
BEFORE THE PATENT TRIAL AND APPEAL BOARD

HESAI TECHNOLOGY CO., LTD.
Petitioner

v.

OUSTER, INC.,
Patent Owner

Patent No. 11,287,515
Inter Partes Review No. 2023-01422

DECLARATION OF JASON JANET

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DECLARATION OF JASON A. JANÉT

I. BACKGROUND AND QUALIFICATIONS

1. My name is Jason Janét. I have been retained as an expert witness to provide my independent opinion in regard to the matters at issue in inter partes review of U.S. Patent No. 11,287,515 (“the ’515 patent”) in IPR2023-01422. I have been retained by Ouster, Inc., the Patent Owner in this proceeding. Petitioner is Hesai Technology Co., Ltd. (“Petitioner” or “Hesai”).

2. I am being compensated \$475 per hour for my time spent working in connection with this case. My compensation is in no way related to the outcome of this litigation. If called as a witness, I would testify as to the statements and opinions contained in this report.

3. I am not a legal expert and offer no opinions on the law. However, I have been informed by Counsel of the various legal standards that apply, and I have applied those standards in arriving at my conclusions.

4. My credentials are set forth in full detail in my Curriculum Vitae which is attached as Exhibit A, incorporated here by reference, and summarized as follows: I am currently CTO for Applied Research Associates (ARA). I also hold the rank of Adjunct Associate Professor at Duke University and at North Carolina State University.

5. I received a Bachelor of Science in Mechanical Engineering from the

University of Virginia in 1990; a Master of Integrated Manufacturing Systems from the Integrated Manufacturing Systems Engineering Institute at North Carolina State University in 1994; and a Ph.D. in Electrical and Computer Engineering from North Carolina State University in 1998.

6. Since 1991, I have been active in the robotics, sensors, artificial intelligence, pattern analysis, and automation fields. My MS thesis, entitled *Global Motion Planning and Self-Referencing for Autonomous Mobile Robots*, leveraged graph theory and time-of-flight and/or Doppler sensors to optimize mobile robot movement through, and perception of, environments. My PhD dissertation, entitled *Pattern Analysis, Tracking and Control for Autonomous Vehicles*, leveraged multiple UGVs, time-of-flight and/or Doppler sensors, point clouds, and neural networks to enhance simultaneous localization and mapping (SLAM), as well as the sharing of knowledge between multiple different UGVs. I have authored numerous publications and have co-authored a textbook entitled *Computational Intelligence*.

7. I have designed, built, and marketed toys, robots, automated systems, measuring systems and components thereof, including ground mobile robots, unmanned aerial vehicles (UAV), unattended sensors, automated storage and retrieval systems (ASRS), submersible mobile robots, proof-of-concept extra-terrestrial robots, manually-manipulated (“twiddled”) submersible foils, wall

climbing mobile robots, corner-grip ballgame goals, proximity and ranging systems, point-cloud systems, pattern analysis tools, and augmented reality systems.

8. I have taught the following courses: Introduction to Robotics and Automation (Duke and NCSU); Introduction to Control Theory (Duke and NCSU); Distributed Real-Time Controls (NCSU); and myriad independent studies courses in the areas of robotics, automation, artificial intelligence, autonomy, pattern analysis, sensors, and control systems. I have also served on several MS- and PhD-level graduate student committees, designed qualifying exam problems, served on the NCSU IMSEI Board, and participated in curriculum development for undergraduate and graduate level programs.

9. I have also started, sponsored, and advised multiple champion student teams for international robot competitions including, but not limited to, the NASA/ASCE Extra-Terrestrial Robotics Competition, the DARPA Grand Challenge, the AUVSI/ONR Autonomous Underwater Vehicle Competition, and the European CLAWAR Wall-Climbing Robot competition.

10. I have initiated multiple unmanned systems projects at both academic and industry levels. Academic unmanned aerial vehicles (UAVs) include, but are not limited to, Quadcopters with Hybrid Remote and Autonomous Control, Marsupial UAVs that Deploy and Recover Unmanned Ground Vehicles, and Wall-

Climbing UAVs. Additionally, the AngelFish Cross-Domain Submersible UAV, a DARPA ASW program that I incubated and procured funding for at Teledyne, included a partnership with North Carolina State University. Unmanned underwater vehicles (UUVs) include, but are not limited to, the MicroHunter-class of very small underwater robots, the PilotFish, Gamera, Artemis and other holonomic robots, and submersible crawlers that are used in nuclear boiler water reactors, the LBC hull inspection system, and the HULLBUG hull cleaning system. Unmanned ground vehicles (UGVs) include, but are not limited to, the miniature PERRY, wall-climbers, all-terrain and subterranean crawlers.

11. I have also supported multiple toy-focused ventures with companies including, but not limited to, Marvel, Hasbro, Twidco, Spin Master, Nottingham-Spirk, IDEO, ARA, and other firms. For Marvel, multiple Spiderman toys were conceived and developed and validated, including the Spiderman Wall-Climbing Car, the Corner-Climbing Spider, and the Inflatable Wall-Climbing Spiderman. For Hasbro, a proprietary corner-gripping technology was employed to place basketball goals in corners. For Twidco, a proprietary flapping foil technology was combined with multiple fish shapes (e.g., shark and clownfish) to enable users to create fish-like motion by “twiddling” a connecting cable from above. For Spin Master and multiple design firms, multiple wall-climbing toys were developed for small wall-climbing robot concepts including simple radio control vehicles and the

“Hangtime 540” Tony Hawk aerial skateboard toy. For ARA, augmented reality systems for indoor and outdoor games.

12. In 1999, while I was employed by Nekton Research (“Nekton”), I captured and managed multiple programs sponsored by the Department of Defense (DoD) and private-sector companies that focused primarily on autonomous underwater vehicles (AUV), remotely operated vehicles (ROV), TwiddleFish toys, and indirect-fire projectiles. During my tenure, Nekton entered into a joint venture agreement with the founders of what eventually became known as Parata Systems – a pharmacy automation solutions company, which I supported launching.

13. After leaving Nekton in March 2002, I joined a then New Jersey-based company called Avionic Instruments, Inc (“Avionic”). While at Avionic, I continued developing and marketing robots and supported engineering related to various design, manufacturing, quality and assembly issues on the core aerospace product lines. Avionic product lines include, but are not limited to, ducted fans, transformer-rectifier units (TRU), regulated TRU (RTRU), auxiliary power unit (APU) control systems, power distribution systems (PDU), frequency converters, corner clamps, and VRAM attractors/thrusters. Customers included DoD, NASA, Boeing, Sikorsky, Augusta-Westland, Dassault, and Lockheed-Martin.

14. At Avionic, I was also tasked with ruggedizing, optimizing, and commercializing two emerging proprietary technologies: the “CFG” and “VRAM”.

The CFG, short for Corner Friction Grip, was a proprietary technology based on non-marring and non-adhesive materials that provided optimal grip patterns on inside and outside corners. CFG formed the basis of a company called “Shelf Works Technologies,” which was spun out of Avionic instruments in 2004, and whose products were sold in Home Depot, Bed Bath and Beyond, etc. CFG also formed the basis of multiple toys including a miniature basketball goal for Hasbro, and a corner climbing Spiderman toy for Marvel.

15. The VRAM, short for Vortex Regenerative Air/Aqueous Movement is a patented method for producing attraction forces between an object and a surface. VRAM is euphemistically referred to as a “tornado in a cup” and generally comprises both cylindrical and toroidal flow patterns that result in vacuum-like regions. The VRAM had several applications, including but not limited to: holding breaching charges and sensors against vertical or inverted surfaces; acting as an attractor for wall and ceiling climbing robots; acting as an attractor for submersible hull-crawling robots; filter-less vacuuming (conceptually similar to the Dyson vacuum); and robotic pick-and-place end-effector (conceptually similar to a gripper) to move articles from one location (e.g., a conveyor) to another (e.g., a collator). The VRAM also formed the basis for multiple toys including: a wall-climbing car for Spin Master, IDEO and Nottingham-Spirk; a Spiderman car for Marvel; an inflatable wall-climbing Spiderman for Marvel; and the Tony Hawk

Hangtime 540 aerial skateboard for IDEO.

16. My work with the filter-less vacuum VRAM prompted me to explore a concept related to pharmacy automation, which ultimately led to a Ferris-wheel concept for rapidly dispensing pills. In mid-2003, my team conceived of two prescription pill counting mechanisms that actually benefitted from centrifugal forces and optimally exploited gravity and vacuum: an inner ring with vacuum-based apertures and an inner-bowl with vacuum-based apertures. The inner-bowl with vacuum-based apertures was deemed most viable, was awarded two US patents, and to this day forms the basis of the RxMedic ADS™ pharmacy robot. The VRAM formed the basis of Vortex HC technologies, many of which have been licensed out to entities including, but not limited to Teledyne SeaBotix, SeaRobotics, and HDT. Both RxMedic and Vortex HC were officially spun out of Avionic in July 2004, at the date Avionic was acquired by Transdigm.

17. In late 2004, soon after Avionic was acquired, I, along with others from Avionic, secured funding to develop an alpha-level multi-dispenser pharmacy robotic system and develop the RxMedic business plan and raise multiple rounds of venture capital. In late 2006, RxMedic (called “APDS” until November 2006) was launched as a stand-alone, sole-focus venture. After the operational launch of RxMedic, I served as General Manager and eventually Chief Technical Officer. Through my roles at RxMedic, I oversaw the development of the RxMedic ADS

robot, managed the intellectual property portfolio, coordinated sales and marketing, and provided strategic, fiscal, and operational leadership. In May 2010, J.M Smith Corporation acquired RxMedic, and to assist in the change of ownership, I served as a Director of RxMedic until May 2011.

18. Also in late 2004, after Avionic was acquired, I, along with others from Avionic, secured funding for Vortex HC through DoD contracts and robot sales, to continue developing the VRAM Mobile Robot Platform (VMRP – a wall-climbing robot), the ARTEMIS AUV (a holonomic submersible robot for counter-mine and counter-obstacle operations), the submersible crawler, the nuclear-grade boiler water reactor (BWR) inspection robot, and other robot products centered around the VRAM. Some DoD programs were/are classified, for which I maintained a SECRET clearance at both the personal and facilities level, and served as the facilities security officer (FSO). In late 2006, corresponding to the full launch of RxMedic, Vortex HC technologies were largely licensed to Teledyne SeaBotix, SeaRobotics, and HDT. However, I have continued to support Vortex HC licensees and customers to-date.

19. After the sale of RxMedic, and after fulfilling my 12-month employment obligation, I joined Teledyne Technologies in Summer 2011. I served as the Senior Manager for the RTP division of Teledyne Scientific, and supported multiple DoD-sponsored robotic-focused programs. Some of these programs

were/are classified, for which I maintained a personal SECRET clearance. Among these programs, were cargo unmanned ground vehicles (CUGV); squad-level autonomous unmanned ground vehicles (UGV); autonomous underwater vehicles (AUV); unmanned underwater vehicles (UUV); a cross-domain autonomous vehicle capable of transitioning between air-, surface- and underwater-domains; the EXACTO program for optically tracking and steering bullets to targets; and LIDAR systems for UGVs, as well as the mapping of urban and subterranean environments (along with sister-company Optech). Cross-domain vehicles that were evaluated, designed and prototyped included, but were not limited to, the AngelFish (later called “EagleRay”) cross-domain submersible UAV for anti-submarine warfare, as well as a ball-shaped robot for beach-, ground- and surf-zone countermining operations. Sensor design, refinement and signal processing was a major component of each program. Sensors employed include, but are not limited to: proximity sensors; ranging sensors; electro-optical imaging; LIDAR. long-, short- and mid-wave infrared (IR); inertial measurement units (IMU); optical flow; and radio-frequency (RF). Additionally, control systems were designed, refined and integrated into the aforementioned systems. Most control systems were closed-loop, in that they utilized sensor-based feedback; others were open-loop, where states were estimated with little or no feedback.

20. In late 2013, Avionic, a Transdigm business unit at that point,

requested that I return to turn around both a supply-chain issue, and the Sikorsky S97 Raider/JMR helicopter programs. The S97 Raider was designed to be the fastest, most maneuverable helicopter, due to its coaxial, counter-rotating variable-pitch wings, and an aft-based push-propeller. Avionic also controlled two business units named Acme Aerospace (Acme) and Aerospace Cooling Solutions (ACS). Avionic, Acme and ACS supported the S97 program, which ultimately met milestones and continues to produce multiple successful demonstrations. In 2013, Transdigm expanded my role to include directorship of the Avionic, Acme and ACS revenue and engineering teams, and to report operational and financial status at six-week intervals. Transdigm required that I move my family to New Jersey in late 2014, which influenced my decision to resign and assume the CEO role offered to me by Delta Five Systems in Raleigh, NC.

21. As CEO of Delta Five, I led a private-equity backed, hospitality-focused venture, coordinating the company's launch and strategic path including an early-stage pivot. Initially focused on back-end robotics and automation, Delta Five shifted its focus to address the rampant bed bug problem—a top priority for hoteliers—with a novel unattended sensor and trap, called the Telemetered Pest Monitoring System (TPMS), which is based on computer vision and internet of things (IoT), and has proven capable of scaling to other pests. In addition to the TPMS, Delta Five developed a novel means to mass produce a natural, unscented

aggregation pheromone that, in concert with placement and heat, lured invertebrates to the TPMS. After leading Delta Five and serving on its Board for four years, I resigned to join ARA, but continue serving Delta Five as a shareholder and transition agent.

22. In 2018, I joined ARA as CTO. My primary responsibilities include leading the commercialization and technology transition efforts, which require technical, business and corporate development, as well as the procurement of capital and managing matrixed rosters.

23. I have served as an expert witness on multiple cases including cases involving IPR, ITC, contract disputes, and civil litigation in District and Federal Courts. My resume lists these cases.

24. In formulating my opinions, I have relied upon my training, knowledge, and experience in the relevant art.

II. LEGAL STANDARDS

25. In formulating my opinions and conclusions in this proceeding, I have been provided with an understanding of the prevailing principles of U.S. patent law that govern the issues of patent validity.

A. Claim Construction

26. I understand that a purpose of claim construction is to determine what a person of ordinary skill in the art would have understood the claim terms to

mean. 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 effective filing date.

27. I understand that the 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 of understanding the meaning of those terms.

28. 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 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.

29. 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 in the course of

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.

30. 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.

31. 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 as provided to me by Counsel.

32. I understand that certain terms appearing in the challenged claims have been the subject of dispute in the district court litigation. For purposes of my analysis here, I do not believe express claim constructions are necessary because the prior art renders the claim obvious under the claim constructions proposed by either party in the district court litigation.

33. I understand that the parties have proposed claim constructions for various terms of the challenged claims in an ITC proceeding. I also understand that no claim construction has taken place in that proceeding.

34. Where claim construction issues arise, I have noted them in my analysis below.

B. Anticipation

35. I am informed and understand that to anticipate a patent claim under 35 U.S.C. § 102, a single asserted prior-art reference must disclose each and every element of the claimed invention, either explicitly or inherently, to a person of ordinary skill in the art. There must be no difference between the claimed invention and the disclosure of the alleged prior-art reference as viewed from the perspective of the person of ordinary skill in the art.

36. Also, I understand that for a reference to be an anticipating reference, it must describe the claimed subject matter with sufficient clarity to establish that the subject matter existed and that its existence was recognized by persons of ordinary skill in the field of the invention.

37. In addition, I am informed and understand that to establish that an element of a claim is “inherent” in the disclosure of an asserted prior-art reference, the extrinsic evidence (or the evidence outside the four corners of the asserted prior-art reference) must make clear that the missing element is the inevitable

outcome of the process and/or thing that is explicitly described in the asserted prior-art reference, and that it would be recognized as necessarily present by persons of ordinary skill in the relevant field.

C. Obviousness

38. I am also informed and understand that even though a prior-art reference does not fully anticipate a claim of a patent, a claim may nonetheless be rendered obvious to a person of ordinary skill in the art if the differences between the subject matter set forth in the patent claim and the prior art are such that the subject matter as a whole of the claim would have been obvious at the time the claimed invention was made.

39. I am informed and understand that obviousness is a determination of law based on various underlying determinations of fact. In particular, these underlying factual determinations include (1) the scope and content of the prior art; (2) the level of ordinary skill in the art at the time the claimed invention was made; (3) the differences between the claimed invention and the prior art; and (4) the extent of any proffered objective *indicia* of nonobviousness. I understand that the objective *indicia* which may be considered in such an analysis include commercial success of the patented invention (including evidence of industry recognition or awards), whether the invention fills a long-felt but unsolved need in the field, the failure of others to arrive at the invention, industry acquiescence and recognition,

initial skepticism of others in the field, whether the inventors proceeded in a direction contrary to the accepted wisdom of those of ordinary skill in the art, and the taking of licenses under the patent by others, among other factors.

40. I am informed and understand that to ascertain the scope and content of the prior art, it is necessary to first examine the field of the inventor's endeavor and the particular problem for which the invention was made. The relevant prior art includes prior art in the field of the invention, and also prior art from other fields that a person of ordinary skill in the art would look to when attempting to solve the problem.

41. I am informed and understand that a determination of obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention. Instead, it is my understanding that to render a patent claim invalid as being obvious from a combination of references, there must be some evidence within the prior art as a whole to suggest the desirability, and thus the obviousness, of making the combination in a way that would produce the patented invention.

42. I am further informed and understand that in an obviousness analysis, neither the motivation nor the purpose of the patentee dictates. What is important is whether there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims.

43. In addition, it is my understanding that to find a patent claim invalid for obviousness, there must be a finding that each element in each limitation of the patent claim is disclosed, taught, or suggested by the asserted combination of prior-art references or elsewhere in the relevant prior art. I understand, however, that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. But multiple prior-art references or elements may, in some circumstances, be combined to render a patent claim obvious. I understand that I should consider whether there is an “apparent reason” or motivation to combine the prior-art references or elements in the way the patent claims. To determine whether such an “apparent reason” or motivation exists to combine the prior-art references or elements in the way a patent claims, it will often be necessary to look to the interrelated teaching of multiple prior-art references, to the effects of demands known to the design community or present in the marketplace, and to the background knowledge possessed by a person of ordinary skill in the art.

44. I also understand that when the prior art “teaches away” from combining prior-art references or certain known elements, discovery of a successful means of combining them is more likely to be nonobvious. A prior-art reference may be said to “teach away” from a patent when a person of ordinary skill in the art, upon reading the reference, would be discouraged from following

the path set out in the patent or would be led in a direction divergent from the path that was taken by the patent. Additionally, a prior-art reference may “teach away” from a claimed invention when substituting an element within that prior-art reference for a claim element would render the claimed invention inoperable.

45. I am informed and understand that a patent for a combination which only recites old elements with no change in their respective functions withdraws what is already known into the field of its monopoly and diminishes the resources available to person of ordinary skill in the field. When a patent claims a structure already known in the prior art that is altered by mere substitution of one element for another known in the field, the combination must do more than yield a predictable result. I am informed and understand that the corollary to this principle is that when the prior art teaches away from combining known elements, discovery of a successful means of combining them is more likely to be nonobvious. Thus, the question to be answered is whether someone reading the prior art would be discouraged from following the path taken by the inventor.

46. I am further informed and understand that when an element is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one. If a person of ordinary skill in the art can implement a predictable variation of that available element, Section 103 likely renders the invention obvious. For the same reason, I

am informed and understand that if a technique has been used to improve one device or process, and a person of ordinary skill in the art would recognize that such technique would improve similar devices or processes in the same way, using the technique is obvious unless its actual application is beyond his or her skill. Following these principles often requires one to look to interrelated teachings of multiple patents; the effects of demands known to the design community present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art to determine whether there was an apparent reason to combine the known element in the manner claimed by the patent at issue. I am further informed and understand that the analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim, because one can take account of the inferences and creative steps that a person of ordinary skill in the art would employ.

47. I am further informed and understand that although the use of the “teaching, suggestion or motivation” test for combining references has not been completely rejected, the obviousness analysis cannot be confined by a formalistic conception of the words teaching, suggestion, and motivation, or by overemphasis on the importance of published articles and the explicit content of issued patents. Under the correct analysis, any need or problem known in the field of endeavor at the time of the invention and addressed by the patent can provide a reason for

combining the elements in the manner claimed. Finally, I am informed and understand that common sense teaches that familiar items may have obvious uses beyond their primary purposes and, in many cases, a person of ordinary skill in the art will be able to fit the teachings of multiple patents together like pieces of a puzzle.

D. Written Description

48. I understand that one requirement of a patent's disclosure is that the patent's specification must meet the "written description" requirement of § 112 paragraph 1.

49. To have an adequate written description, I understand the patent must convey with reasonable clarity to one skilled in the art that, as of the filing date sought, the patentee was in possession of the invention.

50. To demonstrate possession of the invention, I understand the specification must permit a person of ordinary skill in the art to recognize the subject matter purportedly described. Although the specification need not describe the claimed subject matter verbatim to demonstrate possession of the invention, generalized language will not suffice if it does not convey the detailed identity of an invention.

51. To have an adequate written description, each element of the claimed invention must be actually or inherently disclosed in the specification; it is not

sufficient that the specification may render the claim element obvious to a person of ordinary skill in the art.

52. In addition, the patent's specification must contain sufficient written description so that a person of ordinary skill in the art would have had reasonable certainty as to the process and manner of making and using the alleged invention.

E. Enablement

53. In addition to the written description requirement, I understand that a patent's specification must describe the claimed invention in such full, clear, concise, and exact terms as to enable one of ordinary skill in the art to make and use the full scope of the claimed invention without undue experimentation. I also understand that in determining whether a patent meets this requirement, one considers the level of ordinary skill in the art as of the priority date of the patent. I further understand that a claim is invalid if it is not supported by an enabling disclosure as of the alleged priority date.

54. I further understand that the fact that some experimentation may be required for one of ordinary skill in the art to practice the claimed invention does not necessarily mean the patent fails to meet the enablement requirement. However, it is my understanding that the factors that may be considered in determining whether undue experimentation would be required to make and use the claimed invention include: the quantity of experimentation necessary, the

amount of direction or guidance disclosed in the patent, the presence or absence of working examples in the patent, the nature of the invention, the state of the prior art, the relative skill of those in the art, the predictability of the art, and the breadth of the claims.

55. It is further my understanding that a patent need not expressly state information that skilled persons would be likely to know or could obtain.

56. I understand that the full scope of the claims must be enabled, such that the scope of the claimed invention is not greater than the scope of the invention enabled by the specification. I further understand that elements of a claim may not be enabled when the inventor was not able to implement the elements at the time of filing.

57. It is also my understanding that a patent can lack enablement of a given claim element by expressly teaching away from it.

F. Priority Date

58. I understand that the “priority date” of an invention is the date that determines whether a reference qualifies as prior art to the alleged invention. I understand that the priority date is the date the patent application is filed, and that a patent application may claim priority to an earlier-filed application or applications. In order to successfully claim priority to an earlier-filed application, the earlier-filed application must provide (i) sufficient written description support and (ii) an

enabling disclosure for the full scope of the later-claimed invention. If the earlier-filed application fails to provide sufficient written description or lacks an enabling disclosure for the full scope of the later-claimed invention, the patent is not entitled to the priority date of the earlier-filed application.

III. ASSIGNMENT AND MATERIALS REVIEWED

59. As noted above, I have been asked to provide my opinions regards validity of the '515 Patent in connection with the *inter partes* review Petition filed by Hesai. My opinions are based on my years of education, research, and experience, as well as my investigations and study of relevant materials. In forming my opinions, I have considered the materials I identify in this report and those listed in the attached Exhibit B.

60. This declaration represents only those opinions I have formed to date, but they may not be exhaustive of my opinions on the patentability of the claims-at-issue. The fact that I do not address a particular point should not be understood to indicate any agreement on my part that any claim otherwise does not comply with patentability requirements.

61. My analysis of materials in this investigation is ongoing and I will continue to review any new material as it is provided. I reserve the right to revise, supplement or amend my opinions, or any combination thereof, based on new information and on my continuing analysis of the materials already provided.

IV. PERSON OF ORDINARY SKILL IN THE ART

62. I am informed and understand that the claims of a patent are judged from the perspective of a hypothetical construct involving a “person of ordinary skill in the art” (POSITA). The “art” is the field of technology to which the patent is related. I understand that the purpose of using the viewpoint of a person of ordinary skill in the art is for objectivity. I understand that a person of ordinary skill in the art is presumed to know and be familiar with of the relevant art in the field at the time of invention and is also presumed to possess an average level of creativity.

63. I understand that factors that may be considered in determining the level of ordinary skill include: (1) the type of problems encountered in the art at or prior to the relevant time period; (2) pre-existing solutions (i.e., prior art) to those problems; (3) the pace at which solutions innovations were developed at the relevant time period; (4) the sophistication of technology at the relevant time period; and (5) the education level of people working in the relevant field(s) at the relevant time period.

64. I understand that Petitioner’s expert, Dr. Michael Lebby, asserts that a POSITA as of the priority date of the ’515 Patent would have had an undergraduate degree in mechanical or electrical engineering and two to three years of work experience with electro-optical and electro-mechanical devices or

systems where less work experience may be compensated by a higher level of education or vice versa.

65. I disagree that this correctly defines a POSITA for the '515 Patent. In particular, I note that Dr. Lebby has opined that “claims of the '515 patent are directed at a rotor-stator structure that includes an integrated PCB motor for rotating a LiDAR device mounted on a rotor relative to a stator” His POSITA definition, in contrast, would be broad enough to encompass individuals who have never before worked on LIDAR design, much less a LIDAR device implemented on a rotor-stator structure.

66. In my opinion, Dr. Lebby’s definition of POSITA of a definition would be acceptable if it included the caveat that “at a minimum, at least one year of work experience was with LIDAR designs, including LIDAR designs implemented on a rotor-stator structure specifically.”

67. In co-pending IPR2023-01421 between Patent Owner and Petitioner relating U.S. Patent No. 11,175,405, Petitioner proposed a POSITA definition “as having an undergraduate degree in mechanical or electrical engineering or physics and two to three years of experience in LiDAR design.” *Hesai Technology Co., Ltd. v. Ouster, Inc.*, IPR2023-01421, Paper 2 at 12 (Sept. 14, 2023). While I disagree that this is the correct definition of a POSITA for the patent in that proceeding—where the challenged patent focuses on optical aspects of the

LIDAR—I think Petitioner’s proposal to require experience in LIDAR design makes more sense for this proceeding because the ’515 Patent focuses more on the mechanical engineering and systems design aspects of a LIDAR product.

68. Electrical engineers coming right out of college typically understand analog or digital systems but generally not both. The claimed invention of the ’515 patent focuses primarily on the rotating structure. LIDAR systems are electromechanical systems with both digital-to-analog and analog-to-digital conversions built into multiple points of a system where tracking the timings of the components is crucial. The motor in a rotating LIDAR system must track its rotation to create a point cloud. The system must drive the motor, which is inherently analog, requiring a digital-to-analog conversion. There is also an analog-to-digital conversion because the light returning to the LIDAR device is an analog signal that must be converted to a digital one where the intervening steps include signal conditioning and time-gain-variable amplification. Work on LIDAR design requires not just bridging the gap between mechanical and electrical engineering but also the analog-digital gap. This does not take a team of specialists to understand it. Rather, in my experience, it typically requires a person to have one year working with systems with rotating LIDAR devices to grasp all of the concepts involved with the rotating structure of the LIDAR. At that point, in my opinion, they would be a person of ordinary skill in the art.

69. I have applied this level of skill to my analysis in this case. Based on my education and experience, I consider myself to have at least the necessary qualifications of a POSITA and have prepared all opinions set forth herein on the basis of that understanding. Furthermore, I frequently interact with, work with, supervise, and mentor persons with these qualifications.

V. OVERVIEW OF THE '515 PATENT AND BACKGROUND OF THE TECHNOLOGY

A. History of Relevant Technology Before December 2017

70. LIDAR began in the early 1970s, soon after the invention of the first laser. Initially developed as a way for NASA to measure properties of the atmosphere and terrain of the earth, its use spread to many other airborne and spaceborne prototypes throughout the 1980s. In these early 3D mapping systems, the laser would scan a line perpendicular to the path of the platform, with the scans combined into a single view based on the tracked path of the platform, in what is often referred to as a “push broom sweep”. Later, the development of inertial measurement units (IMUs) and GPS allowed external tracking to be replaced by more accurate on-board tracking systems. Also, by the late 1990s, the number of laser scans had increased significantly, providing up to 25,000 points per second. The density of these scans, combined with navigational tracking, paved the way for

generating high resolution geospatial maps and high-accuracy topographies.¹

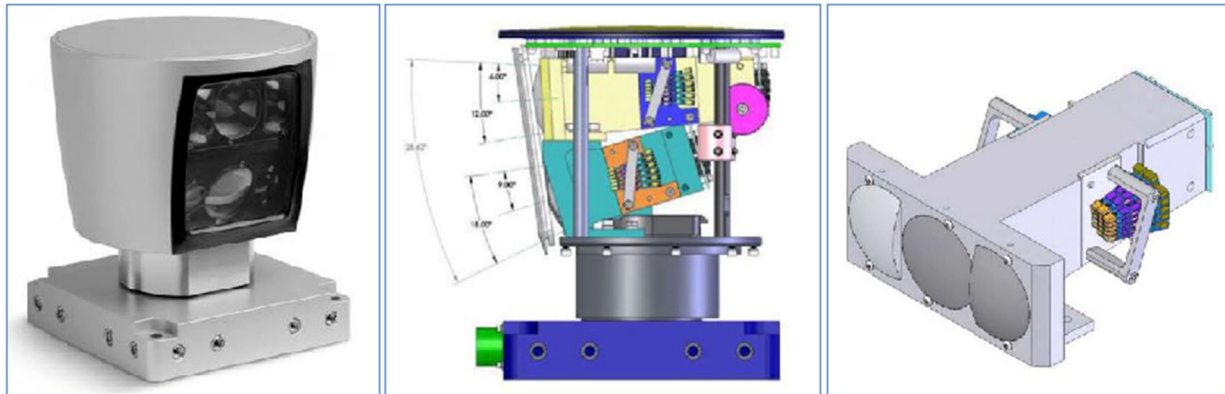
71. In parallel, ground-based applications for LIDAR began to develop for architecture, preservation, and land surveying. Early systems used highly-precise stepper motors or similar technology to create 3D scans, and were excruciatingly slow, taking hours to complete. As laser range finders were adopted more in industry and manufacturing, the idea of spinning mirrors for scanning 2D laser images became popular, with companies like SICK eventually dominating the field. Many of these systems would operate very close to their targets in fairly well controlled environments, so triangulation was often used to create inexpensive and low-power devices. These advances in manufacturing laser scanners fed back into outdoor applications as well, but for decades, the emphasis was on stationary scans, and fast scanning was a convenience, not a necessity.

72. DARPA's Grand Challenge greatly accelerated the development and uses of LIDAR for a mobile ground-based platform. From the first Grand Challenge in 2004 to the last challenge in 2007, advances in laser sensors quickly accelerated from fixed 2D laser scanners as supplemental sensors to spinning laser scanners like the 360-degree 3D scanners. The roof-mounted 360-degree scanning LIDAR model quickly became the most popular approach for autonomous vehicles

¹ <http://blog.bccresearch.com/brief-history-of-lidar-evolution-and-market-definition>

in both research and industry.

