).) A POSA consulting McDonald’s disclosures would have modified Yamaguchi-727 to include a filter within its opening **30** to permit filtration of air from outside of functional component **1** through to the internal cavity at

housing space *S* before reaching the sensors on circuit board **60**. McDonald expressly contemplates such a configuration, explaining that “filters can be permanently attached to ... the housing.” (McDonald, 11:30-31.)

218. The combination of Yamaguchi-727 with McDonald in the manner I articulated discloses “**a filter that is positioned to filter air passing into the internal cavity before reaching the electrical sensor device**” because Yamaguchi-727 as modified by McDonald would have resulted in the placement of a filter in opening **30** that would filter air passing from outside functional component **1** into the unfilled portion of housing space *S* that is in communication with Yamaguchi-727’s sensors **62** and **64**.

VII. NO SECONDARY CONSIDERATIONS OF NON-OBVIOUSNESS

219. I understand from counsel that Patent Owner in the underlying district court litigation has not yet identified any evidence with respect to secondary considerations of non-obviousness.

220. To the extent Patent Owner cites any evidence of sales or any praise or any industry recognition of products that Patent Owner asserts to implement the claimed invention, I am not aware of any information demonstrating that any increased sales, commercial success, praise, or any other secondary factor (that Patent Owner may assert) was a result of *the particular features recited in the ’421*

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patent's claims. Since Patent Owner has not yet identified any evidence of secondary considerations, Patent Owner cannot demonstrate that the limitations of the claimed invention in particular, as opposed to other features of the products at issue, were the factors that caused any increased sales, praise, or any other asserted secondary considerations.

221. Thus, based on my review of the evidence to date, I can summarize my opinions regarding any alleged secondary considerations of non-obviousness relating to the '421 patent, as follows:

222. *No commercial success of the claimed invention.* Patent Owner has not cited any evidence of particular commercial success of products embodying the '421 patent as opposed to products that do not embody the '421 patent. Patent Owner has not cited any evidence that any commercial success of any products is particularly a result of the claimed inventions recited in the '421 patent's claims and not due to any other facts.

223. *No long-felt but unsolved need.* Patent Owner has not cited any evidence of any long-felt need that remained unsolved in the prior art before the '421 patent. To the contrary, as discussed above, the prior art solved the problems that the '421 patent purported to address.

224. *No failure of others.* Patent Owner has not cited any evidence of

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anyone who tried, but failed, to solve the problems addressed by the '421 patent. As shown by my analysis above, there existed prior art references that successfully disclosed and rendered obvious the subject matter claimed by the '421 patent.

225. *No copying of the claimed invention.* Patent Owner has not cited any evidence that any other party (including Petitioner or third parties) ever copied from the '421 patent and its claimed invention.

226. *No unexpected results of the claimed invention.* Patent Owner has not cited any evidence of unexpected results achieved by the '421 patent's claimed invention. To the contrary, the prior art disclosed the predictable, expected results that show why the '421 patent's claims are obvious as discussed in my Declaration.

227. *No praise for the claimed invention.* Patent Owner has not cited any evidence of praise for the claimed invention recited in the '421 patent.

228. *No surprise or skepticism at the claimed invention.* Patent Owner has not cited any evidence that observers were surprised by, or skeptical of, the claimed invention recited in the '421 patent.

229. *No departure from the wisdom of the prior art.* Patent Owner has not cited any evidence that the claimed inventions of the '421 patent departed from the wisdom of the prior art. The '421 patent claims subject matter that was already present in the prior art, including in the references discussed in my Declaration.

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230. Moreover, with respect to the considerations discussed above, I also refer to and incorporate my opinions stated throughout this Declaration, including my analysis showing that the '421 patent is directed to techniques known in the prior art and does not provide any inventive technology.

231. To the extent Patent Owner at a later date cites or provides any other evidence regarding secondary considerations, including any expert opinions, I reserve the right to supplement my analysis and opinions to comment on it.