73. As Dr. Lebby confirms, “Velodyne commercialized its first LiDAR system shortly thereafter with a product called HDL-64E, which is shown below:”



Ex. 1003, ¶ 50.

74. As evident from the images above, this initial commercial LIDAR system included two receivers, one above the other, each with its own, large optical lens and each with a different vertical field-of-view. *See* Ex. 1003, ¶ 50. Accordingly, the Velodyne’s HDL-64 product was large—“roughly the size of a Kentucky Fried Chicken bucket.” Ex. 2007. By 2017, Velodyne had released its “new Velodyne VLS-128, right, [which] ha[d] twice as many lasers and 10 times the resolution of the company’s previous high-end sensor, the HDL-64, left.” *Id.*



Ex. 2008.

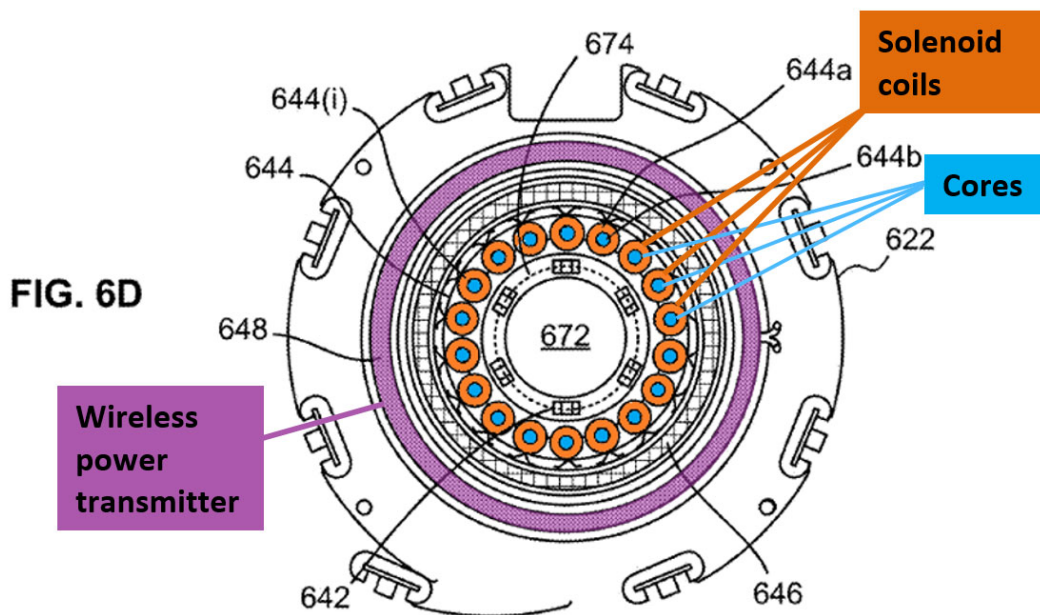
75. As discussed below, Ouster’s ’515 Patent further reduced the form factor to “smaller than that of a coffee mug.” Ex. 1001, 25:30-31.

B. Summary of the ’515 Patent

76. The ’515 Patent sought to improve on rotating LIDAR systems for autonomous vehicles, which are “technologically complex,” “costly to manufacture,” and involve “a conglomeration of different internal sub-systems, each of which can be in itself quite complex.” Ex. 1001 at 1:44-53. To avoid these difficulties, the ’515 Patent teaches a light ranging device implemented on upper and lower circuit board assemblies in which the upper board assembly rotates with respect to the lower board assembly around a shaft that is perpendicular to the board assemblies. *Id.* at 26:19-40. An electric rotary motor is integrated directly

onto these same circuit boards. *Id.* at 30:5-9.

77. As depicted in Fig. 6D (reproduced below) the lower circuit board assembly includes a stator comprised of stator elements 644(i), each of which includes a solenoid coil 644a wound around a core 644b of magnetic material. Ex. 1001 at 30:24-29. Wireless power transmitter 648 is likewise placed on the circuit board outside of the plurality of stator elements. *Id.* at 31:21-48; Fig. 6D.



78. Fig. 8A (reproduced below) is an exploded view diagram showing an upper circuit board assembly 810 utilizing a two-board configuration (*e.g.*, a rotor board 850 and control board 840) arranged above the stator. Ex. 1001 at 34:37-44. As depicted in Figs. 8A and 8B, the rotor board 850 includes a bearing housing 865 that fits over shaft 715 so that rotor board 850 can rotate relative to the stator assembly. *Id.* at 34:51-60.

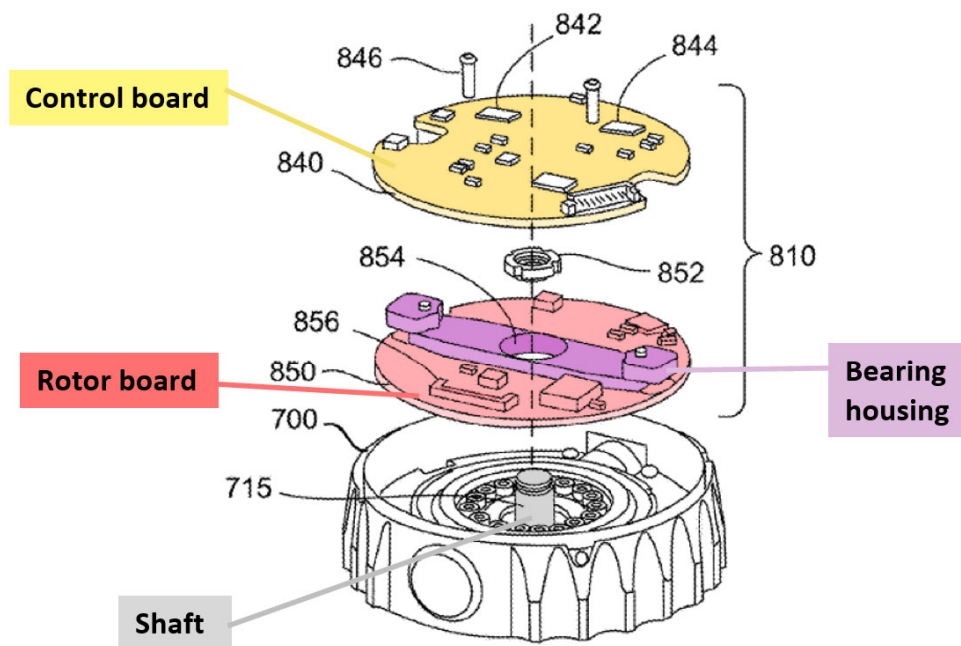


FIG. 8A

79. In contrast to any previous LIDAR devices, this design is a “highly integrated architecture” that results in a “more compact form factor and much simplified assembly process than spinning LIDAR systems that employ a separate electric motor module.” *Id.* at 16:29-33. Indeed, embodiments of this design can be as small as a coffee mug. *Id.* at 25:23-31. This compact form factor opens up new applications for LIDAR, such as deployment on airborne vehicles such as drones. *Id.* at 47:36-42.

C. Impact of the '515 Patent

80. The claimed invention of the '515 Patent quickly made an impact in the market after the release of Ouster's OS sensors. As noted above, Velodyne's

VLP-16 design launched in 2017 was less than half the volume of Velodyne’s prior, bucket-sized HDL-64 product. In turn, Ouster’s OS1 sensor, which embodies the claimed invention of the ’515 Patent and launched in 2018, has less than half the volume of Velodyne’s even smaller VLP-16 PUCK™ sensor. Compare Ex. 2009 and Ex. 2010.² As explained further in my discussion of secondary considerations below, the claimed invention of the ’515 Patent opened the door for Ouster’s customers to put drones carrying OS1 sensors to new uses, such as airplane inspections, that were not possible with earlier LIDAR systems. The claimed invention of the ’515 Patent also provided drones with improved capabilities for other functions such as cave modeling, agricultural inspections, and industrial inspections.

D. Challenged Claims

81. I understand that Petitioner is challenging claims 1-2, 4-9, 11-14, 16-17, and 19-25 of the ’515 Patent, reproduced below.

Claim 1	
1(a)	A light ranging system comprising:
1(b)	an enclosure having a base, a top cover and an optically transparent window disposed between the base and the top cover and extending fully around a periphery of the enclosure;
1(c)	a shaft disposed within the enclosure and defining an axis of rotation;

² Velodyne VLP-16 is 4.06” in diameter and 2.86” tall, whereas Ouster OS1 is approximately 72mm in diameter (2.83”) and 58.35mm (2.29”) tall.

1(d)	a stator circuit board disposed within the enclosure along a first plane perpendicular to the axis of rotation and fixedly coupled to the base of the enclosure;
1(e)	a support component rotationally coupled to the shaft and comprising a sleeve fitted over the shaft and a plurality of arms extending away from the sleeve;
1(f)	a rotor circuit board coupled to the support component and disposed within the enclosure along a second plane parallel to the first plane and between the first plane and the top cover;
1(g)	a stator assembly disposed between the first and second planes and coupled to the stator circuit board, the stator assembly comprising a plurality of stator elements arranged annularly about the axis of rotation, each of the plurality of stator elements including a coil wound around a magnetic core;
1(h)	a rotor assembly disposed between the first and second planes and coupled to the rotor circuit board, the rotor assembly including an annular arrangement in which a plurality of magnetic poles surround the axis of rotation in an alternating pattern such that each magnetic pole has a polarity opposite a polarity of its adjacent magnetic poles; and
1(i)	a light ranging device coupled to rotate with the rotor circuit board within the enclosure, the light ranging device comprising a transmit module comprising a bulk transmitting optic and an illumination source operable to transmit pulses of electromagnetic radiation through the bulk transmitting optic and through the window to objects in a surrounding environment, and an receive module comprising a bulk receiver optic and detector circuitry operable to detect reflected portions of the electromagnetic radiation pulses received through the window that are reflected from the objects in the surrounding environment; and
1(j)	a stator driver circuit disposed within the enclosure and configured to provide a drive signal to the plurality of stator elements, thereby imparting an electromagnetic force on rotor assembly to drive a rotation of the rotor circuit board and the light ranging device about the shaft.
Claim 2	

2	The light ranging system of claim 1 wherein the shaft is hollow and the system further comprises a communication channel that extends through the hollow shaft allowing ranging data from the light ranging device to be transmitted to processing circuitry disposed within the enclosure in a fixed relationship to the stator circuit board.
Claim 4	
4	The light ranging system of claim 1 further comprising: a third circuit board fixedly coupled to the base and arranged in a plane parallel with the first plane and disposed between the enclosure base and the stator circuit board; and a fourth circuit board coupled to rotate with the rotor circuit board between the enclosure top and the rotor circuit board and arranged in a plane parallel with the first plane.
Claim 5	
5	The light ranging system of claim 4 wherein the light ranging device is mounted within a ranging device housing disposed within the enclosure between the fourth circuit board and the enclosure top with the transmit module mounted to a first portion of the ranging device housing and the receive module mounted to a second portion of the ranging device housing directly adjacent to the first portion
Claim 6	
6	The light ranging system of claim 5 wherein transmit module comprises a fifth circuit board with supporting circuitry for the illumination source and the receive module comprises a sixth circuit board with supporting circuitry for the detector circuitry, and wherein the fifth circuit board is mounted to the first housing portion of the ranging device housing and aligned parallel to the axis of rotation and the sixth circuit board is mounted to the second housing portion of the ranging device housing and aligned parallel to the axis of rotation.
Claim 7	
7	The light ranging system of claim 1 wherein the annular arrangement comprises a plurality of separate permanent magnets.
Claim 8	
8	The light ranging system of claim 1 further comprising circuitry to compute ranging data based on the reflected portion of the electromagnetic radiation pulses.

Claim 9	
9	The light ranging system of claim 1 wherein the stator driver circuit is configured to rotate the rotor assembly at a rate between 10 to 30 Hz.
Claim 11	
11	The light ranging system of claim 1 wherein a number of stator elements in the plurality of stator elements is a multiple of three and the stator driver circuit is configured to provide a 3-phase alternating signal to the plurality of stator elements.
Claim 12	
12	The light ranging system of claim 1 wherein the detector circuitry comprises a plurality of pixels with each pixel in the plurality of pixels having a field of view that is non-overlapping with the fields of view of all other pixels in the plurality of pixels, and wherein the illumination source is configured to project discrete beams of electromagnetic radiation into the surrounding environment according to an illumination pattern where each discrete beam in the illumination pattern is coincident with the field of view of one pixel in the plurality of pixels.
Claim 13	
13	The light ranging system of claim 12 wherein each pixel in the plurality of pixels comprises a plurality of single photon avalanche diodes (SPADs).
Claim 14	
14(a)	A light ranging system comprising:
14(b)	an enclosure having a base, a top cover and an optically transparent window disposed between the base and the top cover and extending fully around a periphery of the enclosure;
14(c)	a shaft disposed within the enclosure and defining an axis of rotation;
14(d)	a stator circuit board disposed within the enclosure along a first plane perpendicular to the axis of rotation and fixedly coupled to the base of the enclosure;
14(e)	a support component comprising a sleeve fitted over the shaft and a plurality of arms extending away from the sleeve;

14(f)	one or more bearings coupled between the shaft and the support component allowing the support component to rotate around the axis of rotation;
14(g)	a rotor circuit board coupled to rotate with the support component and disposed within the enclosure along a second plane parallel to the first plane and between the first plane and the top cover;
14(h)	a stator assembly coupled to the stator circuit board and comprising a plurality of stator elements arranged annularly about the axis of rotation, each of the plurality of stator elements including a coil;
14(i)	a rotor assembly coupled to the rotor circuit board, the rotor assembly including an annular arrangement in which a plurality of magnetic poles surround the axis of rotation in an alternating pattern such that each magnetic pole has a polarity opposite a polarity of its adjacent magnetic poles; and
14(j)	a light ranging device coupled to rotate with the rotor circuit board within the enclosure, the light ranging device comprising a transmit module comprising a bulk transmitting optic and an illumination source operable to transmit pulses of electromagnetic radiation through the bulk transmitting optic and through the window to objects in a surrounding environment, and an receive module comprising a bulk receiver optic and detector circuitry operable to detect reflected portions of the electromagnetic radiation pulses received through the window that are reflected from the objects in the surrounding environment; and
14(k)	a stator driver circuit disposed within the enclosure and configured to provide a drive signal to the plurality of stator elements, thereby imparting an electromagnetic force on rotor assembly to drive a rotation of the rotor circuit board and the light ranging device about the shaft.
Claim 16	
16	The light ranging system of claim 14 wherein the plurality of magnetic poles rotor in the annular arrangement of the rotor assembly comprise a plurality of separate permanent magnets.
Claim 17	

17	The light ranging system of claim 14 further comprising a wireless power transformer integrated directly onto the stator and rotor circuit boards, the wireless power transformer comprising a first annular transformer coil disposed on a surface of the stator circuit board and a second annular transformer coil disposed on a surface of the rotor circuit board in an opposing relationship with the first annular transformer coil, wherein the first transformer coil is concentric with and positioned outside an outer perimeter of the plurality of stator elements and the second transformer coil is concentric with and positioned outside an outer perimeter of the rotor assembly annular arrangement.
Claim 19	
19	The light ranging system of claim 14 wherein the light ranging device determines distances to objects in the surrounding environment based on elapsed times between the pulses of electromagnetic radiation emitted from the illumination source and the detection of reflected portions of the electromagnetic radiation pulses by the receive circuitry.
Claim 20	
20	The light ranging system of claim 14 wherein the detector circuitry comprises a plurality of pixels with each pixel in the plurality of pixels having a field of view that is non-overlapping with the fields of view of all other pixels in the plurality of pixels, and wherein the illumination source is configured to project discrete beams of electromagnetic radiation into the surrounding environment according to an illumination pattern where each discrete beam in the illumination pattern is coincident with the field of view of one pixel in the plurality of pixels.
Claim 21	
21	The light ranging system of claim 20 wherein each pixel in the plurality of pixels comprises a plurality of single photon avalanche diodes (SPADs).
Claim 22	
22(a)	A light ranging system comprising:

22(b)	an enclosure having a base, a top cover and an optically transparent window disposed between the base and the top cover and extending fully around a periphery of the enclosure;
22(c)	a shaft disposed within the enclosure and defining an axis of rotation, the shaft including a hollow channel axially aligned with the axis of rotation and extending through a length of the shaft;
22(d)	a stator circuit board assembly disposed within and coupled to the enclosure in a fixed relationship, the stator circuit board assembly comprising:
22(d.i)	a first circuit board disposed along a plane perpendicular to the axis of rotation;
22(d.ii)	a second circuit board disposed parallel to and adjacent to the first circuit board and having a first aperture formed through a central portion of the second circuit board; and
22(d.iii)	a stator assembly comprising a plurality of stator elements arranged about the axis of rotation;
22(e)	a rotor circuit board assembly disposed within the enclosure and rotationally coupled to the shaft, the rotor circuit board assembly comprising:
22(e.i)	a support component having lower and upper surfaces, a sleeve extending away from the lower surface and fitted over the shaft, a plurality of arms extending away from the sleeve, and a plurality of alignment posts extending away from the upper surface;
22(e.ii)	a third circuit board coupled to the lower surface of the support component and disposed adjacent to and in an opposing relationship with the second circuit board;
22(e.iii)	a fourth circuit board coupled to the upper surface of the support component and arranged parallel with the third circuit board between the third circuit board and the top cover, the fourth circuit board having a plurality of alignment cutouts sized and shaped to accept the alignment posts; and

22(e.iv)	a rotor component coupled to the rotor circuit board assembly and spaced apart from and concentric with the stator assembly, the rotor component comprising an annular arrangement in which a plurality of magnetic segments surround the axis of rotation and are distributed along the annular arrangement in an alternating pattern such that each magnetic pole has a polarity opposite a polarity of its adjacent magnetic poles;
22(f.i)	a light ranging device coupled to rotate with the rotor circuit board within the enclosure, the light ranging device comprising a transmit module and a receive module, the transmit module comprising a bulk transmitting optic and a light source operable to transmit pulses of electromagnetic radiation through the bulk transmitting optic and through the window to objects in a surrounding environment, the receive module comprising a bulk receiver optic and detector circuitry operable to detect reflected portions of the electromagnetic radiation pulses received through the window that are reflected from the objects in the surrounding environment,
22(f.ii)	wherein the detector circuitry comprises a plurality of pixels, each pixel comprising a plurality of single photon avalanche detectors (SPADs) and
22(f.iii)	wherein the light ranging device determines distances to objects in the surrounding environment based on elapsed times between the pulses of electromagnetic radiation emitted from the light source and the detection of reflected portions of the electromagnetic radiation pulses by the detector circuitry
22(g)	a stator driver circuit disposed within the enclosure and configured to provide a drive signal to the plurality of stator elements, thereby imparting an electromagnetic force on the rotor component to drive a rotation of the second circuit board assembly and the light ranging device about the shaft;

22(h)	a wireless power transformer integrated directly onto the stator and rotor circuit boards, the wireless power transformer comprising a first annular transformer coil disposed on a surface of the stator circuit board and a second annular transformer coil disposed on a surface of the rotor circuit board in an opposing relationship with the first annular transformer coil, wherein the first transformer coil is concentric with and positioned outside an outer perimeter of the plurality of stator elements and the second transformer coil is concentric with and positioned outside an outer perimeter of the rotor assembly annular arrangement; and
22(i)	a communication channel extending through the hollow channel in the shaft and operatively coupled to allow ranging data from the light ranging device to be transmitted to circuitry disposed within the enclosure in a fixed relationship to the stator circuit board assembly.
Claim 23	
23	The light ranging system of claim 22 wherein the plurality of stator elements and the annular arrangement of the plurality of magnetic segments are each disposed between a surface of the second circuit board and a surface of the third circuit board.
Claim 24	
24	The light ranging system of claim 22 wherein each magnetic segment in the annular arrangement of the rotor component comprises a permanent magnet.
Claim 25	
25	The light ranging system of claim 22 wherein the light source comprises a plurality of emitters configured to project a plurality of illuminating beams in a field ahead of the optical system according to an illumination pattern that substantially matches, in size and geometry across a range of distances from the system, a plurality of non-overlapping fields of view of the plurality of pixels.

VI. DR. LEBBY'S ASSERTED PRIOR ART

82. Below are summaries of the prior art Dr. Lebbby is asserting in this IPR that I discuss at length in this declaration.

A. Pacala

83. Below are summaries of the prior art Dr. Lebbby is asserting in this IPR that I discuss at length in this declaration.

84. U.S. Patent Application Publication No. 2014/0211194 A1 (“Pacala”) is a patent application that discloses “[a] lidar-based apparatus and method” using “a multi-channel time-to-digital converter (TDC) electronic circuit, with each TDC having an individually adjustable voltage threshold.” EX1004, [0010].

85. Figure 1 of Pacala shows an external view of a LIDAR sensor with a static base **20** and a static head **30**:

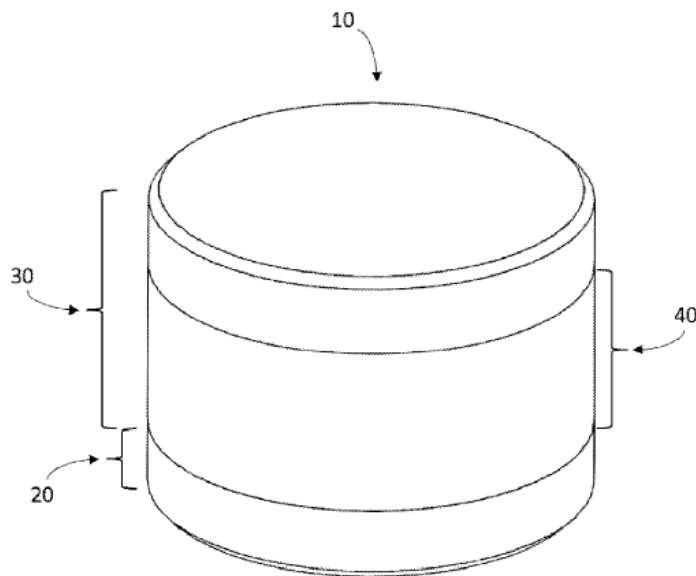


Fig. 1

EX1004, Fig. 1.

86. Figure 2 of Pacala shows an internal view of the LIDAR sensor with the base and head removed:

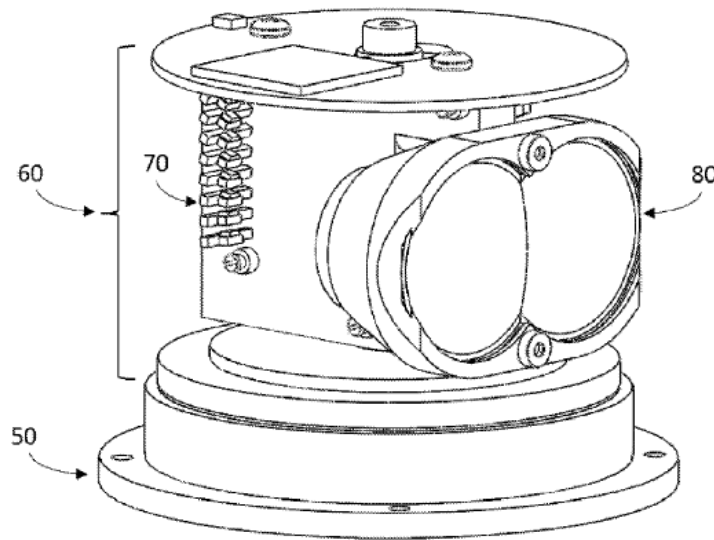


Fig. 2

Id., Fig. 2. The internal view shows “a static base **50** that contains a motor and distributed electronics, and a spinning turret **60** that contains optoelectronic component **70** (including optical transmitters and receivers), collimation and focusing lenses **80** and distributed electronics.” *Id.*, [0013].

87. Much of the written description of Pacala is dedicated to the discussion of the time-to-digital converter (TDC) electronic circuitry of a LIDAR sensor. *Id.*, [0014]. Pacala’s teachings enable “weak signal detection and signal disambiguation through waveform approximation utilizing a multi-channel time-to-digital converter (TDC) electronic circuit, with each TDC having an

individually adjustable voltage threshold.” Ex. 1004 at [0014]. Pacala’s “TDC-based pulse width ToF [(time-of-flight)] approach achieves the low cost associated with the TDC based pulse width ToF approach while solving the signal quality issues associated with the standard single-threshold TDC-based approach.” *Id.*

88. The final sentence of Pacala’s specification states: “The multi-channel TDC electronic circuitry with multiple voltage thresholds can be implemented with discrete integrated circuits (ICs), in the form of FPGA logic, as part of an application-specific integrated circuit (ASIC), or integrated into the pixels of a detector array (e.g., Single-Photon Avalanche Diode [SPAD] array).” *Id.* This parenthetical in the last sentence of Pacala’s specification is the only disclosure of the use of single-photon avalanche diodes, or SPADs.

B. Johnson

89. U.S. Patent No. 10,790,077 (Johnson, Ex. 1005) discloses a “Device and Methods for an Electromagnetic Coil.” Ex. 1005 at Title. Johnson explains its “electromagnetic coil may include multiple coil windings in a coaxial relative arrangement about a shared core region.” *Id.* at 3:3-5. The Petition relies specifically upon Johnson’s electromagnetic coil shown in Figs. 3C-3D as the stator in a rotary joint built into a multilayer PCB. *See* Petition at 32-33. The Petition asserts Johnson’s arrangement “provides a ‘compact’ design.” Petition at 11 (citing Ex. 1045, 4:1-6).

90. Fig. 3C is a cross section view showing “electrically conductive material(s) (e.g., tracks, traces, copper, etc.) patterned along a first layer of the PCB;” likewise Fig. 3D shows “electrically conductive material(s) patterned along a second layer of the PCB.” Ex. 1005 at 12:11-17; Figs. 3C-3D. Johnson explains that conductive paths utilizing conductive material from each of the two layers and the interconnect between the two layers form the “toroidal coil windings” of Johnson’s electromagnetic coil. *Id.* at 13:26-34. These coil windings “extend around axis 306 and about a substantially ring-shaped core region inside the first coil winding.” *Id.*

91. For example, a “first toroidal coil winding” may include “in this order: structure 340 [in Fig. 3C’s layer], interconnect 350 [extending between Figs. 3C and 3D], structure 360 [in Fig. 3D’s layer], interconnect 354 [extending between Figs. 3C and 3D], structure 344 [in Fig. 3C’s layer], etc. through structure 364 [in Fig. 3D’s layer].” *Id.* at 13:24-40, 16:26-34. Detailed views of Johnson’s Figs. 3C and 3D have been reproduced below with blue annotations identifying the conductive elements belonging to the “first toroidal coil winding” and red annotations identifying the conductive elements of a “second toroidal coil winding” (described at Ex. 1005 at 13:37-40) where the exemplar interconnects 350, 352, 354, 356 common to both Figs. 3C and 3D have been annotated green.

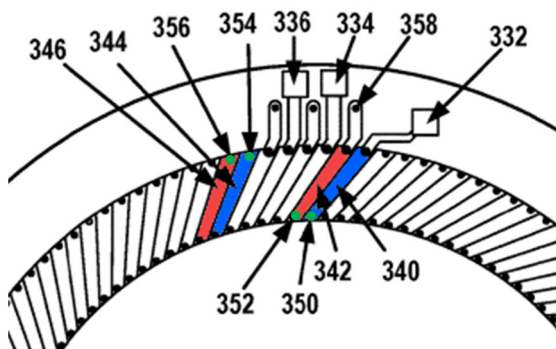


Fig. 3C (detail)

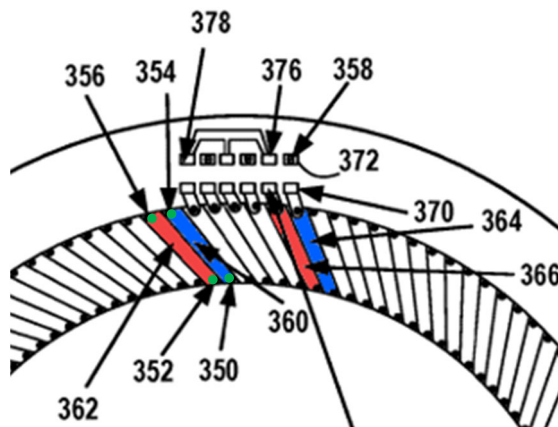


Fig. 3D (detail)

92. An annotated version of Johnson's Fig. 3C is reproduced below with all conductive structures of Johnson's first toroidal coil winding colored blue, and the structures of Fig. 3D overlaid onto those of Fig. 3C to better illustrate one full toroidal coil winding.

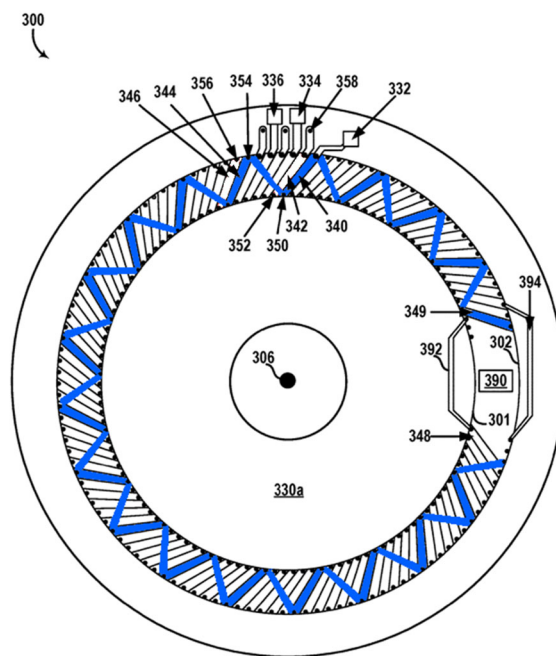
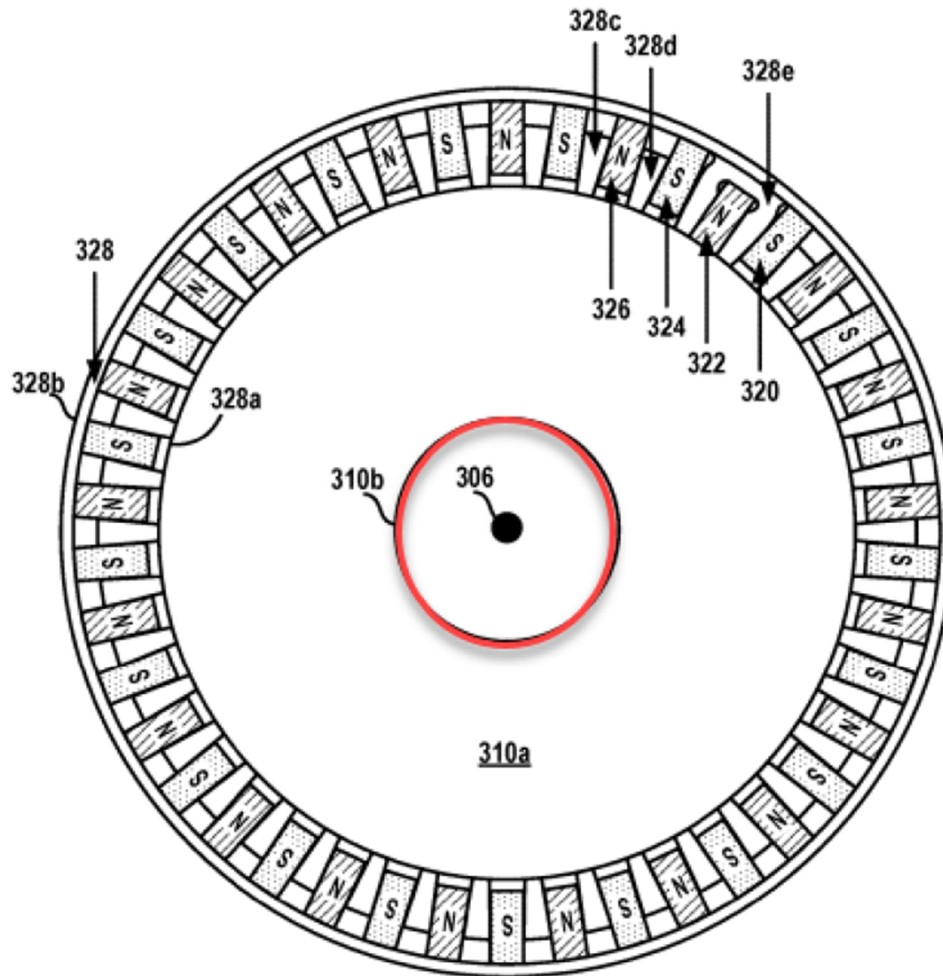


FIG. 3C

93. All the "interleaved toroidal coil windings" of Johnson's single

electromagnetic coil are wound about a common “shared core region around axis 306.” *See* Ex. 1005 at 13:41-50. Johnson’s shared core region within its coil is in the shape of a ring between circles 301 and 302 of Fig. 3C; it may be the middle layers of a PCB and may comprise either dielectric material or a conductive “magnetic core that enhances the stator-platform magnetic field therein.” *Id.* at 13:30-14:10.

94. Johnson further describes, with reference to Fig. 3B (reproduced below with annotations from Petition at 50), an annular transformer coil “arranged around edge 310 b” of its rotor, with “a magnetic core (not shown) extending through the center gap to guide a magnetic flux generated by a similar transformer coil (not shown) of platform 330.” Ex. 1005 at 11:51-60.

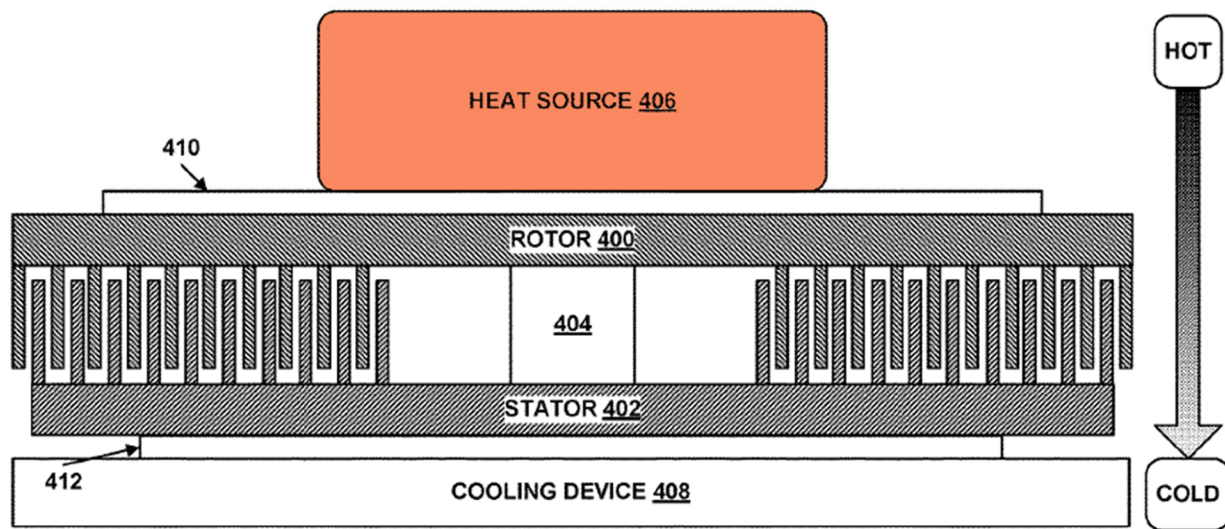


95. Whereas the claimed invention of the '515 Patent requires a wireless power transmitter 648 and receiver 348 “positioned at the outermost region of the boards 622 and 612,” Johnson places its transformer coil in the center region around inner edge 310b as shown in Figs. 3B-3D, and positions the rotor and stator elements—not the transformer coils—at the outermost region of its two boards. *Compare* Ex. 1001 at 31:20-48, Figs. 6A-6E to Ex. 1005 at 11:51-60, Figs. 3B-3D.

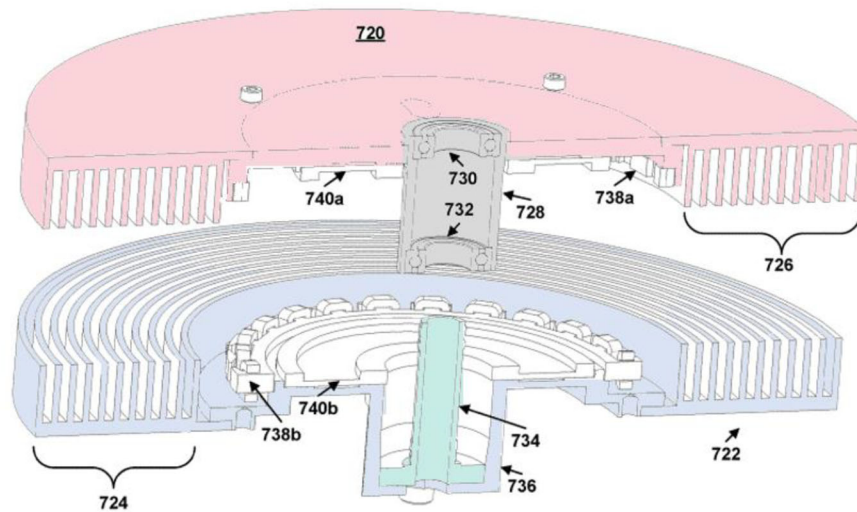
C. Pardhan

96. U.S. Patent No. 10,749,308 (Pardhan, Ex. 1006), entitled “Thermal

Rotary Link,” discloses a “thermal rotary link is configured to transfer heat between two or more devices, systems, or objects in rotational motion with respect to one another,” including specifically a rotor and stator. Ex. 1006 at 1:27-34. In contrast to Pacala, which teaches “an electronic circuit that comprises a plurality of time-to-digital converters with individually adjustable voltage thresholds . . . wherein the time-to-digital converter with the lowest voltage threshold has a trigger setting that allows the detection of weak signals slightly above the noise level,” (Ex. 1004 at Claim 12), Pardhan teaches “[i]n order to acquire scans with a sufficient resolution or signal-to-noise ratio, the power with which the LIDAR device is operated might need to be above a threshold power level.” Ex. 1006, 4:56-59. However, Pardhan further teaches that “operating the LIDAR device above the threshold power level may generate excess heat that the LIDAR device might not be able to dissipate at a rate sufficient to maintain the LIDAR device within a safe operating temperature range.” *Id.* at 4:59-63. Accordingly, Pardhan’s over-powered LIDAR serves as an exemplar “heat source” in need of cooling. *Id.* at 17:5-9. In particular, Pardhan describes how its “thermal rotary link may be used to transfer heat from a heat source such as a rotating LIDAR device to a cooling device” through the rotor and stator as depicted in Pardhan’s Fig. 4 (reproduced below). *Id.* at 4:39-53, 17:1-7, 18:60-63.



97. Pardhan explains “[t]he inability to dissipate heat at a sufficient rate may stem from, for example, a density with which the electrical and optical components of the LIDAR device are packaged inside the LIDAR device housing.” Ex. 1006 at 4:54-5:7. Accordingly, Pardhan discloses expanded rotor and stator plates (720, 722), each including an array of concentric fins (726, 724) so that “[h]eat may be transferred from the fins of the rotor to fins of the stator by way of an air gap separating adjacent fins.” *Id.* at 4:39-44, 20:40-50, Fig. 7B. As explained in the Petition, “[t]he rotor plate 720 (along with its fins) may be manufactured as ‘one piece’ that is made from a ‘metallic material with high thermal conductivity’ so as to transfer heat away from the LiDAR device.” Petition at 15 (citing Ex. 1006 at 18:6-19). This is depicted in Pardhan’s Fig. 7B (as annotated in the Petition at 15 and reproduced below).



D. Zhang

98. WO Publication 2018/201567 (Zhang, Ex. 1007) discloses a “rotating structure for a laser radar.” As depicted in Zhang’s Fig. 2 (reproduced below), the “rotor (1) is in the shape of a cylinder” and the stator (4) “encloses the motor coil 2.” *Id.* at 7. The “first coupling coil (5)” of the electrical power transmission system is likewise “cylindrical” and internal to the rotating structure. *Id.* at 8.

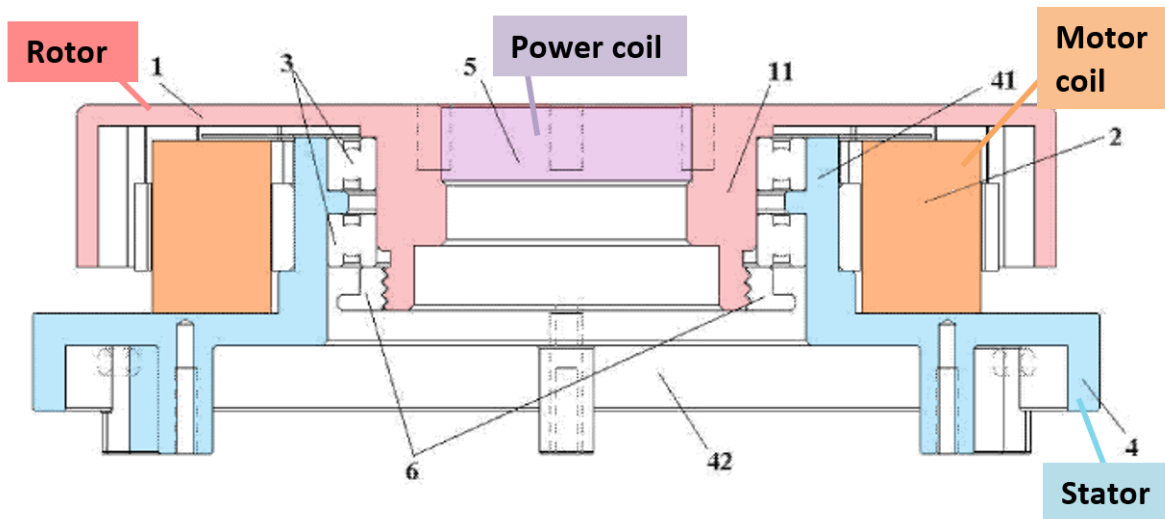


Figure 2

99. Zhang further teaches “at least one hollowed-out heat dissipation hole (12) is configured on the end face of the rotor (1),” so that “the heat generated during the operation of the rotating structure inside it can be released in time, increasing the operating life of the rotating structure” as depicted in Fig. 1 (reproduced below with arrows depicting heat being released from the rotating structure). Ex. 1007 at 9.

E. Droz

100. U.S. Patent No. 10,605,984 (“Droz”) is a patent that discloses waveguides for use in an optical receiver system. Figure 3B shows an array of waveguides:

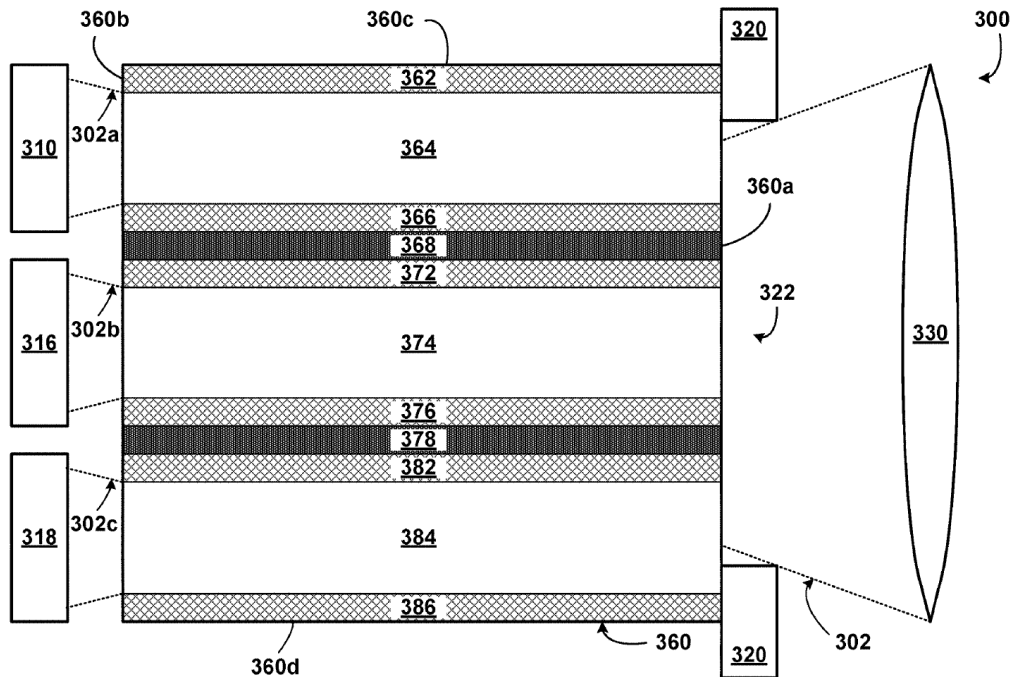


FIG. 3B

EX1006, Fig. 3B. The waveguides consist of multiple layers. Core layers **364**, **374**, and **384** “may comprise a relatively high index of refraction material, such as a glass or high-index polymer substrate, for instance, that is transparent to at least some wavelengths of light **302**.” *Id.*, 13:35-38. Cladding layers **362**, **366**, **372**, **376**, **382**, and **386** “may comprise a relatively low index of refraction material, such as polymer coated or fluorine-doped glass substrates for instance.” *Id.*, 13:31-34. Further, absorbing layers **368** and **378** “may comprise an absorber formed from any material suitable for absorbing wavelengths of light **302** guided within waveguide array **360**.” *Id.*, 13:39-41. Each waveguide receives a portion of light **302** from lens **330** and “guide[s] the [] portion of light **302**, via total internal reflection for instance, toward and out of an output end” as diverging light **302a**,

302b, and **302c**. EX1006, 14:4-17.

101. Droz only discloses using its waveguides in stationary applications—not in applications involving scanning or rotation. The only reference in Droz to any movable portion is the discussion that the system can adjust the angle of element **320** or array **360** with respect to other elements in the system like lens **330**, including via the movement of an actuator. *Id.*, 16:5-10. A POSITA would not have understood such movement as scanning or rotation for purposes of detecting a scene, but rather as mere adjustment of the spatial relationship between components in Droz’s system.

F. Pacala-2017

102. U.S. Patent Pub. No. 2017/0289524 (Pacala-2017, Ex. 1013) is another reference from Ouster’s founder, Angus Pacala. Pacala-2017 teaches and claims a more efficient design for the optoelectronics in a LIDAR system wherein optical channels for receiving photons and detecting the photons are arranged on a single image sensor fabricated directly onto a semiconductor chip. Ex. 1013 at [0050], Claims 1, 5, and 6. Pacala-2017’s system focuses on “achieving a relatively high signal-to-noise ratio (“SNR”)” through techniques that ensure “minimal power output by the system (via the illumination sources) is wasted.” Ex. 1013, [0016]. Accordingly, Pacala-2017 “achieve[s] a relatively high ratio of output signal (i.e., illuminating beam power) to input signal (i.e., photons passed to

an incident on the pixel array).” *Id.*; *see also id.* at [0027] (explaining how its improved optics “reduce[s] crosstalk between channels, thereby improving SNR within the system.”)

G. Other References

103. Dr. Lebby has also asserted several other references, which I discuss below where relevant.

VII. PATENTABILITY OF CHALLENGED CLAIMS

104. Dr. Lebby opines that the challenged claims are obvious based on nine grounds: (1) claims 1-2, 4-9, 11, 14, 16-17 and 19 over Pacala, Johnson, Pardhan and Zhang, (2) claims 2, 4-6, and 17 over Pacala, Johnson, Pardhan, Zhang, and Cai, (3) claims 5-6 over Pacala, Johnson, Pardhan, Zhang, Cai, and Hall, (4) claims 12 and 20 over Pacala, Johnson, Pardhan, Zhang, and Spector, (5) claims 13 and 21 over Pacala, Johnson, Pardhan, Zhang, Spector, and Droz, (6) claims 22-24 over Pacala, Johnson, Pardhan, Zhang, Droz, Cai, and Yan, (7) claim 25 over Pacala, Johnson, Pardhan, Zhang, Droz, Cai, Yan, and Spector, (8) claims 1, 2, 4-9, 11-14, 16-17, and 19-21 over Pacala-2017, Johnson, Pardhan, and Zhang, (9) claims 22-25 over Pacala-2017, Johnson, Pardhan, Zhang, Cai, and Yan. I disagree with Dr. Lebby that the challenged claims would have been obvious to a POSITA over any of his asserted prior art grounds.

105. Having reviewed the Petition, it is my opinion that each of claims 1-2,

4-9, 11-14, 16-17, and 19-25 of the '515 Patent is patentable. The Petition does not establish any of these claims is invalid. The following sections provide my detailed opinions regarding the specific invalidity grounds set forth in the Petition.

A. Ground 1 – Claims 1-2, 4-9, 11, 14, 16-17 and 19 are patentable over Pacala, Johnson, Pardhan, and Zhang

106. Dr. Lebby asserts that claims 1-2, 4-9, 11, 14, 16-17, and 19 would have been obvious over Pacala, Johnson, Pardhan, and Zhang. I disagree with Dr. Lebby for the reasons provided below.

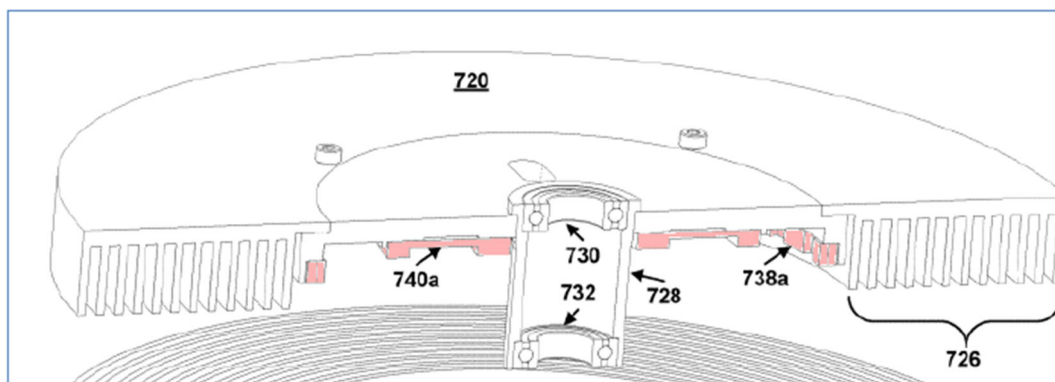
1. Petitioner fails to provide an adequate motivation to combine the “compact” design of Johnson with the voluminous rotating heat sink of Pardhan

107. First, Dr. Lebby has opined that “Johnson teaches the use of a PCB motor integrated into the rotor and stator platforms to provide a more compact and efficient use of space.” Ex. 1003, ¶ 84. Accordingly, Dr. Lebby concludes that “Johnson’s design is particularly well-suited for Pacala because it integrates the ‘PCB motor’ directly onto the rotor-stator structure to provide a ‘a more compact design and/or efficient use of space.’” *Id.* However, no such benefit is realized by the Petition’s combination of Pacala, Johnson, Pardhan and Zhang because Johnson’s “compact” design is subsumed by the intentionally voluminous design of Pardhan.

108. To dissipate the heat generated by running excessive power through its lasers, Pardhan provides an oversized design with vertically oriented fins

extending from both the rotor and stator. Ex. 1006 at 18:60-19:6. Pardhan further teaches that a design with a *larger* volume prevents the overheating that can occur by packing electrical components in too small a space. *Id.* at 4:63-67. Thus, in my opinion, Pardhan teaches away from a compact design like the one taught in Johnson.

109. Moreover, the Petition proposes placing Johnson’s PCB *within* Pardhan’s large volume as shown below in the annotated figure from the Petition (at 31) where the proposed location of Johnson’s rotor is highlighted in red. This directly negates the compact design Petitioner supplies as the reason for utilizing Johnson’s design with Pacala in the first place.



2. There is no motivation to combine Pacala’s LIDAR with Pardhan’s “thermal rotary link”

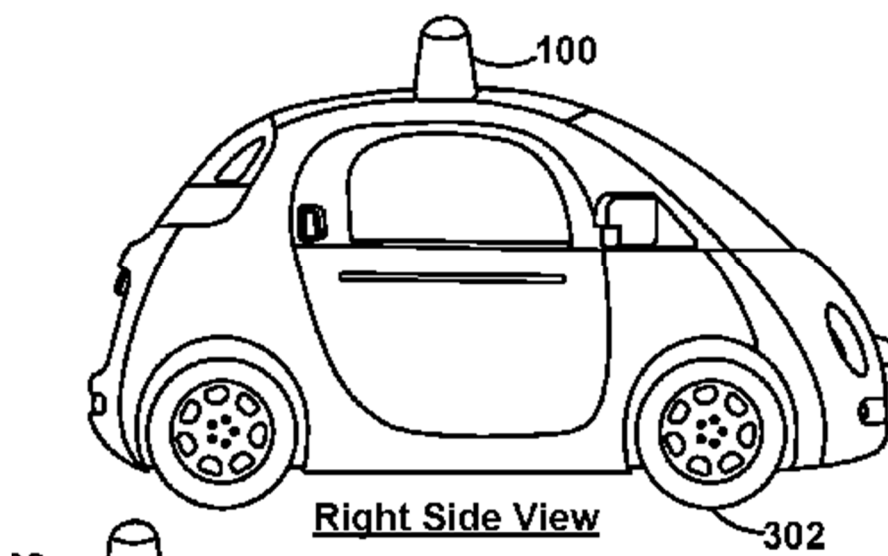
110. The Petition asserts a POSITA would have been motivated to combine Pacala’s LIDAR with Pardhan’s support structure because “a LiDAR device mounted on a rotating platform ‘generate[s] excess heat’ that makes it difficult to operate the device ‘within a safe operating temperature range’ without techniques

for ‘transfer[ing] excess heat away from’ the rotating LiDAR device.” Pet. at 52-53 (citing Ex. 1006 at 4:54-5:80, 19:2-6). The Petition cites Pardhan (Ex. 1006) to support this contention, but it misstates Pardhan’s teachings.

111. Pardhan expressly teaches that “[i]n order to acquire scans with a sufficient resolution or signal-to-noise ratio, the power with which the LIDAR device is operated *might* need to be above a threshold power level.” Ex. 1006 at 4:56-63 (emphasis added). Pardhan further explains “operating the LIDAR device above the threshold power level *may* generate excess heat” that would then need to be dissipated with its thermal rotary link (i.e., a large rotating heat sink with interleaved fins). Ex. 1006 at 4:56-63. These qualifications in Pardhan’s teachings—which Dr. Lebby ignores—confirm a POSITA’s understanding that not *every* LIDAR device is expected to overheat such that it would become a “heat source” in need of Pardhan’s design. Rather, a POSITA would understand that what the Petition designates as Pardhan’s “support component” (which “includes a rotor plate 720 (with fins) made from a ‘metallic material with high thermal conductivity’ to avoid overheating”) is only necessary for *Pardhan’s* LIDAR device, because it is presumed to be powered at an excessively high level in an effort to obtain better resolution or signal-to-noise ratio, thereby causing excessive heat generation.

112. Pardhan expressly describes the implementations of LIDAR device

100 that could need its oversized, rotating heat sink. Pardhan teaches its LIDAR device 100 has a first receiver 110 and second receiver 112 that have “the same horizontal FOV (e.g., 360°) while having different vertical FOV.” *Id.* at 10:29-31. Pardhan further teaches an optical lens for the first receiver 110 of its LIDAR device with “dimensions of approximately 10 cm x 5 cm as well as a focal length of approximately 35 cm” as well as an additional optical lens for its second receiver 112. Ex. 1006, 8:66-9:4, 9:54-60. Notably, Pardhan’s first lens alone was too large to fit in the prior art Velodyne VLP-16, which had a 10.3cm diameter and window height of 3.9 cm. Ex. 2009. Rather, a POSITA would have recognized Pardhan’s LIDAR device as being similar to the then-antiquated, bucket-sized Velodyne HDL-64 design from many years prior, which had large power requirements. *Compare* Ex. 2028 at 2 (showing the older, larger HDL-64 required 64W) to Ex. 2029 at 31 (showing the newer, more compact VLP-16 required only 8W).



Ex. 1006 (Pardhan), Fig. 3 (illustrating size of Pardhan’s LIDAR device 100).³

113. Ground 1, however, does not use Pardhan’s LIDAR device, it uses Pacala’s LIDAR device, including what the Petition refers to as Pacala’s “bulk transmitter and receiver optics, illumination sources, and detector circuitry.”

Petition at 16; *see also* Petition at 34 (“Pacala’s LiDAR device includes a transmit module comprising a bulk transmitting optic 80 (*i.e.*, focusing lens) and illumination source (*i.e.*, laser transmitters) to transmit pulses of electromagnetic radiation (*i.e.*, laser) through window 40 to the surrounding environment . . . bulk receiver optic 80 (*i.e.*, focusing lens) and detector circuitry (*i.e.*, a SPAD array and

³ Even though Pardhan does not state its Fig. 3 is to scale, a POSITA would understand from Pardhan’s discussion of the dimensions of its LIDAR device (e.g., at 8:66-9:4, 9:54-6) that Pardhan’s Fig. 3 (reproduced below) is meant to illustrate the relatively large size of Pardhan’s inefficient LIDAR.

TDC circuitry) to detect reflected portions of the radiation pulses received through window 40. *Id.*, [0004], [0012]-[0014].”).

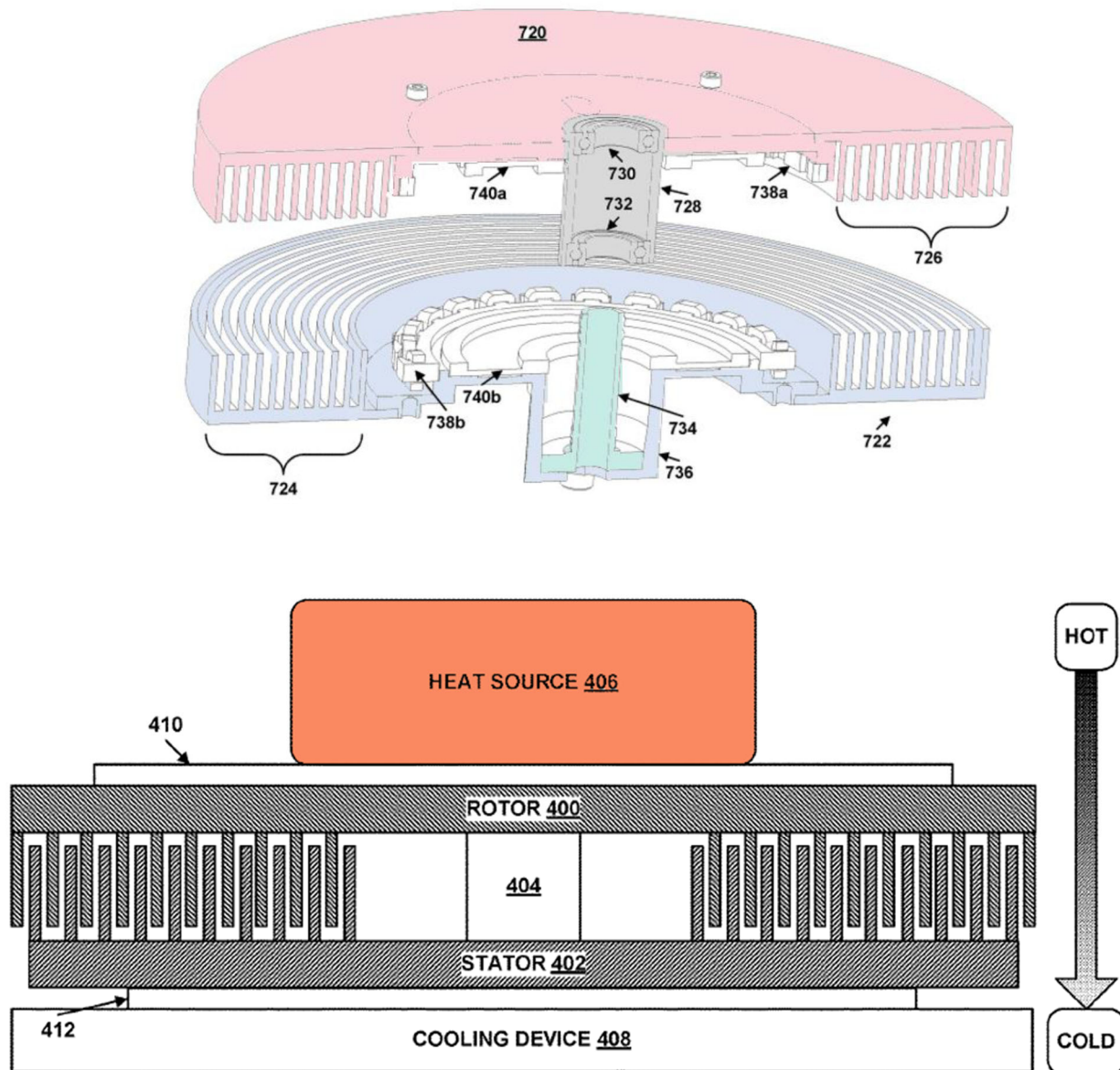
114. In contrast to Pardhan, Pacala teaches a LIDAR system employing a multi-channel TDC (time-to-digital converter) with individually adjustable voltage thresholds, allowing for the detection of weak return signals just above the noise level without necessitating an increase in transmit power. Ex. 1004 at [0014], claims 12, 19, 27. A POSITA would recognize that use of Pacala’s sensitive multi-channel TDC receiver would avoid the need to operate the LIDAR device at the high power levels described in Pardhan in the first place. As a result, heat generation would be minimized such that no excess heat would be generated by Pacala’s design. As explained above, a POSITA would have been aware of the trend towards more sensitive LIDARs, which could be operated at much lower power levels than earlier designs. *See e.g.*, Ex. 2028 and Ex. 2029. Therefore, a POSITA would have recognized there was no reason to add Pardhan’s thermal rotary link, including Pardhan’s rotor plate 720 (with fins), to a system using Pacala’s LIDAR device. Contrary to what the Petition claims, a POSITA would have recognized that Pardhan’s thermal rotary link (with or without combination with Zhang’s heat dissipation structures) would *not* have increased the operating

life⁴ of Pacala's LIDAR device in Petitioner's combination.