VIII. CONCLUSION

232. In signing this Declaration, I recognize that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in this proceeding. If required, I will appear for cross-examination at the appropriate time.

233. I hereby declare that all statements made herein of my own knowledge are true and that all statements are 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 18 U.S.C. § 1001.

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Dated: February 20, 2025

Respectfully submitted,

A handwritten signature in cursive script, appearing to read "Isaac Davenport", written in black ink.

Isaac Davenport, Ph.D.

APPENDIX A

ISAAC DAVENPORT PHD

December 9, 2024

SKILLS

- Strategy
- Technical Sales
- Product Architecture
- Software and Firmware Development
- Project Management
- Digital/Analog Design and PCB Layout
- Technical Documentation
- Communication Protocols
- Systems Engineering Requirements Mgt.
- Account Management
- Technical Leadership/Development
- Expert Witness
- Image Processing
- Embedded Systems
- Instrumentation/Test Equipment Design
- User Interface Design
- Experiment Design / Data Analysis
- Medical Device Design

ACADEMIC DEGREES

PhD Electrical Engineering, University of Colorado at Boulder 1998
MS Electrical Engineering, University of Colorado at Boulder 1997
BS Electrical Engineering, Georgia Institute of Technology 1995

JOB HISTORY

2023 – Present Board of Directors and COO at Fluent Renewables
2022 - Present Advisor to Colorado State University STRATA Technology Transfer Group
2021 – Present Founder of SleepSound Systems
2017 - Present Technology Advisor to Actall Corp.
2016 – 2020 Founder Toys2Life
2011 – Present Independent Engineering Consultant
2013 – 2014 VP Engineering, Orbotix Sphero
1998 – 2012 Engineer then President then CTO at Synchroness \ Kinetek
1995 – 1998 Research Assistant, University of Colorado Boulder
1993 – 1995 Coop Engineer, Ethicon, a Johnson and Johnson Company

My role has been design engineer, technical lead, account manager, reviewer, project manager, and executive. At Kinetek Systems (which was purchased by Synchroness) I held the titles of design engineer through president. As CTO at Synchroness I re-organized the operations/engineering department creating new roles for existing employees to bring clarity to the engineers, project managers, account managers and especially the customers about what would be done by whom on our projects. I provided leadership and direction to managers who in turn provided leadership for thirty engineers between their departments. I have also held two year's worth of weekly training seminars to develop senior technical staff in sales, leadership, communication, technical, and process development skills. At Sphero I traveled extensively to Asia to ensure design transfer and manufacturing success as well as supervising the engineering team responsible for the firmware, electronics, and mechanical design of the Sphero and Ollie robots.

PROJECTS

2024 NitroCat Nitrogen Catalysis System I assisted in the technoeconomic analysis, fundraising, strategic partnerships and customer discovery for a new catalyst technology using unique nanostructures and multiple metals to catalyze multistep chemical processes in a single reactor to create ammonia and urea fertilizers from various high nitrogen waste streams.

2024 Soliro cellular metabolism instrumentation I managed vendors, performed system integration, market research work and customer discovery for a novel live cell measurement instrument that measures cellular metabolism using electrical sensors to detect rates of extra-cellular acidification and generation of reactive oxygen species within a microfluidic chamber. The instrument has application in drug discovery, cancer therapy, and in vitro fertilization.

2023 Fluent Biocrude Digester System I assisted in the technoeconomic analysis for a new digester technology for turning various organic waste streams into either methane or biocrude. I specified peristaltic pumps, LabJack Controllers and DAQFactory control software to allow flexibility in the remote control and remote monitoring of the second generation research systems. I developed control algorithms to optimize a large variable space that included target hydrocarbon output molecules, input feedstock mixture classification, pH, temperatures, pressures, recirculation flows, salinity, microbe variety, microbe nutrient types and levels to promote the target cell populations.

2022 Driven eBike Drive Train Continuously Variable Transmission Control I assisted a team of engineers with project planning and electronics architecture on creating a gearbox and drive train similar to those used in electric cars for eBikes. The system involved PID control of an assist motor and a planetary gear variable transmission motor. Wrote provisional patent application.