115. A POSITA would understand that Pardhan's rotating heat sink would provide no clear benefits in Pacala's LIDAR system design. LIDAR systems already have a rotating optical assembly, which as explained above, requires precisely tracking the rotation of the motor so it can coordinate with the LIDAR device. Building onto that assembly with a rotating heat sink that relies on minimal clearance between rotor fins and complementary stator fins for operation would increase mechanical complexity and potential failure points. LIDAR systems typically have stringent size and weight constraints; a POSITA would know that the volume of Pardhan's rotating heat sink mechanism could not be accommodated for within the compact volume of Pacala's design (compare Ex. 1006, Figs. 4, 7B and Ex. 1004, Fig. 1).

116. In short, a POSITA would understand that adding the rotating heat sink would be a major additional complication to Pacala's system without any countervailing benefit. As shown below in Pardhan's annotated Fig. 4 (below) and annotated Fig. 7 (further below – as annotated in the Petition at page 15), Pacala's rotor plate 720 adds substantial weight far from the central rotating axis.

⁴ The Institution Decision identified this as the Petition's motivation to combine Pardhan Johnson and Pacala, but the only mention I saw in the Petition regarding increasing the operating life of the LIDAR device was in terms of combining "Pardhan and Zhang into Johnson's rotor-stator structure." Petition at 53.



117. This mass distribution is far from ideal. Introducing the weight from Pardhan’s rotor plate 720 with fins under Pacala’s LIDAR would cause motor inefficiencies as well as stability issues that raise the risk of catastrophic failure to the system. In Pardhan’s design, the rotor plate 720, including fins, are made of “a metallic material with a high thermal conductivity such as aluminum or copper.”

Ex. 1006, 18:11-12. The amount of additional weight from Pardhan's plates and fins would therefore be substantial, likely increasing the total mass of the system by 50% or more and significantly increasing the moment of inertia, which increases with the square of the radius.⁵ A POSITA would understand that Pacala's LIDAR (like Pardhan's LIDAR) is used in dynamic systems. *See e.g.*, Ex. 1004. [0003] ("The present invention relates generally to the field of vehicle or robot or automated equipment safety and efficiency.") Consequently, Pardhan's placement of extra mass far from the axis of rotation would cause increased stresses on the system due to centrifugal forces and would also make gyroscopic effects from movement of the vehicle (and other external perturbations) more pronounced, further increasing the strain on the system. The system (spinning at 10 Hz or more) would be more likely to experience induced oscillations (e.g., from hitting a modal frequency), warping, and even risk potential collisions between the rotor and stator fins. These issues could lead to reduced performance, increased wear and tear, and a higher risk of catastrophic failure. For a system spinning at 10 Hz, a nudge from a gyroscopic force could easily cause the system to hit a modal frequency (i.e., the natural frequency at which the system tends to oscillate, often

⁵ The larger the moment of inertia is about a particular axis, the harder it is to make an object to rotate about that axis. The smaller the moment of inertia, the easier to make the object to rotate.

and large, violent amplitudes), causing induced oscillation or resonance.

118. Notably, Pardhan's fins also limit the placement of the rotor magnets and stator coils to a small radius which reduces torque capacity. This is problematic because a LIDAR system requires a predictable, controllable angular velocity and the amount of torque plays a large role in overcoming external perturbations such as gyroscopic forces. Further working against Pardhan's design is the friction in the air (or other fluid) between the fins that must be overcome. At 10 Hz or more, the friction caused by these fins (and Pardhan teaches some fluid is necessary for heat to flow from the rotor fins to the stator fins) would be substantial. The motor would need to push through this additional resistance.

119. Further, the fluid between the fins 726 of the rotor plate and the fins 724 of the stator would cause attractive forces such as observed in the Vortex Regenerative Air Movement (VRAM)⁶ that draw the plates closer to each other and significantly increase the risk of interference, oscillations, and damage.⁷

⁶ See U.S. Patent No. 6,960,063. VRAM can also stand for Vortex Regenerative Aqueous Movement when used in incompressible fluids.

⁷ Pardhan teaches alternative use of a "liquid coolant" that is more conductive than atmospheric air such as, for example, a mixture of water and ethylene glycol. Ex.

120. Ultimately, a POSITA would have expected the resulting stress from these problems would *reduce* the operating life of the LIDAR system.

121. Furthermore, the complexity of the proposed design will make it more challenging to manufacture, assemble, and maintain. The intricate arrangement of fins and the tight clearances between the rotor and stator will require stricter tolerances and more precise fabrication methods. This will likely increase production costs and lead times. Moreover, the complex design will make it more difficult to access and service the internal components, increasing maintenance costs and downtime.

122. Additionally, as I discuss further below, implementing the heat dissipation structures of Zhang onto Pardhan's rotor plate would only add more stress and vibration to the system further decreasing operating life. Every window edge in Zhang will draw in and/or expel air, creating a rotary effect that causes vortices, etc. The amount of turbulence would depend on the Reynolds number of

1006, 24:6-11. This could, potentially act as a liquid bearing to prevent the fins from touching, but then the motor would need additional torque to push through the liquid medium with its increased friction, which would cause increased heat generation, and would require sealing of the rotor-stator structure as shown in Pardhan's Fig. 11, which is not in line with the grounds of the Petition.

the fluid, but increased vibration from Zhang’s heat dissipation structures would be a certainty.

123. In summary, Pardhan’s thermal rotary link provides no advantage to a system utilizing Pacala’s efficient LIDAR design. In my opinion, a POSITA would conclude that modifying Pacala’s LIDAR to include Pardhan’s thermal rotary link is unnecessary and would introduce significant complications without any benefit. Thus, the proposed combination would not be pursued by a POSITA.

3. Johnson and Pardhan do not provide the details for Pacala’s rotating structure

124. Dr. Lebby has opined that Pacala “does not detail the rotational structures of the device . . . and thus a POSITA would look to other references for implementation details.” Ex. 1003, ¶ 137. In Dr. Lebby’s opinion, “Johnson and Pardhan—both assigned to Waymo—teach these details.” *Id.*, ¶ 138. I disagree with Dr. Lebby’s logic. If a POSITA intent on utilizing the LIDAR system of Pacala were to “look to other references for implementation details,” the POSITA would not look to a reference such as Pardhan, which teaches a very large LIDAR device that differs greatly from the more compact and efficient design of Pacala. If Pardhan’s rotor plate 720 were implemented on Pacala’s LIDAR, the result would be that it would extend far outside the LIDAR housing, which would indicate to a POSITA that Pardhan does *not* teach the details of Pacala’s rotating structure nor is would it be an improvement to it.

125. Additionally, if Dr. Lebby's logic were credited, there are other references by the same inventors (Angus Pacala, Tianyue Yu, Louay Eldada) that, like Pacala, were assigned to Quanergy Systems Inc. such as U.S. Patent Publication 20160047901 (Pacala-2016) (Ex. 2006). Pacala-2016 includes effectively the same Figure 1 as Pacala. This is shown below.

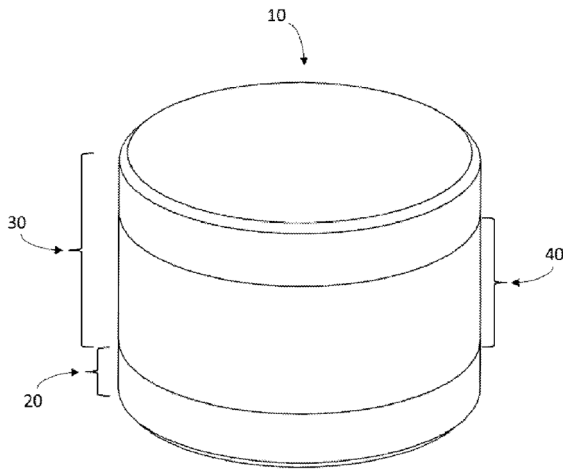


Fig. 1

Pacala (Ex. 1004)

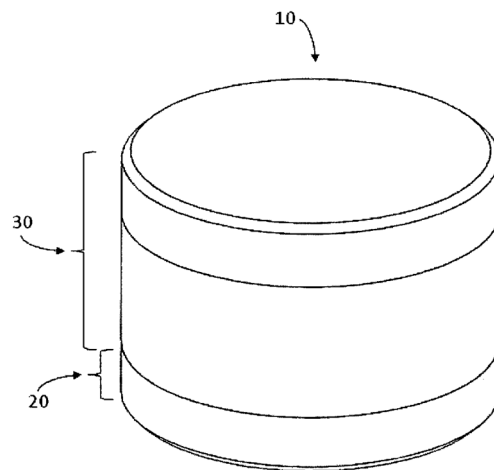


Fig. 1

Pacala-2016 (Ex. 2006)

126. Pacala-2016 provides further details regarding the rotational structures of the device. In particular, Pacala-2016 teaches “[a]s opposed to U.S. 7,969,558, the present invention does not require a support structure.” Pacala-2016, [0011]. A POSITA at the time of the invention of the ’515 Patent (whether December 2017 or December 2018) following Dr. Lebby's logic would therefore understand from Pacala-2016 that Pacala's compact design is achieved by omitting any rotating

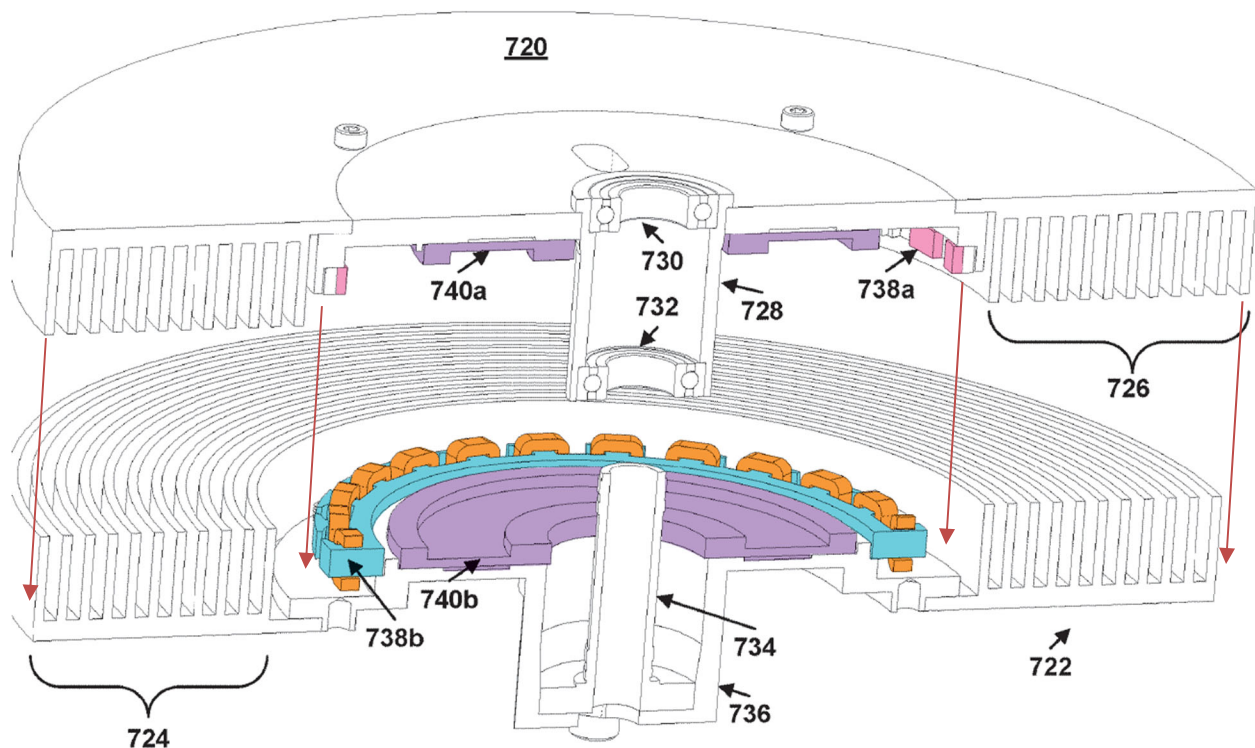
support structure as described in U.S. Patent No. 7,969,558 (*e.g.*, Ex. 1027 at claim 8) in favor of a design where the LIDAR device is built *around* a spinning turret (rather than above one) and that this would result in compact design without the many detrimental effects that flow from Pardhan’s rotating structure.

4. **A POSITA would not have replaced Pardhan’s rotor magnets, transformer coils, and motor windings with Johnson’s PCB rotor and PCB stator**

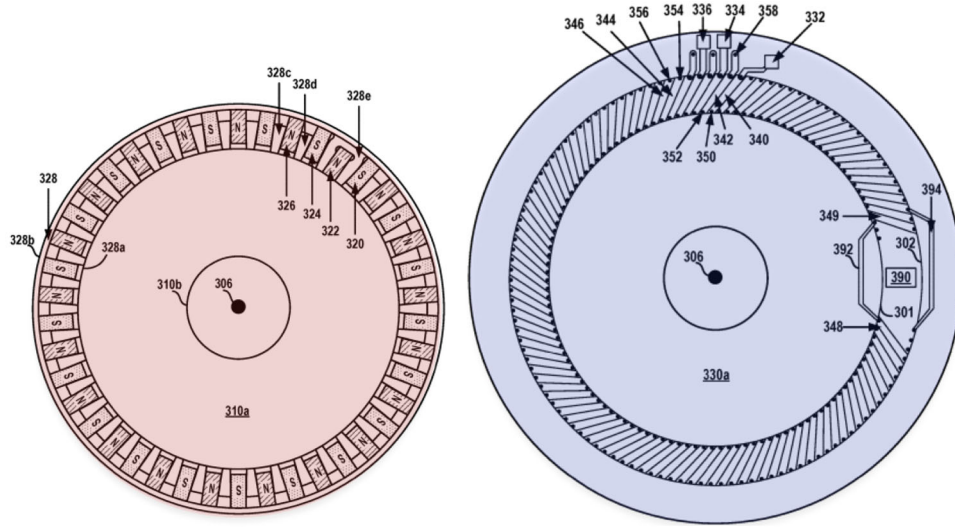
127. A POSITA would understand that Johnson and Pardhan teach stator electromagnets and rotor magnets in different configurations, but the Petition operates under the erroneous assumption that there is a single “rotor-stator structure taught by Johnson-Pardhan” collectively. *See e.g.*, Petition at 21. A POSITA, however, would have recognized that while Johnson and Pardhan have the same assignee, they are directed to entirely different systems. In my opinion, a POSITA considering these two designs would not have been motivated to replace Pardhan’s rotor magnets, transformer coils, and motor windings with Johnson’s PCB rotor and PCB stator as the Petition contends.

128. Dr. Lebby incorrectly believes that replacing Pardhan’s rotor magnets 738a and motor windings 738b with Johnson’s PCB rotor and PCB stator would be a simple substitution. Ex. 1003, ¶ 173. Not so. A POSITA would have recognized that, as shown below, Pardhan’s design is a radial flux motor that—when assembled per the red arrows—positions the rotor magnets 738a (pink) laterally

from slotted motor windings 738b (gold) containing ferromagnetic cores (blue) to produce strong magnetic flux density in the air gap between the cores of the motor windings 738b and the adjacent magnets 738a rotating outwards from those motor windings. Ex. 1031 at 90-91.



129. In contrast, Johnson utilizes an axial-flux design where the rotor magnets are spaced axially above the toroidal coil windings of its PCB stator. As shown in Johnson's Fig. 3B and 3C below, Johnson's rotor PCB is positioned on top of its stator PCB so that the rotor magnets and stator coil windings are on opposing faces.



130. Johnson's toroidal coil windings and ring-shaped core would not produce as strong a magnetic flux density into the air gap between the stator and the rotor magnets without also producing strong magnetic flux in a large volume around the stator generally. This difference is crucial because Pardhan surrounds its rotor magnets and stator coils with metallic plates of high thermal and electrical conductivity, susceptible to eddy currents from moving magnetic fields. Ex. 2005, 95:13-96:10; Ex. 1005 at 17:41-43, 18:10-12. A POSITA would have expected placing Johnson's PCB rotor and PCB stator within Pardhan's rotary thermal link could generate significant waste heat due to the eddy currents induced in the metal plates of the thermal link itself. In essence, Pardhan's heat sink would be converted into a heat *source* if combined with Johnson's PCB rotor and PCB stator.

131. Far from the simple substitution it was made out to be, Dr. Lebby's

proposed combination of Johnson and Pardhan would be a complete redesign of Pardhan's electric motor that a POSITA would not take lightly because of the likely need for cascading changes throughout the design. Ex. 1031 at 105-107. In my experience, designing a motor is not easy, and making modifications to one is even less easy. However, apparently due to his mistaken belief that Pardhan's Figure 7B teaches an "axial flux motor" simply because the rotor plate is above the stator plate (Ex. 2005, 83:4-84:4), Dr. Lebby failed to consider any of the complications a POSITA would have needed to address before contemplating such a redesign of Pardhan's motor. This would include, for example, the need for determining the mechanical, electric, and electromagnetic power losses (e.g., due to eddy currents), performing a thermal analysis (e.g., with a computational fluid dynamics (CFD) analysis), conducting a new torsional analysis, and so on. *See* Ex. 1031 at 105-107.

132. Additionally, as explained above, because Johnson's motor was intended for a compact design, and Pardhan adds substantial mass extending outwards from the central axis of the motor, a POSITA would have expected difficulties in generating sufficient torque from Johnson's PCB motor to function within Pardhan's design in the first place.

133. As explained in Section VII.A.2 above, all of these considerations would be complicated by Pardhan's unusual decision to utilize a rotating heat sink

with interleaved fins in a system for a bucket-sized LIDAR meant to be “mounted to a vehicle” (Ex. 1006, 20:1-11) thus introducing additional concerns relating to fluid dynamics, gyroscopic forces, etc. None of these issues were addressed in the Petition or by Dr. Lebbby.

134. Because of the complexity involved, a POSITA would have been reluctant to use Pardhan’s design standing alone. In my opinion, a POSITA would have recognized that Pardhan’s design was ill-advised. And even if a POSITA had mistakenly assumed Pardhan’s design was viable because it was disclosed in a patent, a POSITA would have needed a *very* strong incentive to make *any* tweaks to that unusual design, but the Petition does not identify any suitable incentive for the changes it proposes.

135. Additionally, the Petition mistakenly assumes Johnson’s design offers “simplified electrical connections” and “reduced electronic noise” without any support. *See* Petition at 31. In my opinion, this is not correct. Johnson itself explains that its design carries significant drawbacks. Johnson explains that its design results in “interference from the stator-platform magnetic field of the coil windings” that affect any other electronic components in the vicinity. *See id.* at 15:1-7. Johnson explains its compact design carries significant drawbacks regarding electrical connections as well. *See e.g.*, Ex. 1005 at 3:9-24 (“[I]n some scenarios, adjacent coil windings may be unintentionally (e.g., due to a defect or a

manufacturing error, etc.) electrically coupled (e.g., shorted) at locations other than the terminals (e.g., ends) of the respective coil windings,” and “testing each coil winding separately may be technically challenging.”) A POSITA would understand that a PCB motor introduces risks of ground loops, unintentional capacitance, and inductive problems, which can severely impact the motor's performance and reliability. These issues can lead to sudden failures, damage to expensive components, and increased maintenance costs. Moreover, the sensitivity to perturbations in a PCB design can make the motor more vulnerable to external factors, such as electromagnetic interference or power supply fluctuations. This can result in inconsistent performance and reduced overall system reliability. Finally, the rotating platelike structures can tend to flex when subjected to gyroscopic forces, causing them to physically interfere with each other, short circuit the stator and cause a catastrophic failure of the motor. Maintaining the separate rotor and stator components in Pardhan’s configuration also allows for better heat dissipation and easier maintenance.

136. Taken all together, in my opinion, a POSITA would not have been motivated to modify Pardhan to incorporate Johnson’s PCB rotor and PCB stator as the Petition contends.

5. Petitioner’s proposed combination does not disclose or render obvious the required “stator assembly . . . coupled to the stator circuit board”

137. Claim elements 1(g) and 14(h) of the ’515 Patent each require “a stator assembly *coupled to* the stator circuit board.” In my opinion, this means the “stator assembly” and the stator circuit board” must be separate components.

138. The Petition relies on Johnson as disclosing claim elements 1(g) and 14(h) as well as the “stator circuit board” of claim elements 1(d) and 14(d). Pet. at 21-23, 31-33, 36-37. More specifically, the Petition maps the “stator circuit board” element to Johnson’s “stator platform 330,” which it states can be “implemented as ‘a multi-layer circuit board (e.g., PCB) or may comprise a multi-layer PCB” such that Johnson’s “Figures 3C-3D illustrate two layers of a stator circuit board.” Pet. at 21-22. Next, the Petition maps the “stator assembly comprising a plurality of stator elements arranged annularly about the axis of rotation” to “electrically conductive” subcomponents of Johnson’s stator circuit board. See Pet. at 32 (mapping the stator assembly to conductive structures integrated into Johnson’s stator circuit board) (citing Ex. 1005, Figs. 3C-3D, 11:66-12:13, 3:40-64). Johnson’s relied upon disclosure explains “platform 330 can be physically implemented as a multi-layer PCB” where “one or more components shown in FIG. 3C may correspond to electrically conductive material(s) (e.g., tracks, traces, copper, etc.) patterned along a first layer of the PCB, and one or more components

shown in FIG. 3D may correspond to electrically conductive material(s) patterned along a second layer of the PCB.” Ex. 1005, Figs. 3C-3D, 11:66-12:13; *see also id.* at 3:40-64 (“...the coil windings can be formed in a multi-layer circuit board (e.g., printed circuit board (PCB))...”).

139. A POSITA would understand that Johnson’s multi-layer PCB implemented as platform 330 is a single component that includes the conductive material patterned into it. Because Johnson’s platform 330 /multi-layer PCB is mapped to the “stator circuit board” and the alleged “stator assembly” is simply “one or more components ... patterned along a first layer of the PCB” and “one or more components ... patterned along a second layer of the PCB” (as well as vias), the Petition has mapped the “stator assembly” limitation to a subcomponent of the “stator circuit board” rather than a distinct structure that is “coupled to” the “stator circuit board” as described and claimed in the ’515 Patent.

140. The Petition does not give any effect to the “coupled to” language of the claim. It is also not consistent with the ’515 Patent’s specification, which only discloses embodiments where the “plurality of stator elements” forming the “stator assembly” are separate structures coupled to the stator circuit board, not part of the stator circuit board itself. Ex. 1001 at 30:15-35, Fig. 6D.

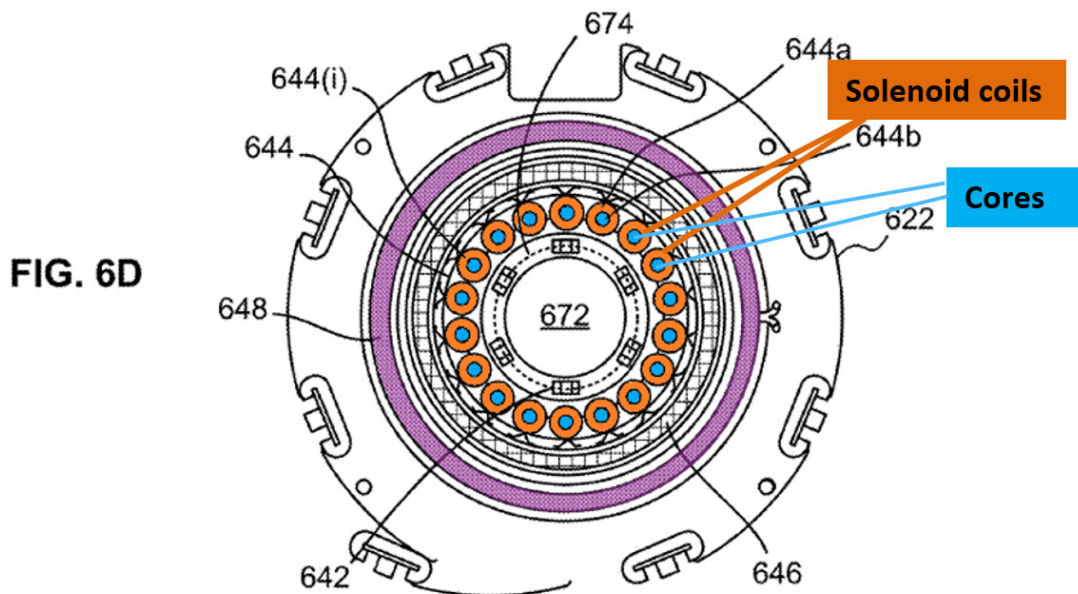
141. The Petition points to Johnson’s disclosures that “magnetic sensor 390” is “mounted to” side 300a of platform 330 (Ex. 1005, 15:34-42) as evidence

that the “stator elements” are “‘coupled to’ the circuit board under any proposed construction.” Pet. 32 (citing Ex. 1005, 15:34-42). The Petition also points to Johnson’s similar disclosure regarding the mounting of communications interface 236, power interface 238, and magnetic field sensor 290 to a PCB. *Id.* (citing Ex. 1005, 8:62-68). A POSITA would recognize, however, that the devices Johnson describes as “mounted to” the PCB are not the claimed “stator elements including a coil” that form the “stator assembly.” Because Johnson discloses those other devices are “mounted to” the printed circuit board and does *not* describe any of the conductive structures forming the toroidal coil windings as being “mounted to” the printed circuit board, this further confirms Johnson’s coils form part of platform 330 (i.e., they are “components” of the printed circuit board) and are not “coupled to” it. Unlike mounted components that can be removed from the printed circuit board they are coupled to, Johnson’s conductive structures that Dr. Lebby points to as the plurality of stator elements are subcomponents of the printed circuit board that cannot be removed without destroying the printed circuit board itself.

6. **Petitioner’s proposed combination does not disclose or render obvious “. . . each of the plurality of stator elements including a coil wound around a magnetic core”**

142. The ’515 Patent teaches and claims “an annular arrangement of multiple stator elements 644(i)” where “[e]ach stator element 644(i) can include a solenoid coil 644*a* wound around a core 644*b* of magnetic material.” *Id.* at 30:15-

26. “The coils are oriented such that the magnetic field exiting the solenoid is substantially oriented in a direction that is substantially perpendicular to the plane of the circuit board.” *Id.* at 30:26-29. Fig. 6D of the ’515 Patent (reproduced below) shows, as an example, eighteen (18) individual stator elements 644(i), each including a coil wound around a magnetic core (*i.e.*, 18 coils wound around 18 separate cores). *Id.* at 30:30-35.



143. Consistent with the ’515 Patent’s written description, claim element 1(g) recites “a plurality of stator elements arranged annularly about the axis of rotation, each of the plurality of stator elements including a coil wound around a magnetic core.” *See* Ex. 1001 at 30:15-35. The plain language of claim element 1(g) thus requires multiple magnetic cores (*i.e.*, one for each of the multiple coils).

144. The Petition, however, relies on Johnson’s embodiment where a

single “‘ring shaped’ core may be disposed in the middle layer of platform 330 ‘between the conductive structures of Figs. 3C and 3D’” as meeting element 1(g). Petition at 37. In my opinion, Johnson’s disclosure of a plurality of coil windings wound around a single, ring-shaped core shared by all coil windings does not teach or suggest a plurality of stator elements *each* including a coil wound around a magnetic core. *See* Ex. 1001 at 30:15-35.

145. In the claimed configuration a POSITA would understand that each stator has its own magnetic core, which permits the creation of distinct magnetic poles in the stator that better enable flux coupling with the magnets in the rotor to enable generation of rotating magnetic fields that interact with the rotor magnets to produce torque.

146. In the Petition’s relied-upon configuration of Johnson, the intended effect of the single ring-shaped core shared by all of Johnson’s toroidal coil windings is unclear as it is not explained by Johnson, Dr. Lebby, or the Petition. What is clear, however, is that would function very differently from claimed configuration of the ’515 Patent.

7. Petitioner’s proposed combination does not disclose or render obvious the required “plurality of arms extending away from the sleeve”

147. The Petition identifies Pardhan’s “hollow shaft 728” as the claimed sleeve. Petition at 24-25. Dr. Lebby admits that Pardhan’s alleged support

component “does not include arms extending away from the sleeve.” Ex. 2005, 71:2-7. The Petition asserts a POSITA would have combined Pardhan’s shaft 728 with “Zhang’s arms on the upper surface of the support component.” Petition at 27.

148. Zhang, however, does not teach or suggest a plurality of arms extending away from a sleeve. Indeed, a POSITA would understand that Zhang has no teachings relating to arms whatsoever. *See generally* Ex. 1007.

149. The Petition nevertheless claims Zhang teaches arms based on (i) the Petition’s selective coloring of Zhang’s Fig. 1 to make it *appear* as though arms are present and (ii) a truncated quote from Zhang’s page 6 (*i.e.*, page 9 of Ex. 1007) regarding heat dissipation structures. *See* Pet. at 27; *see also* Ex. 2005, 78:3-23. I understand that the Institution Decision found that “[f]rom Zhang’s Figure 1, the alleged arms appear thicker, and thus stronger, than the areas defining the heat dissipation structures.” Paper 13 at 36. I disagree with this assessment. A POSITA would not expect any alleged “arms” that purportedly emerge from viewing Zhang’s Fig. 1 to “strengthen attachment” or “minimize vibration” as the Petition contends.

150. The source the Petition relies upon as teaching that adding arms would minimize vibration teaches a number of methodologies for preventing bearing axial movement but none of those solutions include arms extending away from a sleeve. Ex. 1031, 364-366. It discloses that the “most common way” to

prevent bearing axial movement is “to use shaft shoulders and retaining rings, which are inserted in machined grooves on the motor shaft to position the bearings precisely.” Ex. 1031, 364. It further explains “proper fits of the bearing inner ring on the shaft and the outer ring in the bearing bore of the endbell/housing also help hold the bearings in their positions against axial movement.” *Id.* at 365. An “end play control system include[ing] a thrust collar, retaining ring, and washers” is also proposed. *Id.* None of these solutions include arms. Finally, as “an alternative approach” a “single platelike bearing holder ... made from a single metal plate” is proposed. This platelike device has “fingers” and a plurality of “butt straps” neither of which are a “plurality of arms extending away from [a] sleeve” as claimed in the ’515 Patent. Moreover, the platelike bearing holder with butt straps, fingers and bottom hooks is very much a membrane which would not prevent vibration, it would easily be subjected to or even cause vibration in the axial direction and wave-like action as well as pivotal vibration.

151. Even assuming, for argument’s sake, the general proposition that arms *could* “strengthen attachment” or “minimize vibration” in some situations, Zhang’s alleged arms are formed through “thinning of the end face of [the] rotor” (Ex. 1007, 9), so they would not be “thicker, and thus stronger” than Pardhan’s rotor plate was *before* implementation of Zhang’s heat dissipation structures; Pardhan’s rotor plate would be *thinner* and thus weaker after the heat dissipation structures

are added. Moreover, the POSITA would also recognize these alleged arms would only be about 1mm thick and thus would not have expected *any* benefits in terms of attachment strength or minimizing vibration from such alleged arms as is evident from Zhang's Fig. 1 (below). If anything these thin arms would induce flutter and vibrations like a flapping membrane introducing instability to the rotor's dynamics and potentially leading to unwanted oscillations and structural fatigue over time.

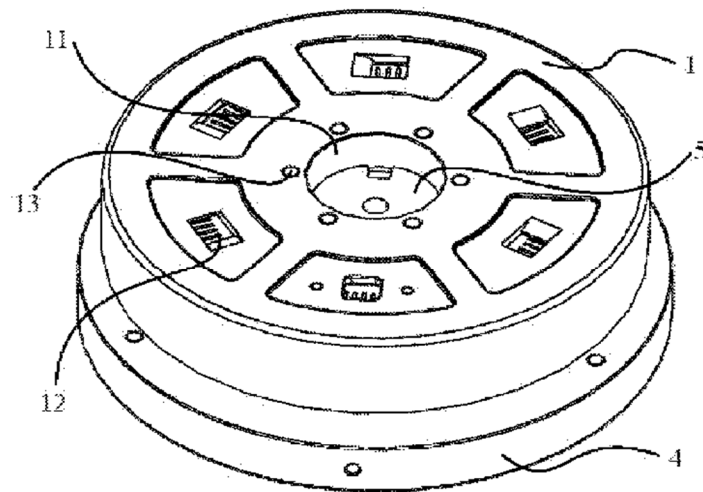


Fig. 1

152. A POSITA would expect that implementing the heat dissipation structures of Zhang onto Pardhan's rotor plate would add more stress and vibration to the system further decreasing the operating life. Every window edge from Zhang will draw in and/or expel air, creating a rotary effect that causes vortices, etc. The amount of turbulence would depend on the Reynolds number of the fluid, but

increased vibration from Zhang's heat dissipation structures would be a certainty. Essentially, the airflow through the heat dissipation structures would create a low-pressure area under the rotor (i.e., a vacuum) from the system would recover before reforming the low-pressure area. The additional vibration induced within Pardhan's thermal rotary link would cause problems for Pacala's LIDAR and potentially catastrophic failure for the rotating system. A POSITA would not expect the proposed combination of Ground 1 to tolerate the vibrations caused by implementing Zhang's heat dissipation structures and would not have been motivated to implement Zhang's heat dissipation structures for any structural reinforcement.

153. Further, the full teaching from Zhang relied on by the Petition explains that "...where at least one hollowed-out heat dissipation hole (12) is configured on the end face of the rotor (1), the heat generated during the operation of the rotating structure inside it can be released in time, increasing the operating life of the rotating structure." Ex. 1007 at 9.

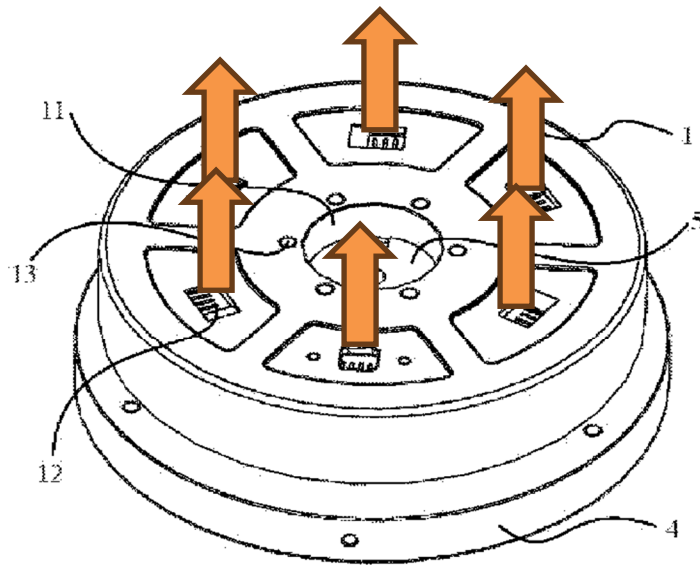
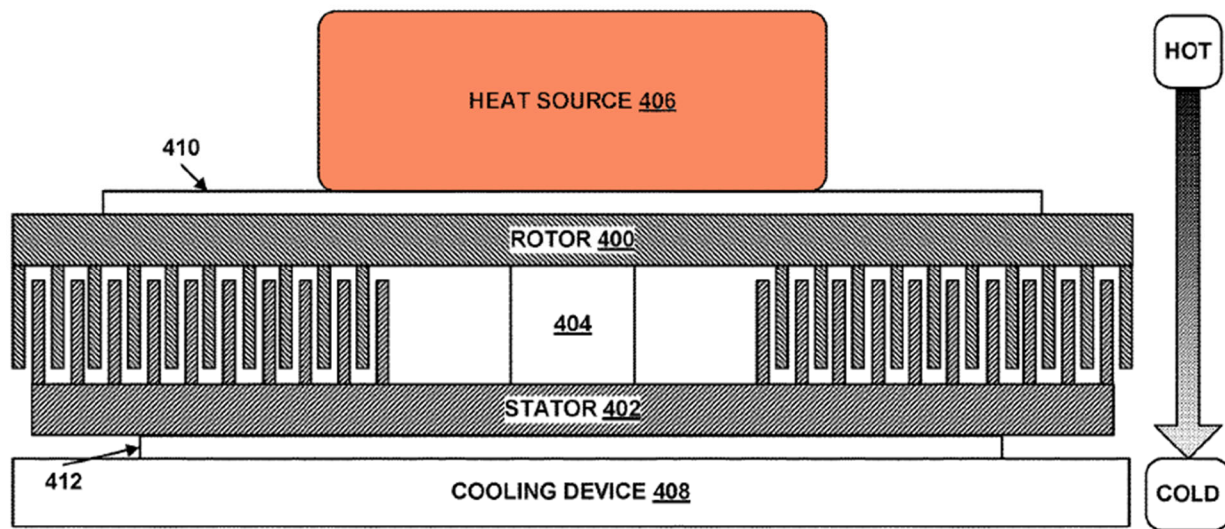


Fig. 1

154. As depicted above with orange arrows, Zhang’s heat dissipation structures are provided so heat produced *inside* the rotating structure (i.e., beneath and within the rotor / outer casing) “can be released” upwards thus “increasing the operating life of the rotating structure.” Ex. 1007 at 9.

155. Pardhan, in contrast, teaches using the rotor and stator as a heat sink to pull heat produced by the LIDAR from *outside* the rotor and stator *down* as expressly diagrammed in Pardhan’s Figure 4 (reproduced below). *See e.g.*, Ex. 1006 at Fig. 4.



156. The Petition’s proposed combination allegedly “transfers excess heat away from the LiDAR sensor, thereby allowing the device to avoid[] overheating.” Petition at 30. Zhang’s release of excess heat upwards from below the rotor towards the LIDAR would thus be counter-productive, and a POSITA would not have been motivated to implement Zhang’s heat-dissipation structures on Pardhan’s rotor plate 720. Rather, Zhang teaches away from using such structures within the Pacala, Johnson, Pardhan combination.

157. The Petition incorrectly alleged “Zhang’s heat dissipation techniques are ... complementary with and can be implemented in addition to those of Pardhan.” Pet. at 53. However, at his deposition, Dr. Lebby opined of the combination that “while there is a heat dissipation hole, some of the heat will go through the hole, but the majority of the heat will conduct through the metal,” so “while the design does allow a little bit of air, heat to escape through those

windows, 12, the majority of heat would go downwards, as indicated in Pardhan.” Ex. 2005, at 80:13-21. Even if Dr. Lebby were correct that the majority of heat would go downwards through the metal heat sink as indicated in Pardhan, and only a minority of heat would escape upwards through the heat dissipation structures 12 as indicated in Zhang, there would still be no reason to implement Zhang’s heat dissipation structures on Pardhan’s support component in the first place because it would be counter-productive to Pardhan’s design.

158. Thus, in my opinion, a POSITA would *not* have had any reason to implement Zhang’s heat dissipation structures on Pardhan’s rotor plate.

159. Additionally, in my opinion, Dr. Lebby has not shown that a POSITA would have a reasonable expectation of success in implementing Zhang’s heat dissipation structures on Pardhan’s rotor plate in his proposed combination. As explained above, a POSITA modifying Pardhan with a substantial change, such as implementing the turbulence inducing heat dissipation structures from Zhang to Pardhan’s rotor plate, would have recognized the need for determining the mechanical, electric, and electromagnetic power losses (e.g., due to eddy currents), performing a thermal analysis (e.g., with a computational fluid dynamics (CFD) analysis), conducting a new torsional analysis, and so on. *See* Ex. 1031 at 105-107. Dr. Lebby made no effort to perform any of this analysis.

8. Petitioner's proposed combination does not disclose or render obvious the four required circuit boards

160. Claim 4 recites “The light ranging system of claim 1 further comprising: a third circuit board fixedly coupled to the base and arranged in a plane parallel with the first plane and disposed between the enclosure base and the stator circuit board; and a fourth circuit board coupled to rotate with the rotor circuit board between the enclosure top and the rotor circuit board and arranged in a plane parallel with the first plane.”

161. Dr. Lebby incorrectly opines Johnson teaches four circuit boards as recited in claim 4. As I explain below, Johnson teaches two circuit boards, a rotor PCB and a stator PCB; Johnson neither teaches nor suggests two additional circuit boards nor adding two additional circuit boards.

Johnson's stator PCB is one multi-layer PCB.

162. Multi-layer PCBs were an established technology by the 2000s. It was known that a printed circuit board (PCB) can have multiple layers of conductive traces and components mounted on both sides. This is known as a double-sided or multi-layer PCB design. Even though components are populated on both the top and bottom surfaces, it is still a single integrated circuit board with conductive layers sandwiched in between. Specifically, the different layers are laminated - fabricated together as one cohesive [integrated] unit, with plated, conductive through-holes or vias providing the electrical connections between the layers. So

while the components may be physically mounted on two sides, the entire assembly functions as one unified PCB from an electrical and mechanical standpoint.

163. In my opinion, separating the individual layers of a multi-layer PCB such that each layer is mechanically and electrically isolated is generally not practical. A multi-layer PCB is designed and fabricated as an integrated unit. Restating the above, the multilayer PCB has conductive layers sandwiched with insulating substrates precisely stacked and interconnected through plated through-holes or vias. The very purpose of a multi-layer PCB is to integrate multiple conductive layers into a single compact board through the lamination and via interconnection process. Attempting to separate the layers (physically or functionally) would likely destroy the board's intended operation. Further, the means of deconstructing PCBs (e.g. sanding, chemical etching, delamination) are destructive and would likely ruin any mounted component.

164. As the multi-layer PCB is intended to operate as a single mechanical and single electrical component, and isolating a layer is physically implausible and contrary to the intended use of the component, I believe that a POSITA would understand each multi-layer PCB to be one PCB.

165. Johnson teaches that the stator circuit board is a multi-layer PCB. As a multi-layer PCB is comprised of multiple layers mechanically and electrically

integrated into one component, the bottom and top layers are not separable into two distinct circuit boards. Thus, a POSITA would not consider Petitioner's combination of Johnson with Pacala to teach any "third circuit board" since the plain language of the claim requires a "circuit board" not circuit board layer.

Johnson's rotor PCB is one single-layer PCB.

166. While discussing Figure 3A, Johnson teaches the positioning and distance of the rotor platform 310 and stator platform 330. Ex. 1005, 10:48-62 ("FIG. 3A illustrates a side view of a device 300 that includes ... a rotor platform 310 and a stator platform 330 ...[where] a side 310a of platform 310 is positioned at a given distance 308 to a side 330a of platform 330....side 310a may correspond to a planar mounting surface of platform 310 (e.g., an outer layer of a circuit board)."). Since the planar mounting surface of platform 310 is an 'outer layer of a circuit board', that means the platform 310 is a circuit board because a surface equates to an "outer layer." This does not imply an "inner" layer to Johnson's rotor circuit board.

167. Nowhere in Johnson discloses an "inner" layer of the circuit board mounted to the rotor platform on which electronics may be mounted. Johnson also does not disclose a need for such an additional layer or additional electronics. However, Johnson does discuss inner layers with respect to the stator platform 330 and multi-layer in conjunction with the stator platform being implemented as a

multi-layer PCB. Ex. 1005 12:1-17. This would indicate to a POSITA that the rotor PCB is a single-layer PCB where the single-layer forms the rotor surface that faces the stator.

168. Thus, Petitioner's combination of Johnson with Pacala also does not teach the recited "fourth circuit board."

Multiple single-layer PCBs cannot form Johnson's stator PCB.

169. A POSITA would understand that a multi-layer PCB has specific uses as well as mechanical and electrical properties that depend on the materials in the layers, the positioning of these layers, holes within or between the layers, etc. According to Dr. Lebby's Exhibit 1040, YMS states single layer boards are for simple devices and multi-layer PCBs are used for "complex devices that have many connections." Ex. 1040 at 1. I agree and believe a POSITA would have the same understanding. Microwaves may use a single-layer PCB, but smart phones, tablets and automotive devices typically use multi-layer PCBs. Ex. 1040 at 3 ("The automotive and aerospace industries are using electronic components that are durable and lightweight and the multi-layer PCB is perfect for it. These parts have to withstand with wear, heat and other conditions as it is used in on board conditions, GPS systems, engine sensors, headlight switches.").

170. For more complex devices that require a higher number of components and connections, a single layer does not provide enough space, speed,

or power. Increasing the size or number of PCBs also increases the product's weight and bulk. *See, e.g.* 1040 at 2 (“The final product will be heavier if it has more boards.”). Adding layers may require additional design effort regarding, for example, EM interference shielding. Further, multi-layer PCBs have increased operating capacity and the ability to run at higher speeds than a single layer PCB, even single-layer PCB with increased dimensions, because of the increased circuit density. *See, e.g.* 1040 at 2 (“Single-layer PCBs are used in devices has only one function only and don’t have to store more data or access the internet but this is for all applications.”).

171. A single-layer PCB, especially a larger one, is not ideal for a component moving in a dynamic system like a rotating LIDAR device as the single-layer PCB may buckle and/or tear under the associated forces. The additional layers of a multi-layer PCB increase the thickness of the PCB and hence the durability allowing the multi-layer PCB to withstand higher loads while also allowing the multi-layer PCB to last longer than the single-layer PCB when placed under similar loads. *See e.g.,* Ex. 1040 at 3.

172. Additionally, multi-layer PCBs’ stacked arrangement allows for smaller size and weight for the same functionality as a single PCB. Ex. 1040 at 2. Further, there is a single connection point for a multi-layer PCB, not multiple connection points (e.g., cable connector and socket) as would be necessary with

multiple boards. Multiple connection points increase the amount of wiring in the device.

173. As a general matter, modifying a multi-layer PCB to multiple single layer PCBs is not a simple substitution, rather it would require consideration of numerous factors (e.g. how to separate the functionalities of the multi-layer PCB; location, size, and orientation of each single-layer board; connectivity – while ensuring wires do not cross; overall increased device weight, redistribution of device weight, increased PCB dimensions/size, how to handle decreased power; how to handle decreased capacity; how to power each PCB, how to cool each PCB; how to handle heat dissipation - due to at least the new configurations and additional connections, etc.). A POSITA would understand that materials, mechanical, thermo-mechanical, and electrical overhauls would be required – not a “simple substitution” as Petitioner suggests. Petition at 42.

174. Importantly, Petitioner asserts that coil windings in different layers of a multi-layer circuit board (depicted in Johnson’s FIGS. 3C and 3D) satisfy element 1(g) which limits the stator assembly’s arrangement of stator elements to annularly about the axis of rotation, while also defining what a stator element is. Petition at 31-33; 36-37; Ex. 1005 at 12:11-17 (“To that end, one or more components shown in FIG. 3C may correspond to electrically conductive material(s) (e.g., tracks, traces, copper, etc.) patterned along a first layer of the

PCB, and one or more components shown in FIG. 3D may correspond to electrically conductive material(s) patterned along a second layer of the PCB. Other implementations are possible as well.”). A POSITA would not have had a reasonable expectation of success in distributing Johnson’s stator PCB amongst multiple distinct circuit boards and would not have been motivated to attempt this modification. Johnson’s stator PCB design, which utilizes multiple interconnected layers of conductive material *requires* a multi-layer PCB. Any attempt to place the conductive layers Dr. Lebby has identified as the claimed stator elements into separate circuit boards would fail and not meet limitation 1(g) of the ’515 patent.

175. Dr. Lebby opines that “[m]odifying Johnson to use separate circuit boards would have amounted to simple substitution of one known element (a mutli-layer PCB) for another (separate PCBs) to obtain predictable results (electronics mounted on separate circuit boards).” Ex. 1003, ¶ 222. This carries forward his previously discussed mistake that Johnson teaches mounting stator elements onto Johnson’s stator circuit board when, as discussed above, Johnson clearly teaches the toroidal coils are subcomponents within multiple layers of Johnson’s circuit board. There is no disclosure in Johnson that suggests otherwise. Dr. Lebby’s opinion is mistaken and entirely unsupported.

No fourth circuit board parallel to the stator circuit board.

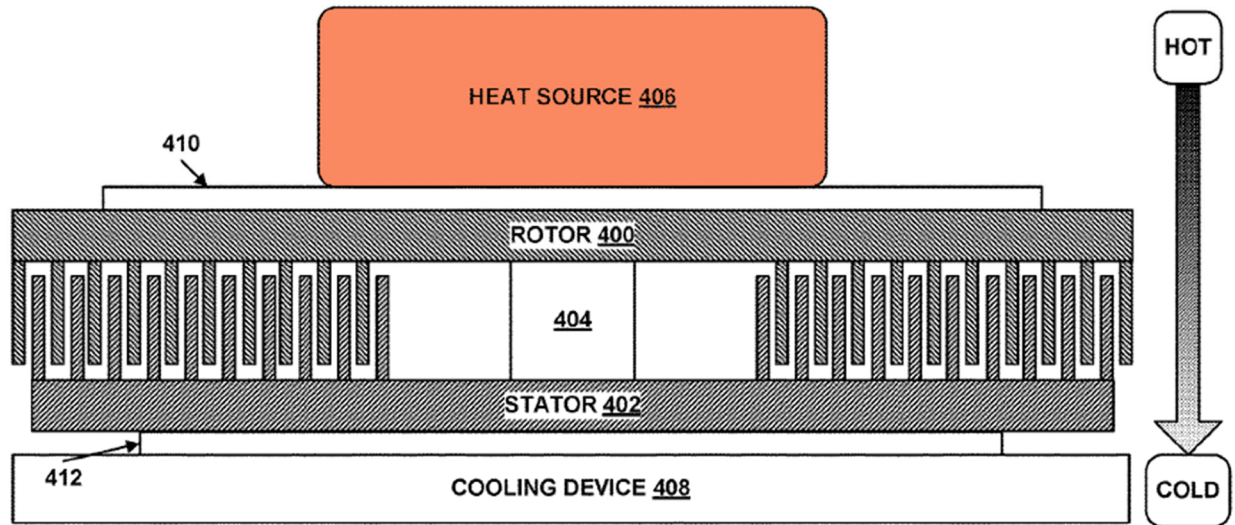
176. Claim 4 requires a “first plane perpendicular to the axis of rotation”

along which the stator circuit board is disposed (element 1(d)) as well as a “fourth circuit board coupled to rotate with the rotor circuit board between the enclosure top and the rotor circuit board and arranged in a plane parallel with the first plane.”

177. Dr. Lebby points to Nubling as evidence that a POSITA would be motivated to use a fourth circuit board above the rotor circuit board. Ex. 1003, ¶ 223. However, while Nubling teaches a potential additional circuit board 50 above the rotor, it is oriented along the axis of rotation and is *not parallel* to the stator. *See, e.g.*, Ex. 1043 at 5:50-52; 5:57-67; Fig. 3. A POSITA would recognize this additional circuit board is arranged to provide mechanical support for Nubling’s optics. *See, e.g.* Ex. 1043 at 5:50-52. Another of Dr. Lebby’s references, Hall, similarly teaches additional circuit boards (121, 122, 123) above the rotor that are used to “provide mechanical support and electrical connectivity between rotating electronics board 111 and various elements of light emission/collection engine 112.[,]” and are, as in Nubling, along the axis of rotation. Ex. 1009, Fig. 2; Fig. 4, 7:3-8. Thus, in my opinion, even if a POSITA had thought a fourth circuit board was needed for the proposed combination of Pacala, Johnson, Pardhan, and Zhang—and nothing in those references suggests one would be—a POSITA would not have configured that circuit board as claimed since it would neither provide structural support nor be in close proximity to the LIDAR.

178. Moreover, Pardhan teaches placement of “coupling 410” between heat

source 406 and rotor 400 in order to “thermally and/or mechanically” couple the two components. Ex. 1006 at 16:55-56; Fig. 4.



179. Petitioner’s proposed combination for Ground 1 (*see* Petition at 44 annotating Fig. 2 of Pacala to show placement of fourth circuit board) incorrectly assumes all LIDAR units overheat and then uses that as a pretext for adding Pardhan’s heat sink. Under that theory, a POSITA would have no reason to place the fourth circuit board directly between the Heat Source 406 (the LIDAR) and heat sink (Rotor 400 and stator 402). A POSITA would understand that because of basic thermo-fluid mechanics, the placement of another heat source between 406 and the heat sink would not be efficient. Specifically, the additional heat source would arrest heat flow from heat source 406 to heat sink, likely resulting in heat source 406 overheating. *See, e.g.*, Ex. 1006, 16:65-17:5, Fig. 4. A POSITA would understand that overheating may result in loss of structural integrity (due to various

coefficients of thermal expansion in the PCB), PCB de-lamination, solder joint failures, semiconductor degradation, component oxidation and corrosion, fire hazard, signal integrity problems, accelerated cyclic fatigue, etc. A POSITA utilizing Pardhan's heat sink, as the proposed combination does, would therefore not place a circuit board in that location because doing so would prevent the LIDAR device from being "maintained at a stable operating temperature," which is Pardhan's primary concern. Assuming the Petition is correct about LIDARs overheating, this combination would be likely to result in a catastrophic failure of the system due to overheating of either the LIDAR or the fourth circuit board itself.

9. **Petitioner's proposed combination does not disclose or render obvious the required first and second transformer coils "positioned outside an outer perimeter" of the plurality of stator elements and rotor assembly annular arrangement**

180. Claim 17 details "The light ranging system of claim 14 further comprising a wireless power transformer integrated directly onto the stator and rotor circuit boards, the *wireless power transformer comprising a first annular transformer coil* disposed on a surface of the stator circuit board *and a second annular transformer coil* disposed on a surface of the rotor circuit board in an opposing relationship with the first annular transformer coil, wherein the first transformer coil is concentric with and positioned outside an outer perimeter of the plurality of stator elements and the second transformer coil is concentric with and

make coils – including wire type, gauge, winding pattern, insulation, etc. – where winding design considers heat dissipation, minimizing losses, reducing noise, reducing vibrations, achieving desired torque, achieving desired speed, etc. As such, a POSITA would understand that the location of Pardhan’s windings provide the location of its stator coils. A POSITA would understand that Pardhan teaches that by placing the windings 738b on the stator rather than the rotor, less power needs to be transferred through the rotary transformer, which is advantageous because it allows for a smaller rotary transformer. Indeed, Pardhan’s Fig. 7B shows that the rotary transformer 740a/740b is inside the outer perimeter of the coil windings 738b of Pardhan’s stator and the magnets 738a of the rotor. Thus, in my opinion, Pardhan’s disclosure of stator windings and explanation that this is advantageous because it allows for a “smaller rotary transformer” teaches away from the configuration of claim 17 where larger transformer coils are placed outside the perimeter of the rotor and stator elements.

184. Consistent with Pardhan, Zhang likewise teaches that a “technical advantage” of its disclosure includes that “[t]he present utility model installs the signal transmission structure and *the electrical power transmission structure on the inner side of the shaft system.*” Ex. 1007 at 6 (emphasis added). Zhang’s Fig. 2 further shows that “first coupling coil 5” (i.e., the power transmission coil) is inside the perimeter of motor coil (2). *See also* Ex. 1007 at 4 (“The motor coil (2)

is configured on the outer side of stator body (41)"); *see also id.* at 5 ("first coupling coil (5) is cylindrical and is configured on the inner side of the stator body (41).") In my opinion, a POSITA would understand Zhang's express teaching that it is advantageous to place the transmission coils (5) on the inner side of the shaft system which is inside the perimeter of the motor coil (2) teaches away from the disclosure in claim 17.

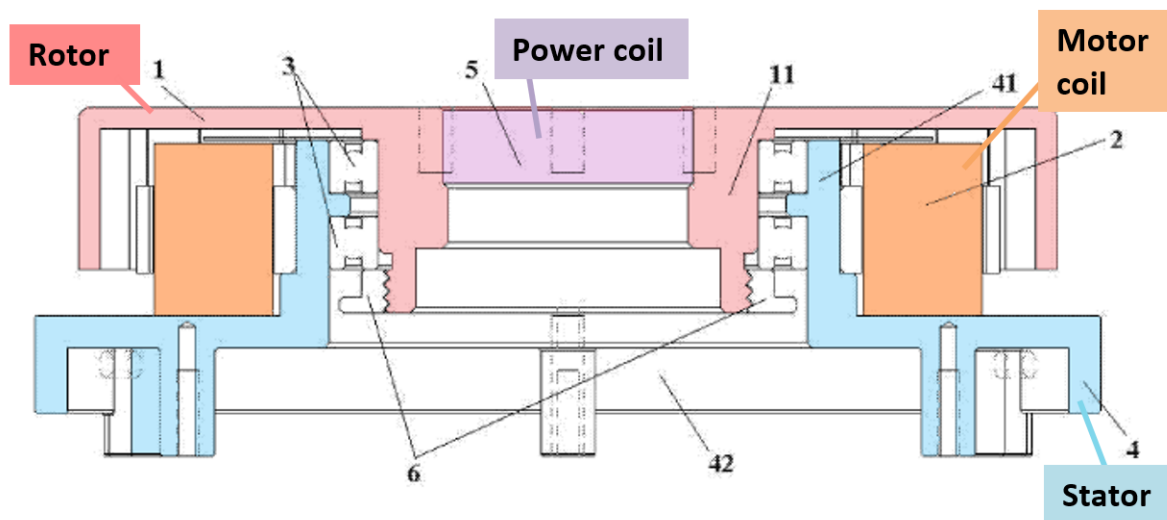
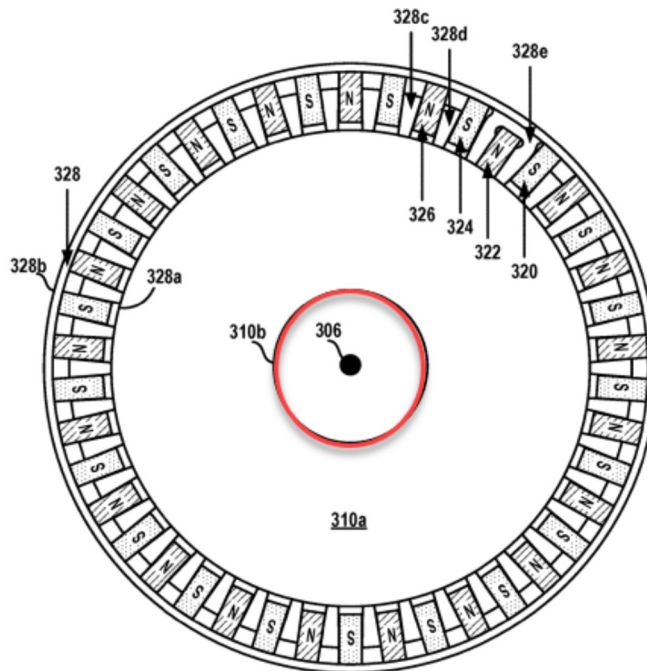


Figure 2

Ex. 1007, Fig. 2 (annotated).

185. As shown below in an annotated version of Johnson's Figure 3B from the Petition, where the transformer coil is marked with a red circle by Dr. Lebby, Johnson also discloses its transformer coils are inside the perimeter of its stator magnets. *See* Ex. 1005, 11:51-60.



186. To opine that it would be obvious to modify Johnson so that the transformer coils are outside Johnson’s rotor magnets and stator coil windings, Dr. Lebby relies on a passage in Johnson discussing Figure 2. Ex. 1003, ¶¶ 247, 254, 279. Specifically, in reference to Fig. 2, Johnson discloses that “Power interface 218 may include one or more components configured for wireless (or wired) transmission of power between platforms 210 and 230. By way of example, interface 218 may include transformer coil(s) (not shown) arranged to receive a magnetic flux extending through the transformer coils to induce an electrical current for powering one or more components (e.g., sensor 212, controller 214, communication interface 216, etc.) of platform 210. For instance, the transformer coils can be arranged around a center region of platform 210 opposite to corresponding transformer coils included in platform 230. Further, for instance,

device 200 may also include a magnetic core (not shown) extending through the transformer coils in interface 218 (and/or transformer coils included in platform 230) to guide the magnetic flux through the respective transformer coils thereby improving efficiency of power transmission between the two platforms. ***Other configurations are possible as well.***” Johnson at 11:64-12:15. This passage begins by explaining that power interface 218 may be configured for wireless or wired transmission of power, provides an example where it is configured for wireless transmission, and then reiterates other configurations are possible (e.g., a wired configuration). A POSITA would not extrapolate this excerpt, as Dr. Lebby does, to teach some alternative configuration of the transformer coils relative to the rotor elements, since the positioning of the transformer coils relative to the rotor elements is not discussed.

187. The Petition asserts that “[t]he region in the center of a circuit board has limited space, so it is logical and common to place transformer coils on the outside of the rotor/stator elements.” Petition at 50 (citing Ex. 1003, ¶ 247). While the Petition cites paragraph 247 of Dr. Lebby’s declaration for support, Dr. Lebby did not support that statement in his paragraph 247. However, in Dr. Lebby’s paragraph 254, he opined that “the permitter [sic] of the motor magnets and windings depends on the size of the motor, such that certain applications may use smaller motors with limited space in the center region for system components (e.g.,

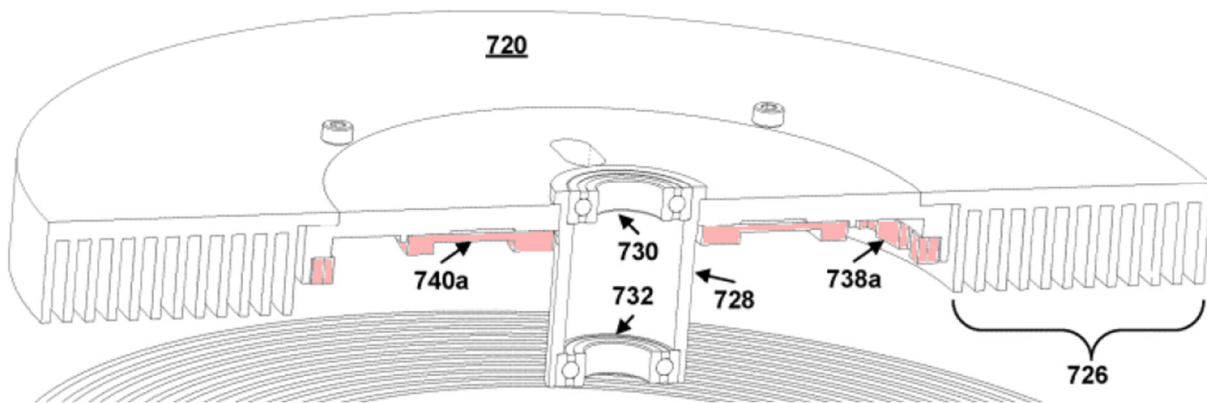
transformer coils, communication interfaces, etc.). It may also be desirable in certain applications to use larger transformer coils that do not fit in the limited center region space.” I interpret Dr. Lebby’s references to “certain applications” where it could be desirable to have larger transformer coils as an acknowledgement that larger transformer coils are not desirable in Johnson’s design, Pardhan’s design, Zhang’s design, nor the combination of Ground 1. There is no room for Johnson’s transformer coils to be positioned outside of its stator and rotor elements because those elements are specifically placed at the outermost portion of the rotor and stator platforms. A POSITA would understand that this positioning of toroidal coil windings and rotor magnets would maximize the torque produced while maintaining a compact design.