2020 Build a Robot CTO I worked as a fractional CTO for Build a Robot LLC. I assisted in running some of their after school robotics and programming workshops as well as supervising their ecommerce and web development specialists. I developed Build a Robot curricula based on by Toys2Life STEM toy system. I took part in the evaluation of online curricula and learning systems and their integration in the new remote learning paradigm brought on by the COVID pandemic.

2020 Bridgecomm Ground-Space Optical Communication System I assisted a team of engineers with the project planning, development, integration and debugging of a gigabit optical modem system and pointing control system for maintaining laser based ground to ground or ground to space communications.

2017 Actall LoRa Radio Security System I led a team of hardware, software, and firmware engineers in the redesign of a security system based around a new MultiTech LoRa 900MHz radio module and a Nordic BLE radio chip including managing the antenna design and FCC qualification. I also led the update of the flagship software product to a modern web based architecture. I took charge of IP protection and led the application of several patents.

2016 Toys2Life Bluetooth Synthetic Dialog Engine I developed firmware and C# software to measure distance between toys to detect which toy the child was moving closer to which other toy to trigger dialog between toys. I wrote a templated dialog engine based on tagged phrases. I took the product through FCC and toy safety testing. US patents were issued for the radio solution and the dialog engine.

2015 Calibration System for Current Transformers I developed C# software to control GPIB and serial instrumentation for the measurement of phase and amplitude accuracy of current transformers (CTs) used in energy measurement.

2015 Production Calibration System for Energy Meters I developed C# software and integrated a National Instruments based instrument including DAC, DMM, a relay card, scanner, printer, and MySQL to calibrate energy meter modules. I also had an off the shelf enclosure machined and designed a test fixture board to handle the power supply, device under test connector, relay and analog output board routing, and serial to USB PC interface.

2014 Bluetooth Low Energy Based Dialog Engine Entertainment Prototype I developed firmware and C# software demonstrating how BLE Radios could be used to detect relative proximity between toys and allow players to control randomized dialog generation for their toy characters using dialog models and classified phrases to create new interactions for each character encounter.

2014 Ollie Development and Release Ollie is a BLE (Bluetooth low energy) connected robot. I led the Software Developer Kit, Firmware, Electrical Engineering, and Mechanical Engineering teams through the release of the Ollie robot. In addition to personally managing the transfer of the design to a Chinese contract manufacturer, I also assisted in the integration of the IMU (inertial measurement unit), BLE radio and firmware, antenna design, Cortex M4 processor, motor control, control system, firmware, LiPo batteries, and injection molded parts. I led the ideation team that brought insight from various groups and individuals within the company and turned those insights into a specification for a buildable product.

2013 Sphero 2 Development and Release Sphero is a robotic ball controlled by a smart phone. I led the Software Developer Kit, Firmware, Electrical Engineering, and Mechanical Engineering teams through the release of the

Sphero 2 product. In addition to personally managing the transfer of the design to a Chinese contract manufacturer, I also assisted in the integration of the IMU, inertial measurement unit, classic Bluetooth radio and stack, antenna design, Cortex M4 processor, motor control, firmware and injection molded parts.

2012 CRC Reverse Engineering Algorithm Research I wrote a program that used a known change in CRC to recreate a word of missing data to set a catheter system back to factory defaults in an FDA approved catheter refurbishing process.

2012 Microfluidic Drug Delivery Monitor I worked with the engineering team create a prototype system of a microfluidic drug delivery and monitoring system which used electrodes embedded in a microfluidic channel to monitor the passage of charged markers attached to the molecules of interest.

2004 - 2012 Technical Account Manager / Engineering Manager At Kinetek and then at Synchroness I played the role of account manager and supervisor for the engineers. As an account manager I was ultimately responsible for customer satisfaction. I wrote proposals, engaged in the early sales dialog, selected project leads, performed resource management between multiple customers, and oversaw customer communication and expectation management. As an engineering manager, I provided technical mentoring as well as project management and leadership mentoring. I assisted in troubleshooting, provided technical answers and identified resources outside of the company for specialty needs.