188. For example, a POSITA would understand that for compact designs, like Johnson, transformer coils would be and are positioned internally – as this internal space is available and keeps the design compact. Ex. 1005 at 11:51-60 (discussing enabling of “magnetic core . . . extending through the center gap to guide a magnetic flux” between transformer coils.). Expanding the rotor and stator platforms to include externally placed transformer coils is directly antagonistic to Johnson’s compact design.

189. In any case, given Pardhan, Zhang and Johnson’s disclosures, a POSITA would conclude that there is no space outside of the rotor magnets for the

aforementioned components because Pardhan's fins 726, purportedly used by the combination of Ground 1 "to avoid[] overheating," are located in this position.

Petition at 30; Ex. 1006, Fig. 7B (truncated and annotated).



190. In my opinion, the Petition provides no rational explanation for why a POSITA would modify Johnson's PCB rotor and PCB stator to meet claim 17 when Johnson, Pardhan, and Zhang all teach away from the claimed invention.

B. Grounds 2-5 do not render any of the dependent claims unpatentable

191. In Grounds 2-5, respectively, Dr. Lebby asserts that claims 2, 4-6, and 17 are obvious over Pacala, Johnson, Pardhan, Zhang, and Cai, that claims 5-6 are obvious over Pacala, Johnson, Pardhan, Zhang, Cai, and Hall, that claims 12 and 20 are obvious over Pacala, Johnson, Pardhan, Zhang, and Spector, and that claims 13 and 21 are obvious over Pacala, Johnson, Pardhan, Zhang, Spector, and Droz. I disagree with Dr. Lebby for the reasons provided below.

192. Having reviewed the Petition, it is my opinion that each of claims 2,

4-6, 12, 13, 20, and 21 challenged by Grounds 2-5 are patentable. The Petition does not establish any of these claims is invalid. All of these claims are dependent claims that depend from independent claims 1 and 14, which were not shown unpatentable by Ground 1 as explained above. Grounds 2-5 use the same core combination of Pacala, Johnson, Pardhan, and Zhang from Ground 1 and suffer the same fatal flaws as discussed above.

193. The following sections provide my detailed opinions regarding certain specific invalidity grounds set forth in the Petition that I was asked to consider as part of this proceeding.

1. Ground 2 fails to render obvious claim 4

194. Claim 4 recites: “The light ranging system of claim 1 further comprising: a third circuit board fixedly coupled to the base and arranged in a plane parallel with the first plane and disposed between the enclosure base and the stator circuit board; and a fourth circuit board coupled to rotate with the rotor circuit board between the enclosure top and the rotor circuit board and arranged in a plane parallel with the first plane.”

195. Ground 2 proposes the same combination of Pacala-Johnson-Pardhan-Zhang as set forth in Ground 1 further modified in view of Cai. *See* Petition at 59. The Petition asserts the combined system of Ground 1 “would then be further modified in view of Cai so that transceivers are mounted on additional ‘third’ and

‘fourth’ circuit boards above and below the rotor-stator elements so as to form a wireless communication channel through the hollow shaft.” Pet. at 59.

196. The Petition asserts Cai teaches placing two circuit boards (113/124) “above and below the motor for mounting transceivers (17).” Pet. at 61. However, Johnson already teaches that its second platform 230, “configured as a stator platform in a rotary joint configuration . . . includes a controller 234 [and] a communication interface 236” and “may comprise a circuit board” per the embodiment relied upon by the Petition. Ex. 1005 at 8:54-67. Johnson further explains that:

controller 234 can operate communication interface 236 to transmit signal 204 indicating a transmission of data or instructions similarly to, respectively, controller 214, communication interface 216, and signal 202, for example. For instance, controller 234 can operate interface 236 (e.g., transceiver, antenna, light sources, etc.) to provide a modulated wireless signal indicating instructions for operating sensor 212 and/or any other component of platform 210. Further, for instance, controller 290 can receive a modulated electrical signal from interface 236 indicating modulated signal 202 transmitted from platform 210. Communication interface 236 can be implemented similarly to interface 216 to facilitate communication between platforms 210 and 230 via signals 202 and 204.

Ex. 1004, 9:4-18. Similarly, as to its rotor PCB, Johnson teaches:

platform 210 may include a printed circuit board (PCB) that mounts

communication interface 216 and/or other components of platform 210. The PCB in this instance can also include circuitry (not shown) to electrically couple one or more of the components of platform 210 (e.g., sensor 212, controller 214, communication interface 216, power interface 218, etc.) to one another. The PCB in this instance can be positioned such that the mounted components are along a side of platform 210 facing or opposite to a corresponding side of platform 230.

Ex. 1005, 7:8-21.

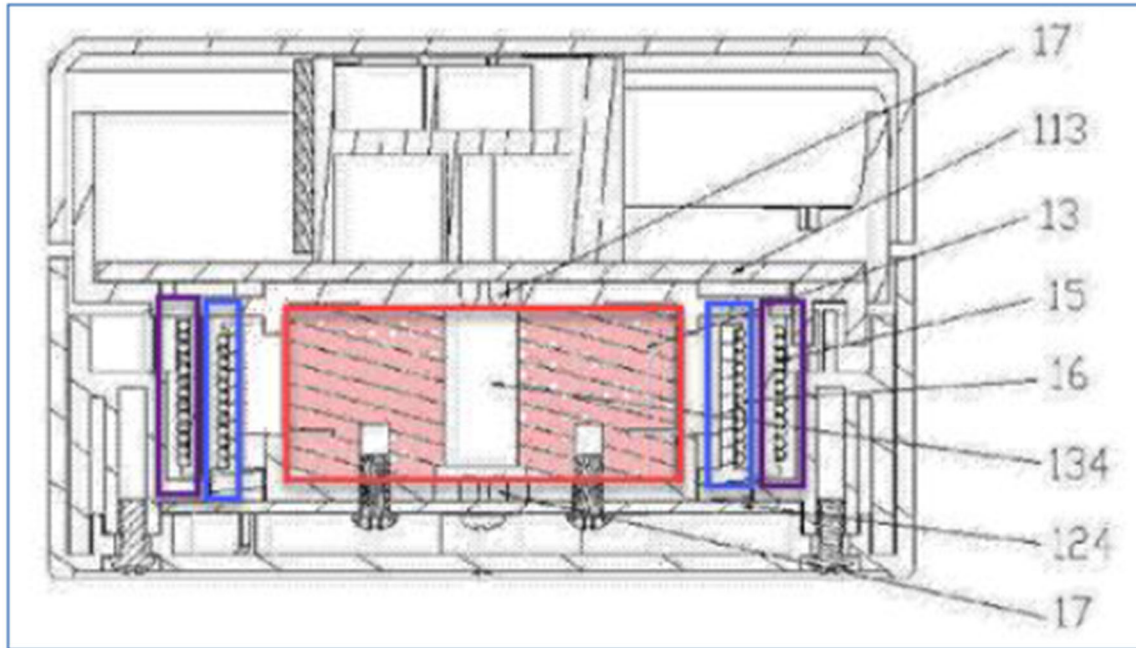
197. Accordingly, a POSITA would understand that Johnson already teaches a means for communication between the rotor circuit board and stator circuit board within its motor without any need for a redundant communication interface between two additional circuit boards outside of its motor. Tellingly, Cai only teaches two circuit boards (113/124) not four circuit boards as required by the claims. Cai's use of transceivers to form a communications interface on its only two circuit boards illustrates that only two circuit boards are needed for a communications interface. Because Johnson already places them on the circuit boards within its motor, there is no need for Cai's redundant communications interface. This is especially true because the POSITA utilizing the combination of Ground 1 was motivated to use Johnson for its compactness. Such a POSITA would not select Johnson for its compact design then unnecessarily increase the size of the system using Cai's circuit boards to provide a redundant feature.

2. Ground 2 fails to render obvious claim 17

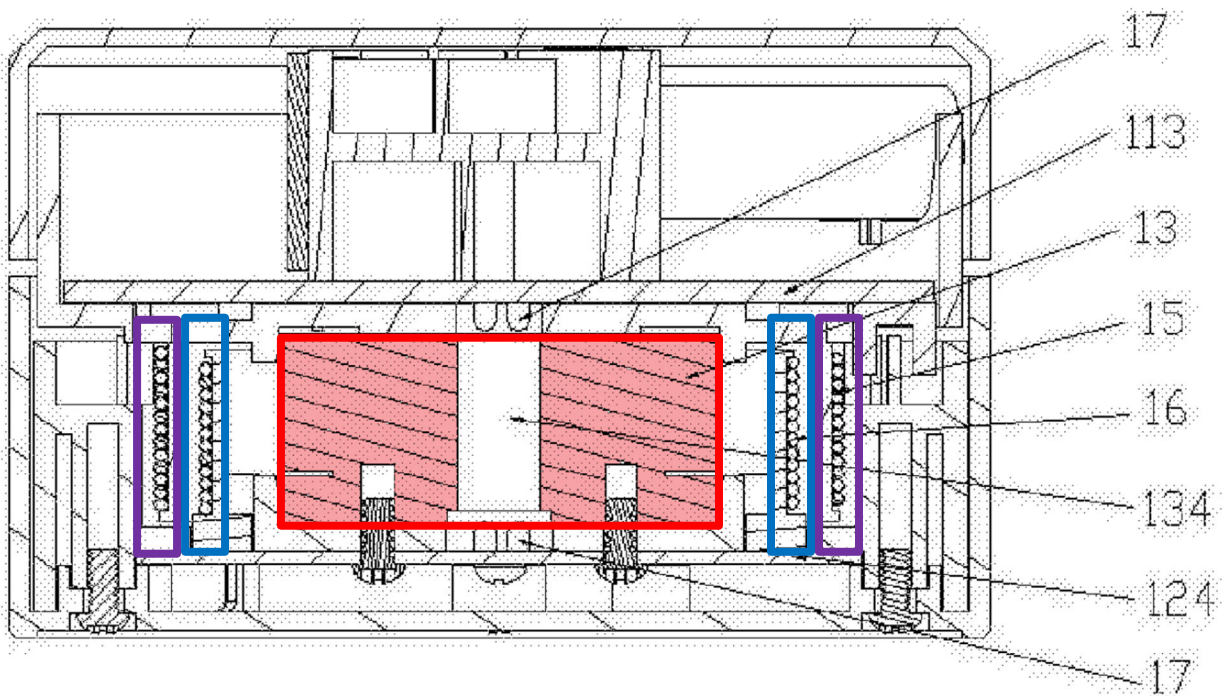
198. For Ground 2, the Petition also asserts that Cai shows transformer coils “outside an outer perimeter” of its motor.

199. Claim 17 details “The light ranging system of claim 14 further comprising a wireless power transformer integrated directly onto the stator and rotor circuit boards, the *wireless power transformer comprising a first annular transformer coil* disposed on a surface of the stator circuit board *and a second annular transformer coil* disposed on a surface of the rotor circuit board in an opposing relationship with the first annular transformer coil, wherein the first transformer coil is concentric with and positioned outside an outer perimeter of the plurality of stator elements and the second transformer coil is concentric with and *positioned outside an outer perimeter of the rotor assembly annular arrangement.*” (emphasis added).

200. The Petition explains that Cai’s “Figure 8 . . . shows the [transformer] coils (purple and blue) are outside the motor (red)” as depicted below.



Petition at 64. A slightly crisper version of Cai's Figure 8 is provided below with Petitioner's annotations recreated.



201. Nevertheless, Ground 2 utilizes the same combination of Pacala-

Johnson-Pardhan-Zhang from Ground 1. There is no room in that combination to move the transformer coils—which Johnson, Pardhan, and Zhang all teach should be in the free space inside of the rotor and stator elements—outside of those elements because that is where Pardhan’s fins are located. Accordingly, a POSITA would not have been motivated to combine Cai with the combination of Ground 1 to include Cai’s transformer coils positioned outside the motor.

202. Additionally, Claim 17, recites “a wireless power transformer ***integrated directly onto the stator and rotor circuit boards.***” It further recites “a first annular transformer coil ***disposed on a surface of the stator circuit board,***” and “a second annular transformer coil ***disposed on a surface of the rotor circuit board.***” Because Cai’s transformer coils are outside an outer perimeter of the motor (as shown in the annotated Fig. 8 of Cai above), they are necessarily outside an outer perimeter of Johnson’s PCBs (i.e., the rotor circuit board and stator circuit board), which are part of the motor. Accordingly, Cai’s transformer coils are not disposed on the stator circuit board or rotor circuit board as required by the claim. If they were, they would be within the red box in the Petition’s annotated figure of Cai.

203. Therefore, in my opinion, Cai teaches away from the claimed invention since it teaches placing transformer coils outside of the motor where the stator and rotor circuit boards are located, but claim 17 requires integrating the

transformer coils “directly onto the stator and rotor circuit boards” such that one coil is “disposed on a surface of the stator circuit board” and the other “disposed on a surface of the rotor circuit board.”

3. Ground 5 fails to render obvious claims 13 and 21

204. Claim 13 recites: “The light ranging system of claim 12 wherein each pixel in the plurality of pixels comprises a plurality of single photon avalanche diodes (SPADs).” Claim 21 recites: “The light ranging system of claim 20 wherein each pixel in the plurality of pixels comprises a plurality of single photon avalanche diodes (SPADs).”

205. Pacala teaches a LIDAR sensor in the context of a “spinning turret.” Ex. 1004 at [0013]. Johnson, Pardhan, and Zhang all, likewise, cover rotary joints. Droz, however, teaches *stationary* (non-rotary) LIDAR. Nevertheless, for Ground 5, the Petition proposes Pacala, Johnson, Pardhan, Zhang, and Spector are combined as set forth in Ground 4 and “[t]he combined system would then be further modified in view of Droz so that the LIDAR device would comprise light detector arrays that each comprise a plurality of single photon avalanche diodes (SPADs).” The Petition provides no explanation for why a POSITA would have been motivated to modify the proposed combination of Ground 5 in view of Droz’s teachings regarding *stationary* (non-rotary) LIDAR or why a POSITA would have had a reasonable expectation of success in making such modifications.

206. The Petition asserts Pacala “discloses that pixels in its LiDAR device may comprise SPAD arrays . . . but does not expressly disclose that each pixel comprises a plurality of SPADs, as recited in claims 13 and 21.” Pet. at 79.

207. The Petition asserts “Droz discloses a LiDAR device with a plurality of light detector arrays, such as light detector arrays 310, 316, and 318. EX1006, 13:1-3.” Pet. at 79. This is correct. The Petition further asserts “[t]he output from each light detector array ‘may correspond to an image pixel.’” *Id.*, 14:37-46; *see also id.*, 4:9-11.” This is a truncation of Droz’s cited disclosure. In fact, Droz teaches at 14:37-40 that “each output from a light detector array (310, 316, or 318) may correspond to an image pixel of a vertical arrangement of pixels represent[ing] the scene. Further, the image pixel is detected over a larger cross-sectional area than a cross-sectional area of a portion of light 302 entering a respective input end. As such, for example, waveguide array 360 can be employed as an optical diffuser that distributes the power density of light 302 transmitted through aperture 322 among the various light detector arrays.” And at 4:1-11, Droz teaches “with this arrangement, a first array of light detectors coupled to a first waveguide may receive light transmitted through a first portion of the aperture, and a second array of light detectors coupled to a second waveguide may receive light through a second portion of the aperture. As a result, the system can determine a one-dimensional (1D) image of the scene, while still allowing for a larger detection

area relative to the size of the aperture. For example, each array of light detectors can be connected in parallel to provide a combined output that represents a single image pixel of the scene.” Accordingly, Ground 5 necessarily *presumes* that Droz’s waveguides were useable with a spinning LIDAR, which is something Dr. Lebby never attempted to show.

208. Additionally, the Petition further misrepresents that Droz “teaches each light detector array ‘comprises a plurality of single photon avalanche diodes (SPADs).’ *Id.*, 13:3-6, 5:28-29, 18:55-57.” In fact, Droz teaches at 13:3-6 that “light detector array 310 may include a plurality of light detectors, similar to detectors 112 and 114” and at 5:28-29 that “[l]ight detectors 112, 114, etc. may include various types of light detectors” and offers SPADs as one example. Similarly, Droz at 18:43-57 claims “a plurality of waveguides . . . and an array of light detectors that detects the guided light transmitted through the output end . . . wherein the array of light detectors comprises a plurality of single photon avalanche diodes (SPADs).” Accordingly, a POSITA would not understand Droz to teach the claim requirement that “each pixel in the plurality of pixels comprises a plurality of single photon avalanche diodes (SPADs).”

209. I disagree with the Petition’s unsupported conclusion that it would have been obvious to incorporate Droz’s waveguides into the combination of Pacala-Johnson-Pardhan-Zhang-Spector. Neither Dr. Lebby nor the Petition show how the

waveguides of Droz would be incorporated into the system of Ground 5.

210. Pacala discloses a spinning LIDAR system. EX1004 [0013] (disclosing “a static base **50** that contains a motor and distributed electronics, and a spinning turret **60** that contains optoelectronic components **70**”). Accordingly, in the Petition’s proposed combinations the waveguides of Droz would spin.

211. Dr. Lebby provided no analysis for how the Droz combination would have been combined. Dr. Lebby also did not provide any analysis on how Droz’s waveguides could fit into the “compact” volume of Pacala-Johnson-Pardhan-Zhang-Spector’s system. Further, Dr. Lebby provides no analysis to indicate how a POSITA would have accounted for the weight of Droz’s waveguides in the combined Pacala-Johnson-Pardhan-Zhang-Spector system. Dr. Lebby did not even begin to do the kind of analysis necessary to determining the impact of Droz’s waveguides on the spinning Pacala-Johnson-Pardhan-Zhang-Spector system. Without analysis accounting for the impact of Droz’s waveguides on the weight of the combined Pacala-Johnson-Pardhan-Zhang-Spector-Droz system, Dr. Lebby’s obviousness opinions regarding the Pacala-Droz combination are unsupported.

212. Similarly, a POSITA would have understood that adding the stack of solid materials in Droz’s waveguides to the spinning Pacala system would have changed the gyroscopic forces acting on the spinning system. A POSITA would have understood that adding mass to a spinning device—particularly a stack of solid

materials like Droz's waveguides—will impact the rotational forces acting upon the device. This would have discouraged a POSITA from incorporating Droz's waveguides into Pacala's spinning system. Dr. Lebby acknowledged that when modifying a prior art design, “gyroscopic forces are certainly something that a POSITA may have reviewed, as well as vibrational forces, electromagnetic forces, stability forces, temperatures forces ... and certainly rotational effects.” Ex. 2005 (Lebby Depo Tr.), 47:11-16. However, Dr. Lebby provided no analysis to indicate how the design of the Pacala-Johnson-Pardhan-Zhang-Spector-Droz system would accommodate the gyroscopic forces caused by the introduction of the Droz waveguides into the spinning Pacala system.

213. Given the myriad design issues a POSITA would have faced in combining the Droz reference with the Pacala-Johnson-Pardhan-Zhang-Spector system, a POSITA would not have found it obvious to combine these systems.

214. In my opinion, combining the Pacala-Johnson-Pardhan-Zhang-Spector and Droz systems would have been a complex and work-intensive operation that would have required a multidisciplinary team and thousands of hours of engineering time. Based on the issues with combining Pacala-Johnson-Pardhan-Zhang-Spector's spinning LIDAR system with Droz's stack of solid waveguide layers—including volume, weight distribution, and rotational forces—a POSITA would have been discouraged by the substantial amount of engineering work necessary to

combine these systems. Accordingly, it is my opinion that it would not have been obvious to combine the Pacala and Droz systems.

215. Moreover, even accepting for arguments sake, the Petition's contentions relating to Droz and claim 13, the "increased sensitivity" the Petition alleges would result from Droz's incorporation (Pet. at 78) only further illustrates the lack of a motivation to utilize Pardhan's thermal rotary link because overheating would not have been expected in the first place.

C. Ground 6 – Claims 22-24 are patentable over Pacala, Johnson, Pardhan, Zhang, Droz, and Cai in further view of Yan

216. Having reviewed the Petition, it is my opinion that each of claims 22-24 challenged by Ground 6 are patentable. The Petition does not establish any of these claims is invalid. Ground 6 utilizes the same Pacala-Johnson-Pardhan-Zhang combination of Ground 1 but further adds three additional references: Droz, Cai, and Yan to address independent claim 22 and dependent claims 23 and 24. The Petition asserts "[m]ost limitations in claim 22 correspond to those in claims 1 and 14, and are thus rendered obvious by the Ground 1 references" citing "Sections IX.B.1-2" of the Petition. Petition at 83. Thus, my analysis for Grounds 1-5 above applies to Ground 6 as well. The following sections provide my detailed opinions regarding certain specific invalidity grounds set forth in the Petition that I was asked to consider as part of this proceeding.

1. Petitioner provides inadequate motivations to combine Pacala, Johnson, and Pardhan

217. Ground 6 relies upon the same purported motivations to combine Pacala, Pardhan, and Johnson cited for Ground 1. *See* Petition at 83-86, 90-91 (citing e.g., Petition at 30-33). Thus, my opinions for Ground 1 apply with equal force to Ground 6. In my opinion, the only reason for combining Pacala, Johnson and Pardhan is Dr. Lebby’s attempts to create a hindsight reconstruction of the ’515 Patent claims.

2. Petitioner’s proposed combination does not disclose or render obvious the required “plurality of arms extending away from the sleeve” (22(e.i))

218. Like independent claims 1 and 14, independent claim 22 recites “a plurality of arms extending away from the sleeve.” The Petition relies on the same arguments made for Ground 1 to allege Pardhan and Zhang disclose or suggest this limitation for Ground 6. *See* Petition at 86-87 (citing Petition Sections IX.E.1(e)-(f)). Accordingly, my opinions as to this limitation for Ground 1 apply with equal force to Ground 6. In my opinion, Ground 6 does not show claims 22-24 are obvious.

219. The Petition also asserts that “Pardhan, when combined with the knowledge of a POSITA . . . renders obvious arms extending away from the sleeve.” Pet. at 87. This is not an argument that was made in Ground 1, which was limited to combining “Pardhan’s support component that includes sleeve 728 and

bearings 730/732 *with Zhang's arms* on the upper surface of the support component.” Petition at 27.

220. The Petition’s proposal in Ground 6 for the POSITA to spontaneously implement element 22(e.i) (“a support component having lower and upper surfaces, a sleeve extending away from the lower surface and fitted over the shaft, a plurality of arms extending away from the sleeve, and a plurality of alignment posts extending away from the upper surface”) without explanation lacks credibility. The Petition’s assertion on page 87 is supported by Dr. Lebby’s testimony on paragraph 335 of his declaration, which is conclusory, and Section IX.E.1(e) of the Petition, which addresses a substantively different limitation claim element: 14(e).

221. I disagree that the bearing housing designs identified on page 26 of the Petition would have strengthened the attachment of Pardhan’s “second hollow shaft 728” to its rotor plate 720 in a way that would have merited the extra bulk. In paragraph 117 above, I explained how the mass distribution from Pardhan was unwise in a dynamic system like the proposed combination, and would lead to increased stress on the system, reduced performance, etc. The bearing housings identified by Dr. Lebby in Exs. 1033, 16 (top) and Ex. 1042, Fig. 6 (see Ex. 1003 at ¶141) would exacerbate these stresses on the system due to the increased moment of inertia in addition to further expanding the system volume, which is,

once again, counter to the POSITA's goal of choosing rotating structures for a "compact" design. Manufacturing costs and system complexity would also increase. Dr. Lebby made no effort to acknowledge or address these drawbacks with the Petition. Rather, he mistakenly believed that bearing housing designs "could be used in a rotor-stator structure interchangeably." Ex. 1003, ¶ 253. They cannot. The bearings in Ex. 1033, 16, are not meant to provide stability to a rotor, they are meant to be affixed to something stable, such as a wall, and provide sufficient radial support for a shaft to rotate within them; these bearings do not constrain an axle (or a rotor) to spin true to an intended axis of rotation. The bearings in Ex. 1033, 16, are also unnecessarily heavy for the application, given that their housings are made of cast iron and/or steel; this elevates the moment of inertia and vulnerability to gyroscopic forces, reducing the life of the motor. A POSITA would recognize that Ex. 1033 discloses a flange and not arms extending away from a sleeve that forms part of a support component for a rotor. Ex. 1042 also does not disclose the claimed "arms." Rather, Figure 6 of 1042 discloses a cage which, unlike arms, completes a circuit from one end of the shaft to another end of the shaft, and enveloping the stator. A POSITA would understand that arms of the '515 Patent are cantilevered, whereas what the Petitioner erroneously identified as "arms" from Ex. 1042 are actually not cantilevered because component 704 (shown more clearly in Fig. 7 of Ex 1042) forms a "U" that is

actually a rigid, self-supporting truss, not an arm. The load paths for a truss are very different than for an arm. Dr. Lebby provided no support for his belief that bearing housing designs are all interchangeable on a rotor-stator structure, nor did he provide support for that opinion, nor did he provide support for his opinion that a “bearing housing with arms” will minimize vibrations.

3. **Petitioner’s proposed combination does not disclose or render obvious the four required “circuit boards” of claim 22 (elements 22(d.i), (d.ii), (e.ii), (e.iii))**

222. Claim 22 elements d - e.iii are as follows:

a stator circuit board assembly disposed within and coupled to the enclosure in a fixed relationship, ***the stator circuit board assembly comprising:***

a ***first circuit board*** disposed along a plane perpendicular to the axis of rotation;

a ***second circuit board*** disposed parallel to and adjacent to the first circuit board and having a first aperture formed through a central portion of the second circuit board; and

a stator assembly comprising a plurality of stator elements arranged about the axis of rotation;

a rotor circuit board assembly disposed within the enclosure and rotationally coupled to the shaft, ***the rotor circuit board assembly comprising:***

a support component having lower and upper surfaces, a sleeve extending away from the lower surface and fitted over the shaft, a plurality of arms extending away from the sleeve, and a plurality of alignment posts extending away from the upper surface;

a ***third circuit board*** coupled to the lower surface of the support component and disposed adjacent to and in an opposing

relationship with the second circuit board;

a fourth circuit board coupled to the upper surface of the support component and arranged parallel with the third circuit board between the third circuit board and the top cover, the fourth circuit board having a plurality of alignment cutouts sized and shaped to accept the alignment posts; ...

(emphasis added)

223. I reiterate my statements and analysis in Section VII.A.8.

Specifically, Johnson teaches two circuit boards (a stator circuit board and a rotor circuit board) and provides no rationale to add more circuit boards. In my opinion, the Petition’s assertions regarding a motivation to use four circuit boards for Ground 6 fail for the same reasons as detailed in above for Ground 1.

224. Neither Cai nor Yan discloses four circuit boards. Neither Cai nor Yan discloses the possibility of LIDAR components overheating and thus necessitating the additional thermal mitigation that Petitioner suggests would be necessary for the combination of Grounds 1-6 (i.e., the motivation to use Pardhan’s heat sink). Petition 92-93.

225. Yan discloses an “automatic sweeping robot” with range detecting devices. Ex. 1012 at [0004]-[0005]; [0075]-[0076]; Ex. 1016 at [0027]. It is noted that indoor range detecting devices “exhibit low power consumption requirements of 2 W or less.” Ex. 1016 at [0027]. This is radically different from Pardhan’s disclosure that its finned rotor plate is needed only when a LIDAR device is

operated “above a threshold power level.” Ex. 1006. at 4:54-63. Accordingly, a POSITA would have recognized Yan’s circuit board was capable of being placed under its lower power consumption detecting device without risk of overheating whereas a circuit board could not be placed under Pardhan’s overheating LIDAR device.

226. As I have explained above, a POSITA would also not have expected Pacala’s LIDAR device used in Grounds 1-6 to be at risk of overheating. However, the Petition makes that assumption as a pretextual reason for the proposed combinations to require Pardhan’s rotor plate 720 with fins. It is my opinion that a POSITA so concerned with the overheating of the LIDAR device that they would resort to utilizing Pardhan’s ill-advised heat sink, would not add an additional PCB between the high-power LIDAR system and the heat sink as Petitioner proposes. This additional circuit board would cause the heat to first flow from the allegedly high-power (high-heat) LIDAR device’s layers, pass through the interface between the high-power device and additional PCB – adding thermal resistance due to air gaps/thermal pads/paste—and then finally the heat would pass through the additional PCB layer before reaching the heat sink. This extended path with multiple material interfaces increases the overall thermal resistance. As a result, less heat can be effectively transferred from the source to the heatsink for dissipation. Introducing additional PCB layers between a high-power heat source

and heat sink adversely impacts thermal performance, including leading to higher operating temperatures, resulting in the likely failures of both the additional PCB as well as the LIDAR heat source as detailed in Section VII.A.8.

227. To summarize, in my opinion, a POSITA would not rely on Yan's placement of components in its sweeping robot to override Pardhan's thermal configuration for a LIDAR system. If Pardhan's heat sink were required as Petitioner contends, then "a fourth circuit board coupled to the upper surface of the support component and arranged parallel with the third circuit board between the third circuit board and the top cover" as required by claim element e.iii would never be used by a POSITA because its inclusion in the system would render the proposed combination inoperable.

4. Petitioner's proposed combination does not disclose or render obvious the required first and second transformer coils

228. Claim element 22(h) recites "a wireless power transformer integrated directly onto the stator and rotor circuit boards, the wireless power transformer comprising a first annular transformer coil disposed on a surface of the stator circuit board and a second annular transformer coil disposed on a surface of the rotor circuit board in an opposing relationship with the first annular transformer coil, wherein the first transformer coil is concentric with and positioned outside an outer perimeter of the plurality of stator elements and the second transformer coil

is concentric with and positioned outside an outer perimeter of the rotor assembly annular arrangement.”

229. The Petition relies on the same arguments for this element in Ground 6 as it does for claim 17 and Ground 1 and Ground 2. *See* Petition at 94 (citing “Sections IX.E.11 and X.B.5”). Accordingly, my opinions as to claim 17 and Grounds 1 and 2 apply with equal force to Ground 6 and claim 22. In my opinion, the Petition has not shown claim 22 obvious in view of Ground 6.