2011 Pump Manufacturer I worked with the engineering team to update and re-architect a high precision peristaltic pump including a new graphical user interface and more advanced independent channel control.

2011 Excision Electrosurgery I managed a project to redesign an Active Electrode Monitor (AEM) medical instrument to prevent burns from stray energy during laparoscopic procedures in which the surgeon wishes to ablate, coagulate, and cut tissue using RF electromagnetic energy.

2011 Automated Lace Tensioning System I worked with the mechanical team on mechanism design, developed the architecture for, supervised the execution of the development of the motor control electronics and firmware, RF interface, and assisted with debug and review.

2011 Surface Plasmon Resonance based Instrument I worked with the mechanical and software portions of the team to develop the microfluidics, laser, detector, and reagent mountings as well as the user interface for the instrument which is used in medical and life sciences research to characterize interactions between, proteins, antibodies, DNA, and other biological molecules.

2010 Electric Car Charging Station I assisted with requirements development, system architecture development, vendor qualification and management, ideation, firmware specifications, debugging, and prototype development.

2010 Pipeline Cleanout Launching Station I assisted with system architecture development, vendor qualification and management, electronics and wiring schema and ladder logic.

2010 Web Based Mass Management Software I assisted in GUI design, early stage mockup coding, database schema design and testing, of this Java based enterprise application.

2010 Design of a Novel Electric Motor I managed a cross disciplinary team to take a novel bench top motor design and package it for beta prototypes.

2009 Cell Flow Cytometer I managed staff responsible for developing the packaging, mounting, thermal management, and wiring harness of an ultrasonic microfluidics chamber for cell flow measurement in the life sciences and medical research markets. The ultrasonic transducer would align the cells for better counting and characterization as they passed the dual laser (488nm and 637nm) sources. My team was responsible for disposables management, mechanical packaging, wiring harnesses, industrial design, housing and mountings.

2009 Debug, Updates, and Re-qualification of Automated Defibrillator I managed staff responsible for developing and qualifying a fix for a circuit shortcoming on this medical device. Later I assisted with customer expectation management and requirements management for GUI updates to the product.

2009 SPL Meter Network Appliance I managed the electronics and firmware design for this TCP/IP based sound pressure level meter.

2009 Power Adapter for Apple Products I managed the electronics and firmware design, performed vendor management, and assisted in development of initial prototypes for this miniature power converter.

2008 Portable Blood Filter I managed the GUI development and electronics integration for a prototype portable blood filtration device to be used as a proof of concept to attract a sponsor from the medical device industry. The filter system used peristaltic pumps and multiple levels of interlocks and control for mobile therapy.

2008 Air Quality Monitor I managed the electronics and firmware design for a pilot production product that packaged a new sensor technology for use in military applications.

2008 SandCherry I assisted in the architecture, project management, and debugging of a USB controlled mute interface between a Motorola hand held voice radio to PBX Interface.

2008 Wireless Bridge Monitoring Product I managed the electronics, firmware design, and manufacturing launch from concept to pilot production for an 802.11 based data acquisition system for testing bridges.

2008 CAN Bus Based Home Automation System I managed the electronics and firmware design for this modular home automation system.

2007 High Pulse Energy Ablation System I worked with the high energy scientists and mechanical design team on the power supply and drill head for an aqueous ablation based drill system using pico second kilojoule pulses at tens of Hz rates to fracture rock.

2007 RV Awning Controller I worked with a small team to design a next generation, lower cost, higher performance version of controller and motor system for an automated awning retraction system for recreational vehicles.

2007 Radiometer Web Based GUI I architected and assisted in reviewing and debugging code for this Ruby on Rails based data visualization and instrument control software.

2007 Background RF Measurement I managed the development of firmware for a linux based airplane mounted computer to collect blackbody signals in flight for terrestrial, atmospheric and oceanic scientific data collection. The system utilized custom FPGA based designs tightly integrated with the FPGA modules provided by the front end card provider. The system would measure blackbody radiation of the target and remove anthropomorphic noise sources in real time.

2007 Electronic Business Card I assisted with parts selection and architecture as well as firmware and software design for a hand held mini-power point card which was cost engineered to be a high end give away.

2007 Capacitive Touch Garage Door Opener Prototype I assisted with parts selection and architecture and managed the prototype build process for this "James Bond" style touchless remote entry concept.

2007 Wireless Sprinkler Control System I provided management and review services to this program to re-vamp a wireless sprinkler controller system.

2007 SandCherry I assisted in the architecture, project management, and debugging of an Auto Gain Control for a Motorola hand held voice radio to PBX Interface.

2006 Heated Coffee Mug I managed the engineers and oversaw the manufacturing launch of this cost engineered, battery powered heated coffee mug. I also assisted in troubleshooting the electronics and firmware which were designed in conjunction with a Chinese contract manufacturer.

2006 Hopscotch I managed the electronics and firmware development for this television time limiting device. This device was designed for high volume production, a low cost of goods sold and a high consumer "WOW" factor.

2006 Votepad I managed the electronics development for this optical vote detection device. I assisted in selection of major components, debugging the electronics and working with the contract manufacturer on early production issues.

2006 Actall I updated the PIC assembly firmware for this wireless man down unit to allow use of a new 900 MHz transmitter module. I supervised testing and assisted with production of the device.

2006 Sakura I managed the firmware and electronics development for this medical instrumentation. The sample slicing microtome is used in the histology market. I assisted in creating the architecture for the system and debugging the firmware and electronics.

2006 Bridge Diagnostics I managed the firmware and electronics development of this wireless strain gage based bridge diagnosis device. I assisted in creating the architecture for the system and debugging the firmware and electronics.

2006 Acunetx I managed the architecture, firmware and electronics development of this pupil and eye tracking prototype for determining fitness of duty. The system automates much of the roadside sobriety field test.

2005 Cornice Production Test Board Layout I performed board layout alongside two engineers I supervised for a hard disk test board. The multi-layer board included many high speed buses and controlled impedances including USB 2.0.

2005 Cardio Optics I created documentation for the quality system. I debugged C, Java, and JNI code in a linux environment to get the customer from beta product to release product. I helped debug the control interface to the IR laser and the camera to make the laser operate more reliably to get a better quality video through the fiber bundle in the catheter. I supervised internal and contract staff to meet release milestones. I attended and technically supported animal trials of next generation research versions of the product. I worked with the research team on a transparent catheter tip for doing ablation during imaging.

2005 Remote Control Weapon Turret I developed firmware, assisted in the architecture and helped debug the FPGA design while managing the program to develop a reticule overlay and azimuth elevation controller for gun turret. The system allows a remote operator to target the enemy using a variety of camera inputs and fire when ready. The system uses NTSC inputs and the FPGA overlays text and graphics by clamping to a low or high voltage corresponding to black or white. The azimuth and elevation motors were controlled using joystick input from the operator.

2004 FIT I assisted in the hardware and firmware design of a home use sensor system for monitoring shower temperature. The device has a 4 button 7 segment LCD user interface. The device is battery powered and water proof with programmable alarm points and display units.

2004 PHT I led the hardware and firmware design for the Core:Tx wireless USB device. The device uses a coriolis effect accelerometer to track user motion and report it to a PC application. The device is battery powered and uses a single LED-single button interface to allow wireless network binding. More information on this product is available at www.performancehealth.com.

2004 TX91 I led the redesign team for the TX90 tension meter. The existing text based display became obsolete and was upgraded to a graphical display. In addition to redesigning the user interface to take advantage of the graphic capability, I also cost engineered the circuitry to reduce the cost of goods sold by 20%. More information on this product is available at www.tensitron.com.