5. Petitioner fails to explain any motivation to combine Droz’s stationary LIDAR with the rotary system of Ground 6

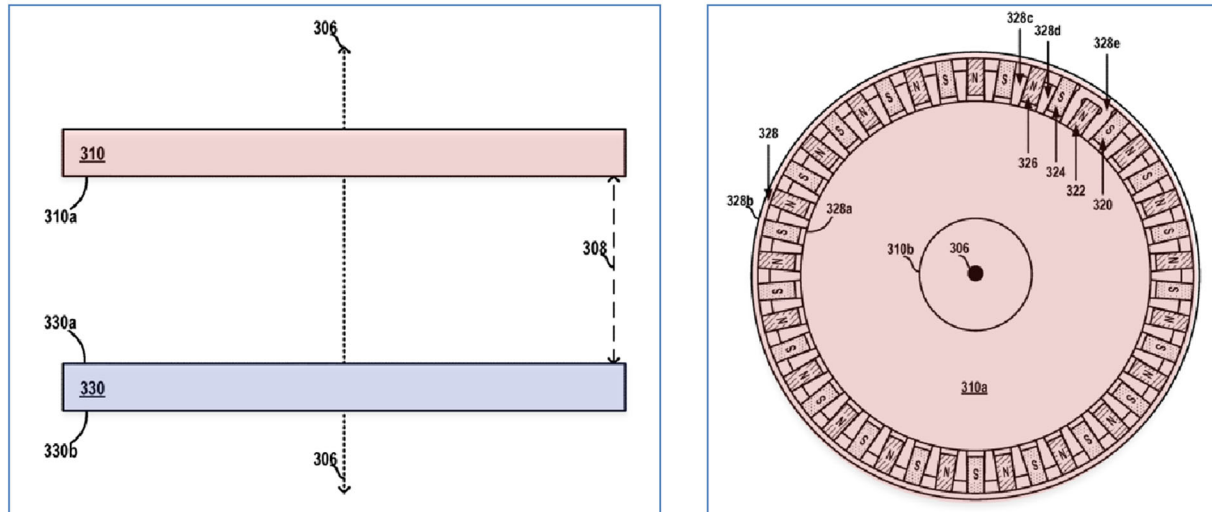
230. Claim element 22(f.ii) recites: “wherein the detector circuitry comprises a plurality of pixels, each pixel comprising a plurality of single photon avalanche detectors (SPADs).”

231. The Petition relies on the same arguments for Ground 6 and claim element 22(f.ii) as for Ground 5 and claims 13 and 21. Accordingly, my opinions as to Ground 5 and claims 13 and 21 apply with equal force. The Petition has not shown claim 22 obvious in view of Ground 6 for this additional reason.

6. Petitioner’s proposed combination does not disclose or render obvious Claim 23

232. Claim 23 recites “the plurality of stator elements and the annular arrangement of the plurality of magnetic segments are each disposed between a surface of the second circuit board and a surface of the third circuit board.”

233. For Claim 23, the Petition (at 94) merely points to Sections XIV.B.1.e and XIV.B.1.i without further explanation. The annotated Figures 3A and 3B of Johnson from Section XIV.B.1.i of the Petition are reproduced below.



234. The Petition asserts “Figure 3B (right) of Johnson illustrates an ‘an outer layer of a circuit board’ that is on a bottom side (310a) of rotor platform 310.” Pet. at 90. The Petition further asserts a “POSITA would have understood that the PCB layer in Figure 3B [of Johnson] is the claimed ‘third circuit board,’” and “the stator circuit board in Figure 3C [of Johnson] would have been disposed on the top side (330a) of the stator platform as the claimed ‘second circuit board.’” Petition at 91. The Petition further explains that “Figure 3D . . . is ‘along a second layer of the circuit board,’ e.g., ‘between sides 330a and 330b,’ or along bottom side (330b).” Pet. at 85.

235. Under the Petition’s mapping, because the conductive structures that

form Johnson’s plurality of coil windings alleged to be the plurality of stator elements are between side 330a (Fig. 3C) and side 330b (Fig. 3D) of Johnson (*see* Ex. 1005 at 13:26-34), the alleged plurality of stator elements disclosed in Johnson are not “each disposed between a surface of the second circuit board and a surface of the third circuit board” as required by Claim 23. To meet the claim limitation, the plurality of stator elements would need to be disposed above side 330a in Fig. 3C of Johnson (and below side 310a), but they are not.

236. Thus, the Petition has not shown claim 23 is obvious.

D. Ground 7 fails to render any of the dependent claims unpatentable

237. I have not formed an opinion as to Ground 7 and claim 25. However, my understanding from Counsel is that because, in my opinion, Ground 6 does not show independent claim 22 is obvious, Ground 7 could not have shown dependent claim 25 to be unpatentable.

E. Ground 8: Pacala-2017, Johnson, Pardhan, and Zhang fail to render claims 1-2, 4-9, 11-14, 16-17, 19-21 unpatentable

238. According to the Petition, Ground 8 “substitutes Pacala-2017 for Pacala.” Petition at 98. The Petition contends as to Ground 8 that all of the limitations discussed above “are disclosed by the Johnson-Pardhan-Zhang combination in the same manner as was discussed in Ground 1.” *Id.* at 100. The Petition further contends a POSITA would have been motivated to combine

Johnson-Pardhan-Zhang for the same reasons as for Ground 1 and contends a POSITA would have been motivated to combine Pacala-2017 for essentially the same reasons as for Pacala in Ground 1. *Id.* at 104-105.

1. Availability of Pacala-2017 as Prior Art

239. Additionally, I understand from Counsel that Pacala-2017 would be unavailable as prior art if U.S. Provisional Application No. 62/596,018 (“the ’018 Application”), to which the ’515 Patent ultimately claims priority, provides written description support for the claims of the ’515 Patent..

240. I have reviewed the ’018 Application and in my opinion, a POSITA would understand that all of the challenged ’515 Patent claims have written description support in the paragraphs, figures, and claims of the ’018 Application as indicated in the table below:

’515 Patent Claim⁸	Representative Support in the ’018 Application (EX2002)⁹
1(a); 14(a); 22(a)	To the extent preamble is limiting: Claim 1
1(b); 14(b); 22(b)	Fig. 5B, [0095]
1(c); 14(c); 22(c)	[0011], [0055]

⁸ The claim element identifiers used here are the ones from the Petition (Paper 2 at viii to xvi).

⁹ All citations in this column are to EX2002.

1(d); 14(d); 22(d); 22(d.ii)	FIG. 3, [0072], [0095], Claim 26
1(e); 14(e); 14(f); 22(e.i)	FIG. 8, [0127], [0128]
1(f); 14(g); 22(e); 22(e.ii)	FIG. 5B, FIG. 8, [0095], [0127] , Claim 26
1(g); 14(h); 22(d.iii)	FIGs., 6D, 6E, 8, [0013], [0110], [0112]
1(h); 14(i); 22(e.iv)	FIGS. 6D, 6E, 8, [0013], [0111]
1(i); 14(j); 22(f.i)	FIGS. 5B, 8, 9A-9C [0096], [0117], [0133], [0136], Claim 1
1(j); 14(k); 22(g)	Claim 11
2; 22(i)	[0012], [0076], [0077], Claim 4; <i>see also</i> [0073], [0099], [0101]
4; 22(d.i); 22(e.iii)	[0039], [0040], [0096], [0098], [0100], FIGS. 5A-5B, Claims 27 and 29
5	FIG. 5A, 5B, 6C, FIG. 8, [0095], Claim 23
6	FIGS. 5A-5B, [0096], [0098]
7; 16; 24	FIG. 6E, [0111]
8; 19; 22(f.iii)	[0038], [0059], [0070], [0067], [0079], [0092]
9	[0074]
11	Claim 20
12; 20; 25	[0060], [0087]-[0089]
13; 21	[0151]-[0154]

17; 22(h)	[0100], [0113]-[0114], Claims 25, 30, 31
22(f.ii)	[0060], [0087]-[0089], [0151]-[0154]
23	FIGS. 3, 5A-5B, 8, [0039], [0040], [0072], [0095], [0096], [0098], [0100], [0127], Claims 26, 27 and 29

2. Ground 8 fails for the same reasons as Ground 1

241. Because Ground 8 essentially substitutes Pacala-2017 for Pacala but otherwise repeats Ground 1, even if Pacala-2017 were to qualify as prior art, my opinions relating to Johnson, Pardhan, and Zhang for Ground 1 apply with equal force to Ground 8 for essentially the same reasons.

242. In fact, Pacala-2017’s availability as prior art would only further affirm that a POSITA would have no motivation to combine Pardhan’s rotating finned heat sink with a LIDAR designed by Angus Pacala. Like Pacala, Pacala-2017 teaches and claims a more efficient design for the optoelectronics in a LIDAR system wherein optical channels for receiving photons and detecting the photons are arranged on a single image sensor fabricated directly onto a semiconductor chip. Ex. 1013 at [0050], Claims 1, 5, and 6. Pacala-2017’s system focuses on “achieving a relatively high signal-to-noise ratio(“SNR”)” through techniques that ensure “minimal power output by the system (via the illumination sources) is wasted.” Ex. 1013, [0016]. In this manner, Pacala-2017 “achieve[s] a relatively high ratio of output signal (i.e., illuminating beam power) to input signal

(i.e., photons passed to an incident on the pixel array).” Ex. 1013, [0016]; *see also id.* at [0027] (explaining how its improved optics “reduce[s] crosstalk between channels, thereby improving SNR within the system.”). A POSITA would therefore understand that Pacala-2017, even more than Pacala, teaches away from combination with Pardhan as I described above.

F. Ground 9: Pacala-2017, Johnson, Pardhan, Zhang in further view of Cai and Yan fail to render claims 22-25 unpatentable

243. According to the Petition, Ground 9 “substitutes Pacala-2017 for Pacala and Spector” as used for Grounds 6 and 7. Petition at 105. As explained above, my understanding is that Pacala-2017 does not qualify as prior art, so Ground 9 fails for the same reason as Ground 8.

244. Even if Pacala-2017 qualified as prior art, the Petition contends “Johnson-Pardhan-Zhang-Cai-Yan are combined in the same way as” in Ground 6 but “[t]he combined system is the[n] further modified by integrating the LiDAR device of Pacala-2017, rather than Pacala-Spector.” *Id.* at 105-106. The Petition contends all the limitations Ouster has discussed above “are disclosed by Johnson, Pardhan, Zhang, Cai and Yan in the same manner as was discussed in Ground 6.” *Id.* at 106. Accordingly, Ground 9 fails to show any of claims 22-24 are rendered unpatentable for the same reasons discussed above.

245. As explained above for Ground 7 and claim 25, I also have not formed

an opinion as to Ground 9 and claim 25. However, my understanding from Counsel is that because, in my opinion, Grounds 8 and 9 do not show independent claim 22 is obvious, Ground 9 could not have shown dependent claim 25 to be unpatentable.

VIII. SECONDARY CONSIDERATIONS

246. My understanding is that one way to rebut a finding of obviousness is to present evidence of secondary considerations of nonobviousness, such as copy, industry praise, unexpected results, commercial success, long felt but unsolved need, and the failure of others to achieve the claimed invention. I also understand that, in order to be relevant to the issue of obviousness, such secondary indicia must have some connection (or nexus) to the claimed invention. I have followed these principles in my analysis below.

A. Petitioner's Copying

247. I was asked to analyze whether the Hesai PandarQT product includes all of the features of claim 1, 4, and 17 of the '595 Patent. I understand that the analysis for determining whether a device embodies a patent claim comprises two steps and is the same analysis used to assess patent infringement. To assess patent infringement, or whether a device practices a claim, I understand that (1) the meaning and scope of the patent claims are construed and (2) the construed patent claims are compared to the accused device. I understand that a device embodies (or infringes) a system or apparatus claim when the device includes each and every

feature of the system or apparatus claim. I applied this approach in my analysis of the Hesai PandarQT product and the '515 Patent.

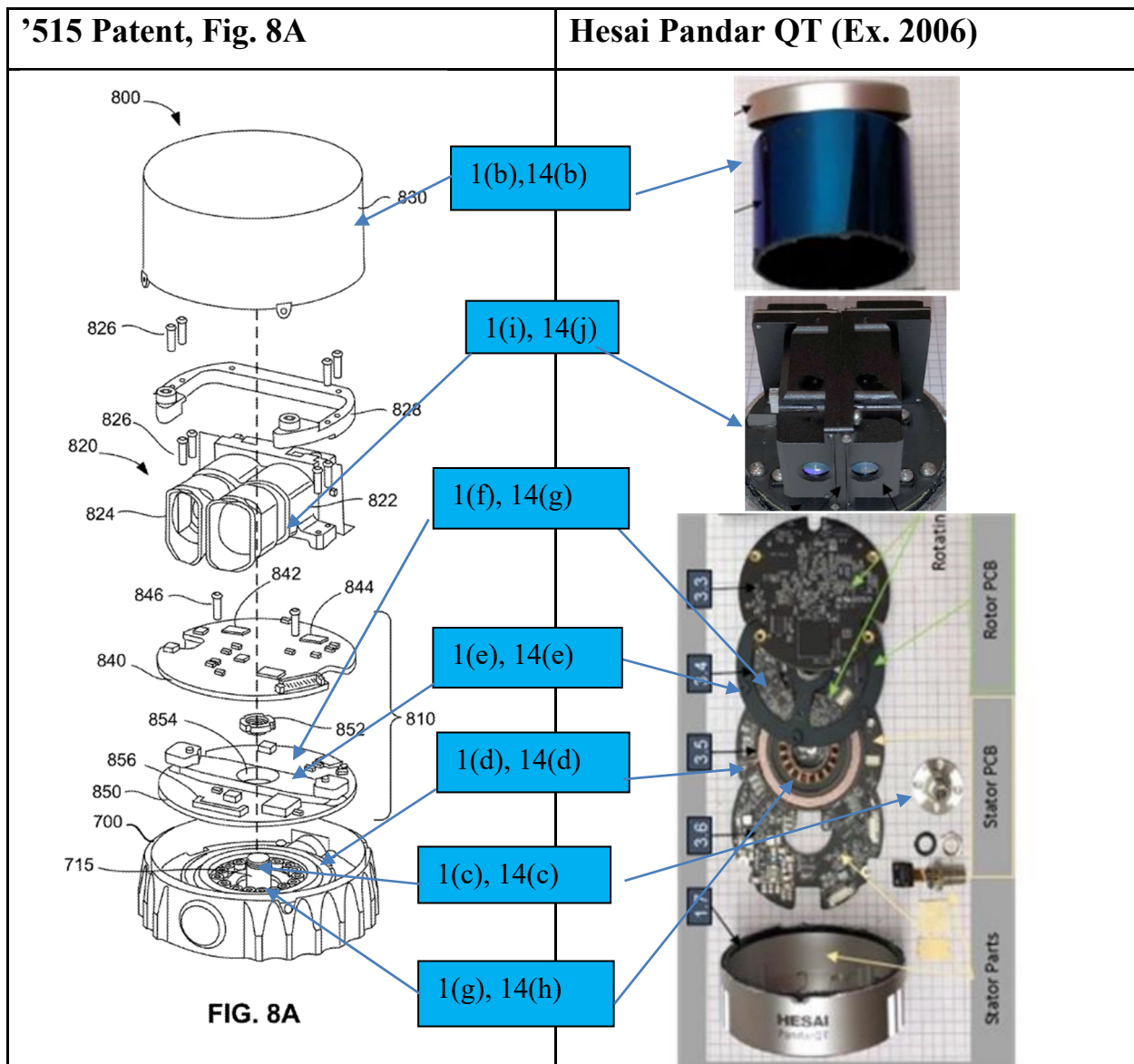
248. I based my understanding of the Hesai PandarQT on the following documents:

- (a) Ouster, Inc. v. Hesai Group et al, No. 1:23-cv-00406-CFC, (D.Del.), Dkt No. 3, Exhibit 15a (Preliminary infringement chart of U.S. 11,287,515 against PandarQT) (Ex. 2011)
- (b) PandarQT 64-Channel User Manual (Apr. 2022) (Ex. 2012)
- (c) QT128C2X User Manual (Aug. 2022) (Ex. 2013)
- (d) PandarQT 64-Channel Point Cloud Video, available at:
https://www.hesaitech.com/product_downloads/pandar64-4/point-cloud-download/
- (e) QT128 Point Cloud Video, available at:
https://www.hesaitech.com/product_downloads/qt128/point-cloud-download/

249. Petitioner's PandarQT is a rotating light ranging system [1(a), 14(a)] as shown in Ex. 2011 at 1-12. *See* Ex. 2012 at 10; *see also* Ex. 2013 at 10.

250. PandarQT is also contained with an enclosure with a transparent window [1(b), 14(b)] as shown in Ex. 2011. *See* Ex. 2012 at 11; *see also* Ex. 2013 at 11.

251. As shown in the side-by-side comparison below, the PandarQT also copies each and every claim element of the '515 patent directly from the '515 patent itself, from the four circuit boards of claim 4, to the support component with arms extending from a sleeve [1(e), 14(e)], to the positioning of the transformer coils outside of the rotor and stator elements as recited in claim 17.



252. In addition to the elements visible in the comparison above, the underside of the PandarQT's rotor circuit board includes a rotor assembly coupled to the rotor circuit board in the form of a multipole ring magnet with alternating magnetic poles [1(h), 14(i)] as recited by the '515 patent claims. *See* Ex 2011 at 27-28. Although the alternating magnetic poles cannot be seen through a visual inspection, multipole ring magnets are "commonly used in brushless DC motors." Ex. 2014. If the ring magnet visible on the bottom of the PandarQT did not have "a plurality of magnetic poles" that "surround the axis of rotation in an alternating pattern such that each magnetic pole has a polarity opposite a polarity of its adjacent magnetic poles," then the LIDAR would not rotate at 10 Hz (*see* Ex. 2012 at 13) and thus would not be operable to create the point clouds shown in Hesai's PandarQT videos.

253. Similarly, a POSITA would understand that during operation, the PandarQT's stator driver circuit provides a drive signal that imparts electromagnetic force on the rotor assembly to rotate [1(j), 14(k)] and, as a result, the LIDAR's transmit module and receive module are operable in the manner recited by the claims [1(i), 14(j)]. *See* Ex. 2011 at 28-43.

254. In my opinion the Hesai PandarQT bears such striking similarities to Fig. 8A of the '515 Patent that that copying can be inferred.

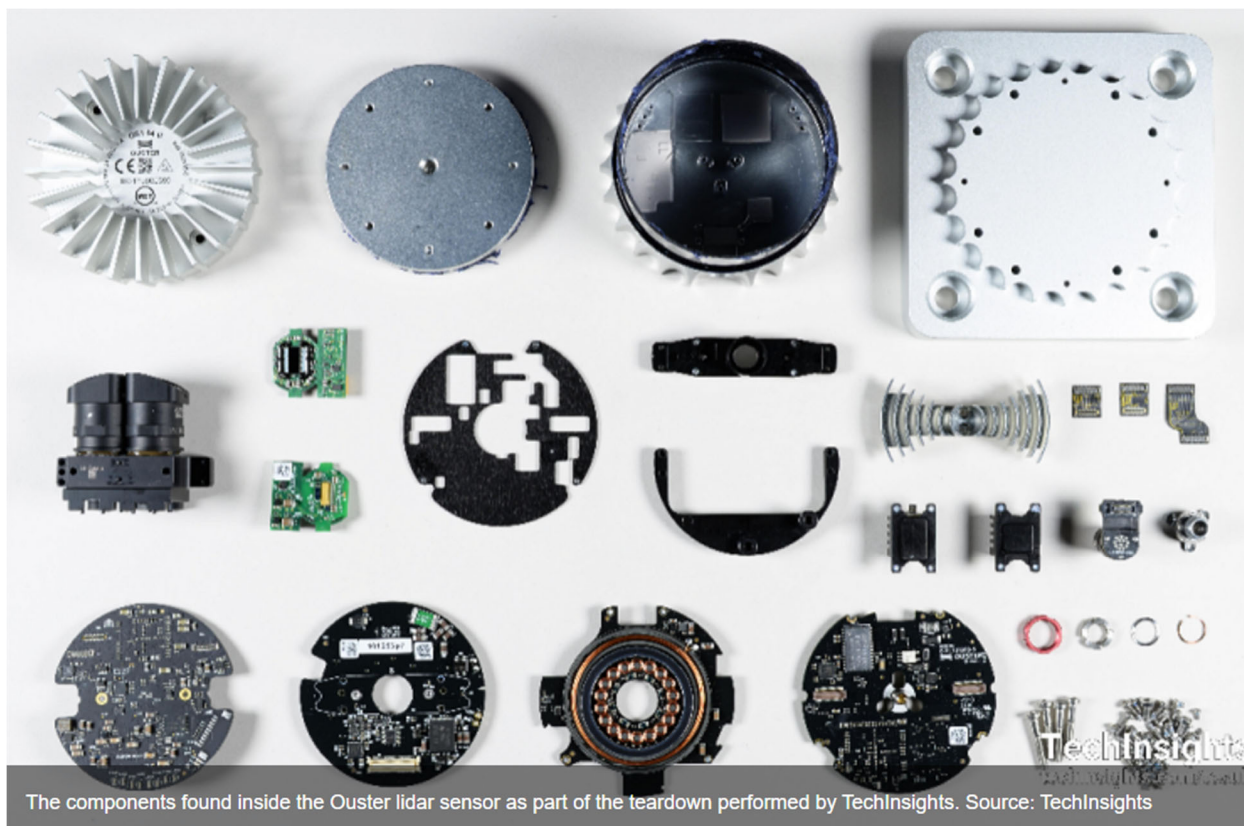
B. Ouster's Products

255. Ouster's OS Sensor products also embody all of the features of claim 1, 4, and 17 of the '595 Patent. In assessing whether the OS Sensor embodies these claims, I applied the same approach for assessing patent infringement as I did for the Hesai PandarQT in the preceding section.

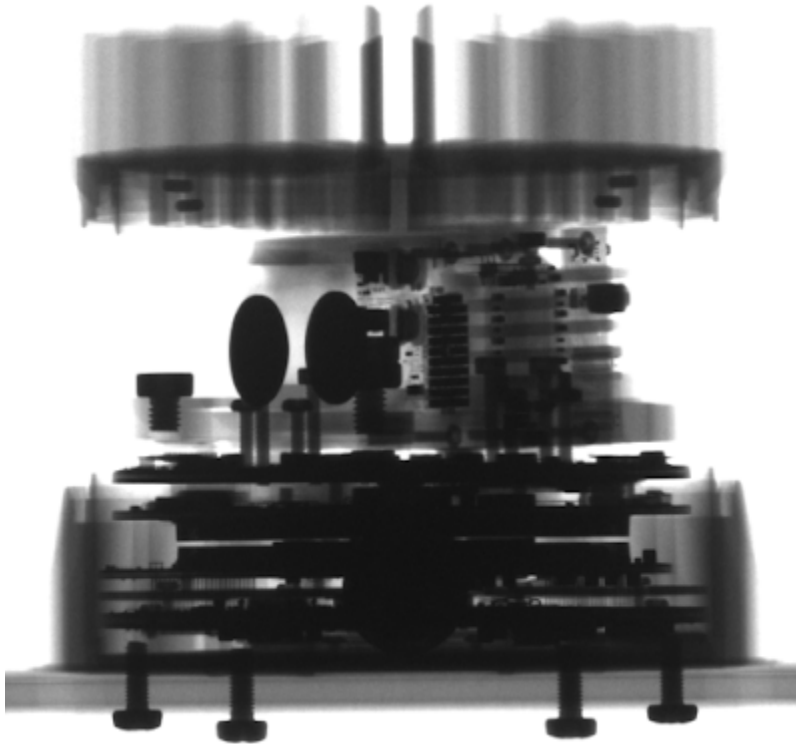
256. The OS Sensor is a rotating light ranging system [1(a), 14(a)]. *See* Ex. 2010 (explaining its capabilities).

257. The OS Sensor is also contained with an enclosure with a transparent window [1(b), 14(b)] as shown in videos found at <https://ouster.com/products/hardware/os1-lidar-sensor>. *See also* Ex. 2010.

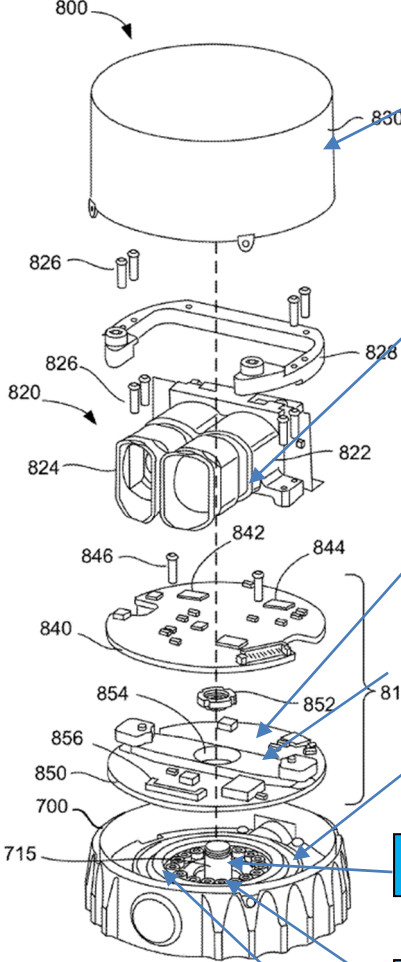
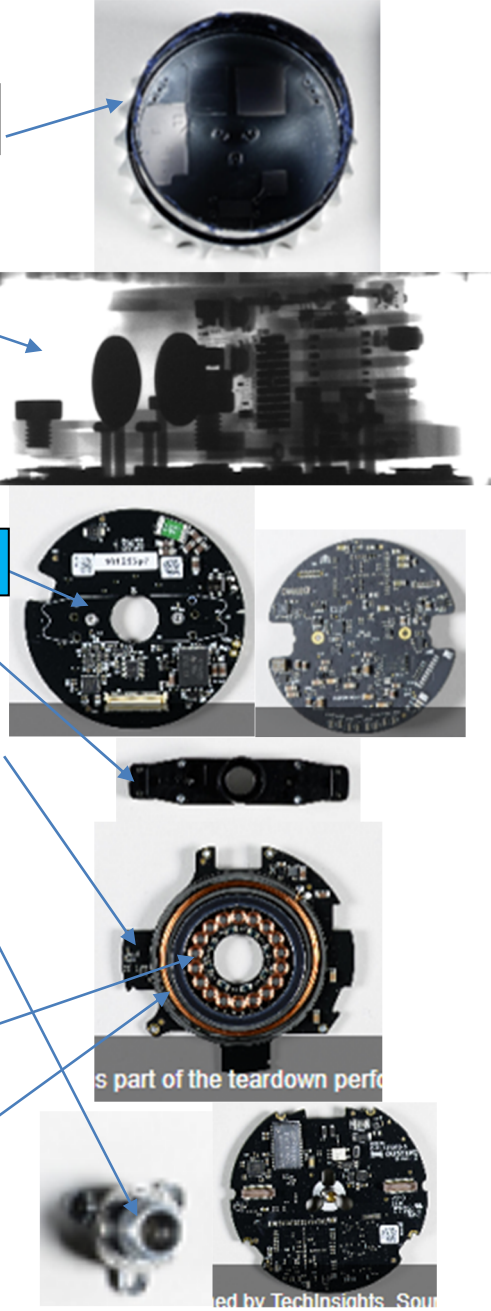
258. To understand the internal structure of an Ouster OS Sensor, I reviewed a publicly-available TechInsights report showing the four circuit boards and other components of a disassembled Ouster OS sensor as shown below. *See* Ex. 2023-2024.



259. I also reviewed a publicly available x-ray image of a side-view of an assembled Ouster OS sensor. *See* Ex. 2021-2022.



260. As shown in the side-by-side comparison below, the OS Sensor also embodies each and every claim element of the '515 patent directly from the '515 patent itself.

'515 Patent, Fig. 8A	OS1-64 Sensor (Exs. 2021-2024)
 FIG. 8A	

261. In addition to the elements visible in the comparison above, a POSITA would understand from the configuration of the stator assembly and the

top-view of the rotor circuit board that the underside of the OS Sensor's rotor circuit board necessarily includes a rotor assembly including an annular arrangement in which a plurality of magnetic poles surround the axis of rotation in an alternating pattern such that each magnetic pole has a polarity opposite a polarity of its adjacent magnetic poles [1(h), 14(i)]—otherwise the motor would not rotate the LIDAR. *See* Ex. 2024; *see also* Ex. 2010 at 1-2 (describing e.g., its 10 or 20 Hz rotation rate).

262. Similarly, a POSITA would understand that during operation, the OS Sensor's stator driver circuit provides a drive signal that imparts electromagnetic force on the rotor assembly to rotate [1(j), 14(k)] and, as a result, the LIDAR's transmit module and receive module are operable in the manner recited by the claims [1(i), 14(j)]. *See e.g.*, Ex. 2010 at 1-2 (describing e.g., its 10 or 20 Hz rotation rate).

263. Ouster's OS sensors practicing the '515 Patent have opened the door to new uses for drones resulting in industry praise for the claimed invention of the '515 Patent.

264. Before the '515 Patent, bulkier LIDAR sensors were used with large drones to perform functions such as surveying of power lines from a large distance. *See* Ex. 2016.



265. Now, lighter, more maneuverable drones utilizing Ouster OS sensors practicing the '515 patent's claimed invention have enabled drones to be used in performing, for example, detailed up-close airplane inspections, such as the mainblades drone with Ouster OS sensor show below.

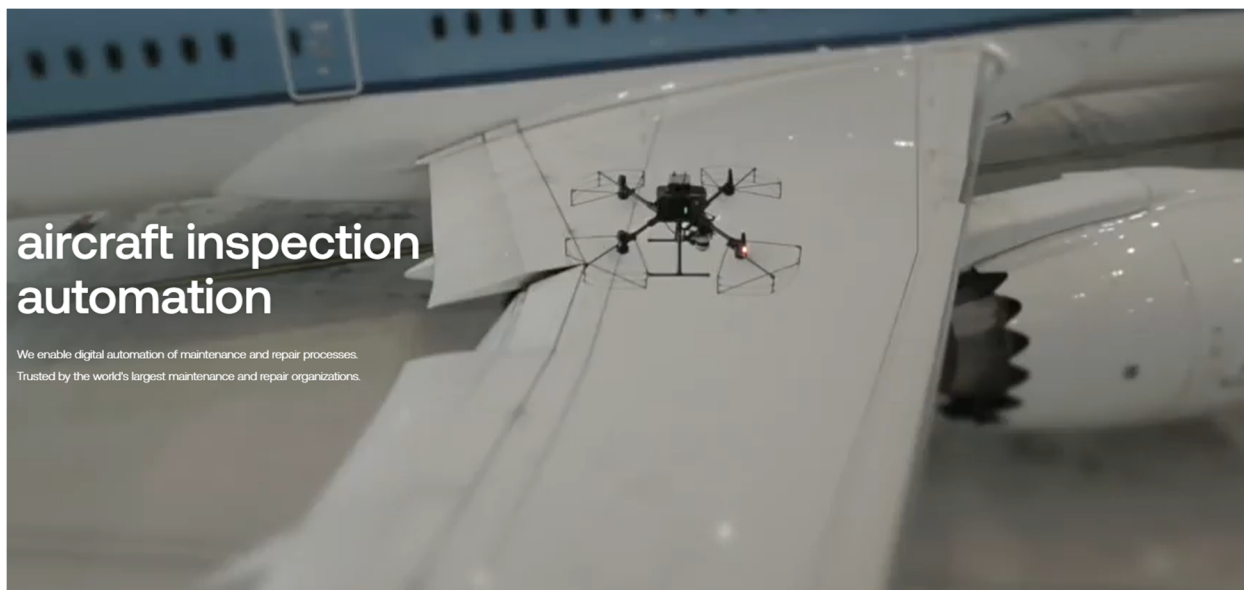


266. A January 27, 2021 article by Aerospace Tech Week reporting on mainblades' airplane inspection drones utilizing Ouster OS drones practicing the '515 Patent explained: "Lidar sensors are ideal for obstacle detection and avoidance because they can cover a wide field of view. . . Traditional lidar systems typically have thousands of independent elements, including lasers and detectors, packed into a single device. Ouster's patented digital lidar technology integrates these components into a simple two-chip architecture. This reduces the number of components and leads to lower costs, a more compact and lighter sensor and improved reliability due to less points of failure. This combination of performance, precision, lightweight, and reliability is particularly critical for moving applications like drones. . . . When surveying crowded and dynamic environments such as

airports where many different maintenance operations take place simultaneously, the drone needs to ensure that a safe and reliable flight plan is developed. Lidar helps to achieve that.” Ex. 2018.