2004 EEE I designed the circuitry for a power system monitoring and control system. I also was involved in designing the firmware for the user interface. Tasks involved controlling several high current sources and loads. The device was controllable through a menu driven, four button, LCD based front panel interface or through an RS232 connection, a modem connection, or a network connection. The device would monitor several voltages currents and frequencies in real time and allowed for programmable load switching set points for parameters that were out of specification.

2004 Schlumberger Down Hole Instrumentation I provided a design review of the circuit and performed the circuit layout for a high reliability, high temperature, high vibration tolerance, high part density, remote sensor probe board with data transmitter for oil field applications.

2003 B&C I designed circuitry and wrote C++ code for a linux based car wash controller interface. The tasks involved were: controlling several peripheral items on various data communication networks such as EIA232, EIA485, MDB and cctalk, performing schematic design and capture, layout and design for manufacture, evaluation

and integration of a Quarter Video Graphics Adapter 240x320 screen, monitoring remote site performance for bugs over the Kiosk's internet connection.

2003 Rubadue Wire I provided an overall architecture and implementation details so that the customer's technician could create a tension controlled wire coating process. The system used a 1/16 DIN PID controller to control let out and uptake motors using a tension based input sensor.

2002-2005 Kinetek I installed and administered a 100 Mbit Ethernet network and Cisco T1 voice-data router for internet and VoIP (voice over IP) service to our offices. I also maintain our PBX phone system.

2002 Synergos I provided system architecture documentation, sensor testing protocols, project management and technical supervision for Jr. technical employees in their development of a roll over tire status detection system. Several sensor technologies were evaluated, including, mechanical switches, optical detectors, piezo electric pressure sensors and video based detection.

2002 Boulder Innovation Group I added features to their 3D positioning probe by updating their FPGA design.

2002 Tactilities I rewrote the faulty firmware for the RN+ wireless nurse call unit. I integrated an Inovonics 900 MHz wireless network transmitter into the design and verified range and packet collision avoidance. I assumed responsibility for technical communications with contract manufacturers and provided manufacturability and reliability enhancements for their design. I diagnosed problems with newly manufactured units as well as units returned from the field. I also improved the performance and safety of the internal NiMH battery charger.

2001-2002 CCS I upgraded their Wattnode product to be LonMark compatible by rewriting and re-organizing the firmware written in Neuron C. The Wattnode is a Lonworks network instrument which measures and logs electrical power.

1999-2002 TX90 I designed, did the circuit lay out, wrote code and brought into production a digital tension and speed meter which included the following features: small size (less than 2"x2"), LCD and 4 button Menu driven interface, integrated trickle charger which runs from an external transformer for a NiMH battery pack, analog output, RS232 interface for data collection, internal calibration for many different wires and filaments as well as user editable calibration curves, CE certification for industrial environments, Microchip PIC powered design featuring re-programmable flash memory, low power operation for long battery life. This product is detailed at www.tensitron.com.

2000-2001 dBm Optics I designed a high speed digital synchronization circuit, wrote C x86 measurement code and managed two engineers for FPGA and PIC programming on a multi-channel optical laser power meter for telecommunications components with the following features: Flat panel SVGA display and mouse, keyboard, scroll wheel, custom keypad interface instrument, expansion chassis support for more channel racks via 100 Mbit Ethernet, complex data acquisition possible while maintaining strict timing synchronization requirements. Timing was key for synchronizing the sweep patterns of the tunable laser source. This system is detailed at dbmoptics.com.

2000-2001 Scientech I wrote microcontroller firmware, and provided hardware design reviews for an RS485 based, networkable laser power meter with the following features: thermopile based calorimeter for laser energy detection, field programmable calibration constants, factory programmable parameters for characterization of physical components, drift following feedback-control to maximizes A/D input range using a software controlled D/A, RS485 control interface and parser designed to French government specifications. Details on this product may be available at www.scientech-inc.com.

1998-2000 Spiral Designs I wrote firmware and performed hardware design for a multi channel electrical power monitor and control system designed for battery backed up networks of DC rectifiers for cell phone base station power systems. The product has the following features: LCD and button interface, multiple channels of analog and digital IO through versatile stackable IO boards, RS485 network control of multiple 3rd party rectifier banks, packet error and collision avoidance on a Modbus protocol network, programmable alarm matrix allowing mapping of any input onto any alarm or control output, full remote control access through a custom communications board which can support modem, direct RS232 or Ethernet via a thin server, Motorola 68HC11 design supports program in place over internet or modem using an external flash chip and custom bootloader software, field programmable PLD for support of new IO board hardware. Information on the product can be found at www.sdicommmtech.com.

1998 World Trade and Marketing I designed, Cost Engineered and did lay out for a water purification control circuit with the following features: extremely small size, the circuit was slightly larger than a quarter so it could be mounted in a standard threaded pipe plug, extremely low cost, could be manufactured in 1000s for less than \$0.70 each, runs from 9V battery power.

1998-2002 Kinetek I installed and maintained the companies 10 Mbit Ethernet network and phone system. I also installed an ISDN 128 kbit internet link and provided support for Qwest technicians for BERT testing when performance would slip due to growing cross talk at our Subscriber Line Interface Card.

1998 Integrated Tire Technology I led a development effort to produce instrumentation involving materials engineering, mechanical engineering, illumination engineering, image processing and systems integration.

INTERNSHIPS

1998-1999 Biostar I developed a machine vision system for quantification of biological analyte which was installed for use in quality assurance.

1995-1998 University of Colorado Biomedical Laboratory I worked with faculty and other graduate students to collect EKG data for the development of algorithms relative to heart rate variability and to collect tissue impedance data for mapping into the voxel data set from the visible human project. I also supported the teaching of undergraduate courses in biomedical engineering and electronic circuits for non-majors.

1996-1998 Samsung Display Devices I designed and performed ergonomics experiments. I managed and coordinated the work of eight engineers from six countries. I designed and managed the development of an Intel 8051 based optical feedback CRT image correction prototype. I developed a PC based video pupillometer instrument for dynamic pupil measurement using unique Matlab and WIT image processing feature extraction algorithms. I led a team of engineers in the optimization of an infra red eye tracking instrument design by improving the circuitry, user interface, and real time software. I supervised exploratory research into real time mechanical feedback for the stabilization of CRT images. I served as network manager for a thin net segment of Win95 and NT machines as well as x-terminals and printers.

1996 Coca Cola I designed and managed the installation of the interface between a PC 104 Linux based control system and the sensors and actuators on an experimental payload launched by NASA.

1995 Georgia Institute of Technology I performed digital editing and recording work for a di-phoneme based speech synthesizer.

1994 Cryolife I assisted in the development of an inexpensive, commercially viable light source for the curing of a biological adhesive, "BioGlue," which has now passed FDA trials. Details on this product can be found at www.cryolife.com.

1993-1995 Ethicon I worked in the MIS department which handled the network and telephony needs of the plant. I managed a mixed Novell - Win 3.11 network with 300 users over Ethernet and Token Ring. I increased the perceived service level of Windows desktop users. I managed contractors and vendors during a period of intense network and PC-systems growth.

1992-1993 Ethicon I provided electrical CAD and PLC programming support. I developed the initial prototype for a machine vision system to perform inspection of sutures and injection molded surgical clips. I managed the technical portions of the design, construction, implementation and site installation of an international packaging system which included a pneumatic label application system, networked international graphics database and inventory control database in an FDA regulated environment. I won the Vice Presidents Award for teamwork. Information on the company can be found at ethiconinc.com.

EXPERT WITNESS ENGAGEMENTS

I have been deposed three times and testified in court once. I have been an expert in six patent cases, one malpractice case, one breach of contract case and one personal injury case. I have worked for both the plaintiff and the defendant in patent cases.

PASCO Sci. v. Vernier Software & Tech. 2023, US patent number 10,481,173, Wireless smart devices having integrated force, position, acceleration, and rotational sensing for science education. Evaluated source code, assisted in claim construction, and wrote expert report and rebuttal.

iLife v. Nintendo 2017, patent number 6,864,796, motion control algorithm using accelerometers. I wrote expert reports, was deposed and testified in federal court.

Criner v. Beazer 2016, injury case, electro-mechanical access control. Expert report given.

IBC vs. Crestron, AMX, Control4 2016 home automation patent number 5,945,993. Expert report given for IPR.

Brigs vs. Walsh, case# 2014CV031291, District Court County of El Paso in the state of Colorado 2015. Medical malpractice using laser ablation suit. Expert report given.

Schrader Bridgeport vs. Continental Automotive, docket # 6:11CV00014 US District Court Lynchburg VA. Patent No. 7,518,495. Claim construction report given 2012.

Zykronix vs. Coraccess I provided written testimony, expert opinion, and was deposed in a breach of contract case involving electronics manufacturing processes in 2007.

Hewlett-Packard Development Company vs. eMachines Inc. Civil Action Number H-05-0778 in US District Court for the Southern District of Texas Houston Division. Patent No. 6,138,184. Claim construction report given 2006.

Sunrise Telecom Inc. vs. Acterna LLC. Case number 04-01601 FMS in the US District Court in the Northern District of California San Francisco Division. Patent 5,619,489. Expert report and deposition provided in 2004-2005.

BOARD OF ADVISOR/DIRECTOR ENGAGEMENTS

Fluent Renewables <https://www.fluentrenewables.com/> transforms waste into renewable natural gas 2023-Present.
Synchroness www.synchroness.com performs contract engineering design 2006 - 2012.
Continental Control Systems <http://www.ccontrols.com/> produces energy metering equipment 2010 – Present.
Insight Photonic Solutions www.sweptlaser.com/ produces an akinetic semiconductor swept laser 2012 – Present.
Actall www.actall.net produces wireless security products 2013 – Present.
BuildARobot Afterschool programs <https://buildarobotk12.com/> 2019 – Present.

PATENTS

I was a co-inventor on the issued, Actall Corporation, US patent ADAPTABLE TRACKING TAG US11,599,761B2, and on the pending application US2022/0240215 A1 DUAL-BAND REAL-TIME LOCATION TRACKING.

I personally filed for and was issued the 2016 patents: US10272349B2 “DIALOG SIMULATION” and US10111035B2 “REAL TIME PROXIMITY TRACKING USING RECEIVED SIGNAL STRENGTH INDICATION”

I worked with the technical team at Sphero on the ideas in the patent application “CAUSING GESTURE RESPONSES ON CONNECTED DEVICES” 2015/0338925.

As an inventor I came up with the electronic design behind a new pneumatic valve controller. I worked with council and engineers at Norgren Inc. to file patent 7,723,864 “AC-TO-DC ELECTRICAL SWITCHING CIRCUIT” which issued in 2010.

I worked with Samsung Display Devices and the University of Colorado Boulder to submit a patent application for my idea of an “ELECTRONIC COPY HOLDER.” The application went to the patent office on August 6th 1997.

PUBLICATIONS AND PRESENTATIONS

Ph.D. Thesis "The Effects of Video Display Terminals on Ocular Function and Performance" 1998
Bioelectromagnetics society presentation published in the Transactions of the Eighteenth Annual BEMS Meeting
"The Effects Of Electric Fields on Steric Hindrance at the Cell Membrane" Victoria Canada 1996
Society for Information Display Conference Proceedings, Toronto "Changes in Ocular Performance After Display
Usage" 1997
Curricula for Photonics Technical Skills Lab, Front Range Community College 2002

TEACHING ENGAGEMENTS

Math and science lab tutor KIP Denver Collegiate High School 2013
GED preparation volunteer, Boulder County Jail 2004-2010
Algebra Based Physics Front Range Community College 2002
Recitation instructor, Circuits for non-majors University of Colorado at Boulder 1995