267. Similarly, a blog post from Ouster’s customer, mainblades, explains their development of automated drones in GPS-denied environments that are used to perform airplane inspections and offers praise for Ouster OS sensor. Ex. 2019. Specifically, in determining whether mainblades’ inspection drones would need both LIDAR and a camera, or whether LIDAR alone would be sufficient, mainblades explained: “During indoor flights we encountered situations in which the lighting was low, and it became troubling for the visual system to keep track. Our main objects of inspection, airplanes, often have large smooth shiny surfaces which can be a challenge to track using a camera. Lidar appeared to have less complications. Which makes sense, and luckily there are few pitch-black aircraft, because that would challenge the lidar. But above all, the drone is equipped with a shiny Ouster lidar for model construction and localization purposes. That made our choice for lidar straightforward. For the reason of keeping it simple, we opted to not investigate the combined lidar and camera option unless it was deemed necessary.” *Id.*

268. A photograph of a drone with Ouster OS sensor inspecting an airplane is reproduced below (from mainblades website).



Ex. 2020.

269. In my opinion, the praise Ouster has received in the industry for its OS sensors practicing the '515 Patent, which customers purchasing the sensors have used to create new drone products and markets is objective evidence of the innovation of the claimed invention of the '515 Patent.

IX. RESERVATION OF RIGHTS

270. The opinions and analyses in this report are based on currently available documents and information. Accordingly, I reserve my right to supplement and amend my opinions if additional information becomes available. Similarly, this report may be supplemented by testimony, and I may also be asked to address issues raised by Petitioner.

271. I also reserve the right to adjust or supplement my analyses in light of any critique of my report or alternative opinion advanced by the Petitioner.

X. CONCLUSION

272. In my opinion, claims 1-2, 4-9, 11-14, 16-17, and 19-25 of the '515 Patent are not invalid in light of the prior art grounds asserted by Dr. Lebby.

273. I hereby declare that statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. Should further information become available to me as this matter proceeds, I may revise my opinions accordingly as necessary. I declare under penalty of perjury that the foregoing Declaration is true and correct and understand that willful false statements and the like are punishable by fine or imprisonment, or both, pursuant to 18 U.S.C. § 1001.

Respectfully Submitted,

June 20, 2024

Date



Dr. Jason A. Janét

EXHIBIT A

Jason A. Janét, Ph.D.

1420 Lillington Drive, Suite 205

Raleigh, NC 27607

Mobile: (919) 225-1724

E-mail: jasonajanet@gmail.com

Education

- Ph.D. Electrical & Computer Engineering, North Carolina State University, 1998
- M.S. Integrated Manufacturing Systems Engineering, North Carolina State University, 1994
- B.S. Mechanical Engineering, University of Virginia, 1990

Employment History

Applied Research Associates (ARA): 2018 - present

- **Corporate Director of IP and Product Commercialization (IP to Product—IP2P) | CTO-SSM:** Corporate/Business development, Intellectual Property Portfolio Build-out/Protection, and IP Transition to Product. Evaluate, quantify, present and recommend portfolios of IP, product lines and ventures on the basis of competitive landscapes, addressable markets, sales strategy, resource availability and technology readiness. Design, propose and mentor organizational structure(s), including cross-department and cross-sector relationships. Relevant technologies include medical technologies, augmented reality, non-GPS, synthetic environments, computer vision, machine intelligence, IoT sensors, robotics, automation, security, photogrammetry, weapons systems, unmanned systems, SaaS, BioTech, and precision agriculture for multiple market domains. Clearance Level: TOP SECRET & SCI.

DeltaFive: 2014 - 2018

- **CEO & Co-Founder:** Lead corporate, business, IP and technical development for spinout focused on IoT sensors, computer vision, machine intelligence, mobile robots, SaaS, and Lure Formulation for hospitality, pest, IT, and security markets. Strategic and tactical direction for sales, marketing and client services teams.
- **Inventor:** Three awarded patents (USPTO) and patents pending.
- **Board of Directors:** Serve on and report to Board of Directors, and chair the Technical Advisory Board.
- See www.deltafive.com, <https://jgc.outgrow.us/deltafive> or www.youtube.com/watch?v=LoQe6_Lxprs.

Transdigm [TDG] (Avionic Instruments | Acme Aerospace | Aerospace Cooling Solutions): 2002 – 2004, 2013 - 2014

- **VP/Director of Development (2002-2004), VP/Director of Sales, Program Management (2013-2014).** See www.transdigm.com, www.avionicinstruments.com, www.acme-aero.com, or www.aerospacecoolingsolutions.com.
 - Manage multiple product lines and cross-functional teams including product line managers (PLMs), account managers, inside sales, international sales, marketing, repair, engineers, technicians, distributors, legal, IP and rep organizations. (270 employees)
 - P&L, strategy, reporting, and forecasting for ~\$105M/yr, 50% EBITDA, and 10% YOY growth.
 - Product lines comprised ~600 SKUs for advanced aerospace systems.
 - Epicor ERP for standard resource planning, including inventory optimization and workflow.
 - Change-Agent: Sikorsky S97/JMR programs and supply chain for Aerospace Cooling Solutions.
 - Incubation, launch, growth and exits for **ShelfWorks**, **VortexHC** and **RxMedic** (below).
- **Programs:**
 - **S97 Raider Light Tactical Helicopter** – Autonomy, power distribution and electrical system (PDES) for the Sikorsky S97 LTH, including FAA-compliant software development per DO-178B. (2013 – 2014) See <http://www.youtube.com/watch?v=qy-Xb3X-bC0>.
 - **Joint Multi-Role (JMR) Helicopter** – Leveraging S97, JMR employs a scaled-up level of autonomy/PDES for Sikorsky-Boeing team, under U.S. Army funding. (2014)
 - **Blue Fans** – Aerospace Cooling Solutions supply chain optimization. (2013 – 2014)
 - **DARPA Distributed Micro-Robotics** – PI/PM for “Mobile Robots that Climb Vertical and Inverted Surfaces.” sponsored by DARPA – MTO. Develop mobile robots that climb walls and ceilings for surveillance, reconnaissance and breaching. Collaborated with Lockheed-Martin for automatic target recognition and Picatinny Arsenal for *Lamprey* SLAM holder. (2002 – 2004)

Teledyne Technologies [TDY]: 2011 - 2013

- **Senior Manager**

- Lead cross-functional teams of scientists and engineers in CONUS
- M&A due-diligence, identification and recommendation (SeaBotix & BlueView)
- Lead contingents of cross-division teams to secure ~\$352M in funding over 24 months.
- Plan and execute CRAD, business development and coordinate with strategic business units
- **ONR/USMC Cargo UGV** – PM for ONR/USMC-sponsored Cargo Unmanned Ground Vehicle (CUGV) Program subcontract (2011-2012). Manage team of engineers and scientists, in coordination with contract prime (Oshkosh) for unmanned combat vehicle control, perception and navigation. Multi-sensor suite included EO/IR Vision, LIDAR, IMU, and GPS.
- **Army LTL** – PM for Army-sponsored Lighten-the-Load (LTL) Program subcontract (2012-2013). Manage team to develop perception system comprised of stereo EO and stereo LWIR cameras to find and track leader(s), perform optical odometry, detect and map obstacles, and enhance SIGINT. Interface with sensors (LIDAR, IMU, GPS), autonomy for ATV-sized unmanned ground vehicles.
- **NASA ESP** – PM for RTP-based tasks for NASA Engineering Services and Prototyping demonstration (2012-2013). Provide Teledyne Engineering Services (lead), SAIC, Oceaneering, and Schafer with robot prototype and vision-based perception to detect, classify and track targets.
- **DARPA EXACTO** – PM for NC-based tasks for DARPA TTO Extreme Accuracy Tasked Ordnance (EXACTO) Program (2012-2013). Program developed first ever guided, small-caliber bullet with MEMS-based actuation, optical bullet tracking, optical target tracking, and bullet guidance to greatly improve accuracy and extend the day and nighttime range over current state-of-the-art sniper systems.
- **DARPA AngelFish/EagleRay** – PI/PM and inventor of the AngelFish Cross-Domain Submersible UAV, a man-portable, floodable airframe with tilt-thrusters capable of operating in and deliberately transitioning between the air, surface and underwater. Designed for optimal balance between hydro-/fluid-dynamics, materials, guidance/navigation/control, power conversion/storage, and perception for wing-in-ground flight.
- **Army PIRST** – Propose and capture the Pursuant In-stride Reconnaissance, Surveillance & Targeting (PIRST) program. By Army Night Vision & Electronics Sensors Directorate (NVESD) in 2013.

RxMedic Systems: 2003 – 2011 (*spinout from Avionic Instruments*)

- **Co-Founder/General Manager/Board Member** (2004-2007), **CTO** (2007-2010), and **Director of Robotic/Automated Systems** post-acquisition by JM Smith (2010-2011).
 - Manage launch from **Avionic Instruments** (2004)
 - Build and lead nationwide growth of cross-functional teams to 75+ employees
 - Direct product development, manufacturing, field support, sales and marketing
 - Manage IP Portfolio & Legal: Patents include USPTO# 7,726,514 and 8,091,733
 - Oversee P&L, accounting, raising of capital, and accounts receivable
- **RxMedic ADS:** Invent, develop, market and support automated pharmacy dispensation and packaging systems for retail, hospital, mail order and industrial fulfillment organizations.
- **RxMedic ACS:** Integrate, refine, market and support automated pharmacy-counting systems for retail and hospital fulfillment organizations.
- Co-negotiated the acquisition of RxMedic Systems by JM Smith, Inc. in May of 2010, established RxMedic as a division, and coordinated 12-month transition. Supported evaluation and integration of automated systems for JM Smith business units including Smith Drug.

Vortex HC: 2002 - 2009 (*spinout from Avionic Instruments*)

- **Vice President** (2004-2006), and **Facilities Security Officer (FSO)** (2005-2006)
 - Manage spin-out from **Avionic Instruments** (2004)
 - Lead cross-functional teams for product development, manufacturing, support, sales and marketing
 - Manage business and corporate strategy, execution, licensing, and ITAR/EAR-compliance
 - Support domestic and international legal and IP portfolio management, P&L, AP/AR
- **DARPA ARTEMIS** – PI and PM for “Vortex-Based AUVs for Counter-Mine and Counter-Obstacle Operations” sponsored by DARPA – ATO. Managed development of holonomic AUVs for landing on mines and performing soft-kill neutralization. Integrated CFD, rugged materials, MEMS-sensors for guidance, navigation and control. Collaborated with UT-ARL for development of circular synthetic aperture sonar and Teledyne RD Instruments for DVL. Developed high-precision acoustic underwater tracking system.
- **Products:** Managed development, manufacturing, world-wide marketing, and support of the following to military, law-enforcement, security, rescue, nuclear and entertainment customers:
 - VMRP Wall-Climbing Robot – Man-portable mobile robots that climb walls and ceilings.
 - Submersible Attractor – Rad-hardened attractor for nuclear energy market, BWR inspection
 - Submersible VMRP Robot – Man-portable underwater robots for bulkheads and tank interiors.

- Lamprey SLAM Holder – Surface-agnostic instant placement mechanism for Picatinny Arsenal’s Selectable Land- and Anti-personnel Mine (SLAM) breaching charge.
- **Licensing:** As part of exit strategy, instituted licensing and transition of VRAM technologies:
 - SeaBotix LBC – Little Benthic Crawler Remotely Operated Vehicle (ROV).
 - SeaRobotics HullBUG – Autonomous hull-grooming robot.
 - BDT – Attractors for high-speed, high-efficiency, low-overhead paper & fabric handling.
 - TMI – Attractors for inspection of nuclear boiler water reactor (BWR) facilities
- **ONR & NAVSEA HullBUG VRAM** – PI/Consultant for “Attractor Design for the Hull Biomimetic Underwater Grooming (HullBUG) Technology” and “HullBUG VRAM Design Optimization”. (2006–2009).

ShelfWorks Technologies: 2002 – 2006 (*spinout from Avionic Instruments*)

- **Charter Officer** (2004-2006).
 - Supported launch from **Avionic Instruments** (2002-2004)
 - Direct military product development, support commercial product development, sales & marketing
 - Bed, Bath & Beyond
 - Home Depot
 - Support IP Portfolio & Legal

Nekton Research (iRobot [IRBT]): 1998 - 2002

- **Vice President of R&D** (1998-2000) and **Director of Business Development** (2000-2002).
 - **Lead:** Cross-functional teams in marine-focused product/business development, production, deployment.
 - **IP Portfolio:** Co-inventor on USPTO# 6,378,801 (2002)
 - **Spinout:** Support incubation/launch of Parata Systems, a pharmacy automation company (1999-2002)
 - **M&A:** Provided early-stage due-diligence and introductions for acquisition by iRobot (2006)
- **Principal Investigator and Program Manager:**
 - **DARPA LSALS-SP3** – PI/PM for “3D Plume Tracing using Ranger™ MicroAUVs,” sponsored by DARPA – MTO. Joint effort with Sandia National Labs, and Woods Hole Oceanographic Institute. Developed multiple collaborative MicroAUVs that search for and localize plume sources and aircraft blackbox, to rescue and/or recover humans and assets.
 - **DARPA Distributed Micro-Robotics** – PI/PM for “Swimming Arrays for Anti-Submarine Warfare”, sponsored by DARPA – ATO. Joint effort with Draper Labs, Johns Hopkins University Applied Physics Lab, and Solers. Mobile acoustic array formations of multiple MicroAUVs. In contrast to towed arrays (e.g., TB-29), *Swimming Arrays* decouple tactical maneuvers from sensing maneuvers; enable protracted sensing, strong source direction discrimination, forward end-fire view, and dynamic array beamforming.
 - **DARPA Distributed Micro-AUVs** – PI/PM for “Aquatic Microbots”, sponsored by DARPA – MTO. Under *Distributed Robotics* program, design, build and demonstrate ultra-small AUVs, called “MicroHunters™”, which maneuver in 3D using only one moving part. Resulting navigation, called “Helical Klinotaxis” was validated on three different platforms and demonstrated to DARPA. Co-inventor on patent “3D Orientation for Aquatic Robots Using Helical Klinotaxis”, USPTO in April 2002.
 - **Forensics ROV** – PM and inventor of porthole-size ROV to perform forensic analyses of sunken assets. Based on a diametrically-opposed, large-diameter, low-velocity, vector thrusters, provide underwater telepresence to search for remains, assets and root-cause indicators. Unique design minimized silt disturbance, and maximized options for ingress and egress. (Private customer)
 - **Deepwater Towfish** – 6500m depth-rated towfish to carry sensor suite for applications in energy sector, telecommunications sector, sub-bottom profiling, and terrain mapping. (Private customer – EdgeTech)
 - **DARPA APLA/MGM** – PI/PM for “MicroHunter Guidance and Control of 60mm Mortars”, sponsored by DARPA – ATO. Under *Anti-Personnel Landmine Alternative/Minimally Guided Munitions* (APLA/MGM) program, collaborate with Battelle Memorial Institute to demonstrate feasibility, integrate microelectronic GNC sensors and actuators, and validate performance of single-actuator control force producer and guidance algorithm for indirect-fire munitions. Performance exceeded specifications.

Parata Systems: 1999 – 2002 (*spinout from Nekton Research serving as VP of Eng and Dir of BD*)

- Supported incubation and launch from **Nekton Research** (1999-2002)
 - Robotic System for Retail & Mass-Fulfillment Pharmacy
 - Technical & Business Development of Alpha- and Beta-level Products
 - Supported initial IP Portfolio

Duke University, Pratt School of Engineering: 1999 - 2021

- **Adjunct Associate Professor** (2005-2021) and **Adjunct Assistant Professor** (1999-2005).
 - Courses Taught Include:
 - Entrepreneurship & Tech Transition (Special Topics)
 - Robotics & Automation (MAE 442, ECE 383, ECE 142/442)
 - Control Theory (ECE 141/441)
- **MS Committee Member:** Serve on graduate student committees and advise research.
- **Advisor** and sponsor for Duke's Wall-Climbing Robot Team, which earned 1st place in the 2004 and 2005 International Climbing and Walking Robot (CLAWAR) Competitions in Madrid, Spain and London, England. Sponsored by the LORD Corporation and VortexHC.
- **Advisor** for Duke's DARPA Grand Challenge Team, in support of the Carnegie Mellon Red Team(s), which earned 2nd and 3rd places. Perception included RADAR, LIDAR, IMUs and GPS.
- **Advisor** and sponsor for Duke's Autonomous Underwater Vehicle (AUV) team, which earned finalist standings five times in the AUVSI/ONR International Autonomous Underwater Vehicle Competition. Participated in multiple annual competitions since 2001, with the following rankings: 2nd in 2006, 4th in 2005, 5th in 2004, 3rd in 2003, 4th in 2002, and 7th in 2001. Sponsored by LORD, VortexHC, and SeaBotix.

North Carolina State University, School of Engineering: 1992 - 2021

- **Adjunct Assoc Professor** (2009-2020), **Board Integrated Manufacturing Systems Engineering Institute** (1998 – 2020), **Adjunct Asst Professor** (2000-2009), **Instructor** (1996-1999), **Researcher** (1992-1996).
 - Teaching Experience:
 - Robotics & Automation (ECE 444, ECE 591)
 - Control Theory (ECE 435)
 - Distributed (Non-Deterministic, Network- & Statistics-based) Controls (ECE 492Z)
- **MS Committee Member:** Serve on graduate student committees, sponsor, and advise research.
- **Advisor & Corporate Sponsor** for NCSU's Autonomous Underwater Vehicle (AUV) team, which began participating in the AUVSI/ONR International AUV Competition. Participated in 2005 and 2006.
- **NASA-HELIOS** – PM for development and demonstration of semi-autonomous robotic system for lunar habitation and transport. Under NASA's Exploration Office, and funding from United Technologies, Caterpillar, and North Carolina Space Grant Consortium. Managed team of 40+ people to build and competitively demonstrate lunar exploration and habitation mission including deployment of lunar lander, UGV, and personnel habitat modules. Mission was demonstrated in full and earned first place and NASA's *1998 Extra Terrestrial Award*. January 1996 to April 1998.
- **DARPA/ONR Outdoor Landmark Recognition** – Researcher for "Outdoor Landmark Recognition Using Hybrid Fractal Vision System and Neural Networks", by DARPA and ONR. Validate new approach to detecting and recognizing outdoor landmarks using the Region-Feature Neural Network. (1993–1996)
- **Other Systems:** Bipedal robot (*Jenner*), a hexapod colony, an autonomous mobile robot (*Lazarus*), home automation & security based on decentralized control networks.

TMI Robotics: 1998 - 2013

- **President**
 - **Robotic & Automation Systems:** Submersible Robotic Hull Crawlers & Attractors for *General Electric*, *Hitachi*, *Framatome/Areva*, *SeaRobotics*, *SeaBotix*, etc. (2009-2018); wall-climbing robots for *SignalScape* (2009-2013); Pioneer mobile robot end-effector and bipedal robot for *Adept MobileRobots* (1998-2004); decentralized fuel pump control systems for *Gilbarco* (1998); Autonomous Following Golf Caddy for *Caddy Master* (1998-1999); Universal rotary actuator system for *Real World Interface (RWI)* and *iRobot (IS Robotics)* (1998-2000), etc.
 - **Artificial Intelligence Software and Textbook:** "Computational Intelligence: Supervised and Unsupervised Learning with Neural Networks", J.A. Janét and J.C. Sutton III. Copyright © 1998-2013. ISBN #0-9678493-0-6. Textbook included a time-limited single-user license for neural network software by TMI Robotics, Inc. Software included data, the Region-Feature Neural Network and the Hyper-Ellipsoid Clustering Neural Network for pattern analysis and machine intelligence. End-users/clients include *NCSU*, *National Technological University (NTU)* and *Video Based Engineering Education (VBEE)*, *IBM*, etc.

Other Professional Highlights:

- **Intellectual Property Litigation Expert Witness:** Provided reports, descriptive imagery and testimony for litigation regarding intellectual property, contracts and trade secrets. Cases are listed below, clients in **bold**:
 - Hesai v. **Ouster** (2024-pres) [USPTO PTAB IPR2023-01421]
 - Hesai v. **Ouster** (2024-pres) [USPTO PTAB IPR2023-01456]
 - Hesai v. **Ouster** (2024-pres) [USPTO PTAB IPR2023-01457]
 - Hesai v. **Ouster** (2024-pres) [USPTO PTAB IPR2023-01422]
 - A360 v **Toyota/Bastian** (2024-pres) [No. 1:23-cv-00198-JRS-TAB, Southern District of Indiana]
 - **Motive** v Samsara (2024-pres) [U.S. International Trade Commission]
 - **Good Sportsman** v Hangzhou ZH Tech [USPTO PTAB PGR]
 - **Tesla** v Autonomous Devices (2024-pres) [USPTO PTAB (IPR)] ‘474 Patent
 - **Becton Dickenson** v **JFCRx** (2023-2024) [Contract, trade secret compliance/audit]
 - Juul v **NJOY** – (2023-pres) [ITC] and [District Court of DE]
 - Textron v **DJI** – (2023-2024) [Case No. 2:22-cv-351-RWS-RSP (E.D. Tex)]
 - Solmetex v. **Dental Recycling** (2023-pres) [Pre-IPR: USPTO]
 - **Daifuku** v. ControlLogix [Pre-IPR: USPTO]
 - Autonomous Devices v **Tesla** (2023-pres) [C.A. No. 22-1466 (MN), District Court of DE]
 - **Tesla** v Autonomous Devices (2023-pres) [USPTO PTAB IPR2023-01172] ‘583 Patent
 - **Tesla** v Autonomous Devices (2023-pres) [USPTO PTAB IPR2023-01055] ‘344 Patent
 - **Tesla** v Autonomous Devices (2023-pres) [USPTO PTAB IPR2023-01054] ‘974 Patent
 - **Tesla** v Autonomous Devices (2023-pres) [USPTO PTAB IPR2023-01169] ‘134 Patent
 - **Tesla** v Autonomous Devices (2023-2024) [USPTO PTAB IPR2023-01170] ‘449 Patent
 - **Tesla** v Autonomous Devices (2023-2024) [USPTO PTAB IPR2023-01171] ‘585 Patent
 - Autonomous Devices v **Tesla** (2023-pres) [Case No. 1:22-cv-01466, District Court of DE]
 - **Ouster** v. Hesai et al, Lidar Systems (2023-2024) [337-TA-1363, U.S. International Trade Commission]
 - **Ouster** v. Hesai et al, (2023-pres) [No. 1:23-cv-00406, District Court of DE]
 - **Boston Dynamics** v Ghost Robotics (2023-pres) [1:22-cv-01483-MN, District Court of DE]
 - Vivint v **SkyBell** Technologies (2022-pres) [2:21-cv-09472, Central Dist of DC]
 - Moog v **SkyRyse** (2022-2024) [1:22-cv-00187, Wester Dist of NY]
 - Velodyne v **Ouster** (2022-pres) [337-TA-1322, U.S. International Trade Commission]
 - **IQRIS** v Point Blank (2022-2023) [21-CV-61976-BB, Southern District of FL]
 - **Opex** v HC Robotics/Invata (2022) [337-TA-1293, U.S. International Trade Commission]
 - **iAqua** v Cayago (2022) [Reexam-EPR814 of 90/014,995 USPTO]
 - Cayago v **iAqua** (2022) [21-CV-61035, Southern District of FL]
 - Cayago v **iAqua** (2022) [Civil No. 21-1212, Puerto Rico]
 - Bacon Sons v **Perception Robotics** (2021-2022) [Case No: 30-2018-01000372, Orange Co, CA]
 - **AutoStore** v Ocado (2021-2023) [IPR2022-00443 USPTO]
 - **AutoStore** v Ocado (2021-2022) [IPR2022-00673 USPTO] (pre-institution)
 - **AutoStore** v Ocado (2021-2022) [IPR2021-00274 USPTO]
 - **AutoStore** v Ocado (2021-2022) [IPR2021-00311 USPTO]
 - **AutoStore** v Ocado (2021-2022) [IPR2021-00398 USPTO] (pre-lit)
 - **AutoStore** v Ocado (2021-2022) [IPR2021-00412 USPTO] (pre-lit)
 - **AutoStore** v Ocado (2021-2022) [PGR2021-00038 USPTO] (pre-lit)
 - **AutoStore** v Ocado (2021-2022) [HP-2020-000035, United Kingdom]
 - **AutoStore** v Ocado (2021-2022) [Spain – Pre-lit]
 - **AutoStore** v Ocado (2021-2022) [Case No. 2:20-cv-494, Eastern District of VA]
 - Ocado v **AutoStore** (2021-2022) [1-21-cv-00041, USDC - DNH]
 - Ocado v **AutoStore** (2021-2022) [1-21-cv-00806, USDC - DNH]
 - **iRobot** v SharkNinja (2021-2022) [337-TA-1252, U.S. International Trade Commission]
 - **Airborne Systems** v Wamore – Steerable parachute systems (2019-pres) [Arbitration – NJ]
 - **AutoStore** v Ocado (2020-2021) [337-TA-1228, U.S. International Trade Commission]
 - Interactive Play Devices v **Spin Master** (2020-2021) [Civil Action File No. 6:20-cv-00066, W.D. TX]
 - **DJI** v Autel – (2017-2021) RC UAV Systems [C.A. No. 16-706-LPS-CJB, District Court of DE]
 - Velodyne v **RoboSense** (2019-2020) [337-TA-1173, U.S. International Trade Commission]
 - Odyssey Marketing v **Spin Master** (2018) Unmanned Air Vehicles [IPR, USPTO]
 - Mattel v **Spin Master** (2018) Transformable Devices [IPR2018-01672, USPTO]

- **Mattel v Spin Master** (2018) Transformable Devices [IPR2018-01673, USPTO]
- **Mattel v Spin Master** (2018) Transformable Devices [IPR2018-01674, USPTO]
- **MPV v DJI** – (2018) [Case No. 2:18-cv-02210-RGK-AGR, Central District Court of CA]
- **Samsung v Cywee** – (2017) IMU Pose & AR [Case No. 2:2017cv00140, Eastern District of TX]
- **DJI v Autel** – (2017-2018) [2:17-cv-00776-RAJ, Western District of WA]
- **Synergy Drone v DJI** – (2017-2018) [Case No. 1:17-cv-00242, TX Western District Court]
- **iRobot v Bissell** – (2017-2018) [337-TA-1057, U.S. International Trade Commission]
- **Hayward Industries** – (2015-2016) Evaluate IP and Enabling Technologies for Submersible Systems
- **Choirock v Spin Master** (2016-2018) Transformable Devices [Case No. IPR2017-00030, USPTO]
- **Spin Master v Sphero, Inc.** (2016-2017) [Case No. IPR2017-01272, USPTO]
- **Sphero, Inc. v Spin Master Ltd.** (2017) [New York Southern District Court, Case No. 1:17-cv-05428]
- **Razor/Chen/Inventist v Jetson Electric Bikes** (2016-2017) [337-TA-1000, U.S. Int. Trade Commission]
- **Razor/Chen/Inventist v Powerboard** (2016-2017) [337-TA-1000, U.S. International Trade Commission]
- **Segway/DEKA/Ninebot v Jetson** (2016-2017) [337-TA-1007, U.S. Int. Trade Commission]
- **Segway/DEKA/Ninebot v Powerboard** (2016-2017) [337-TA-1007, U.S. Int. Trade Commission]
- **Segway/DEKA/Ninebot v Jetson** (2016-2017) [337-TA-1021, U.S. Int. Trade Commission]
- **Segway/DEKA/Ninebot v Powerboard** (2016-2017) [337-TA-1021, U.S. Int. Trade Commission]
- **DJI v Yuneec** [No. 5:16-cv-595, U.S. District Court, Central District of CA]
- **Rehco LLC v Spin Master Ltd.** (2015-2020) [No. 1:2013cv02245, Northern District of IL]
- **Segway/DEKA v Ninebot** [Inv. No. 337-TA-935, U.S. International Trade Commission]
- **Segway v Shenzen Inmotion** – [Inv. No. 337-TA-935, U.S. International Trade Commission]
- **ScriptPro v Innovation** – Pharmacy Automation (2015) [2:06-cv-2468-CM-JPO U.S. Dist Court, KS]
- **ScriptPro v Innovation** – Pharmacy Automation (2011-2015) [06-2468-CM U.S. District Court, KS]
- **Spinmaster v YourStoreOnline** – Wall-Climbers (2009-2010) [CV 09-5803 CAS]
- **SpinMaster v YourStoreOnline** – RC Helicopters (2009-2010) [CV 09-2121 CAS]
- **Patent Inventorship:** Other patents pending
 - 6,378,801: Devices and methods for orienting and steering in three-dimensional space.
 - 7,726,514: Automated article dispensation mechanism.
 - 8,091,733: Automated article dispensation mechanism.
 - 8,751,035: Automated laundry drop-off and retrieval system.
 - 9,664,813: Automated Insect Monitoring
 - 9,999,211: Automated Insect Monitoring (Removable Chambers with Transparent Sides for Inspection)
 - 9,999,212: Automated Insect Monitoring (Signal Processing to Detect and Recognize Invasive Pest)
 - 11,382,324: Insect Traps and Monitoring System (IoT Monitoring System with Detect/Classify Ability)
- **Board of Directors/Advisors Experience:** Provide strategic technology, business and corporate expertise.
 - **Delta Five** – Distributed unattended sensors, automation, SaaS and IoT.
 - **Panacea BioMatx Inc** - Automated customized medications and nutraceuticals. (www.panacea.me)
 - **Lealear** – Automated storage and retrieval systems.
 - **RxMedic** – Automation for preparing prescription orders in retail, government, and hospital pharmacies.
 - **VortexHC** – Non-dexterous gripping, robot climbers (air and underwater), and 6DOF holonomic AUVs.
 - **NCSU Integrated Manufacturing Systems Engineering Institute** – Multi-disciplinary graduate school

Selected Publications (of ~40)

- IoT Solutions Enabling Hotelier's to Monitor for Bed Bugs, www.deltafive.com/wp-content/uploads/2018/06/DeltaFive_BedBugAwarenessWeek2018_PressRelease.pdf, June 2018.
- New York City Challenged by Bed Bugs, www.newswire.com/news/new-york-city-challenged-by-bed-bugs-delta-five-offers-green-solution-20043137, November 2017.
- On the Heels of the Largest Bed Bug Lawsuit Judgement, Delta-Five Has a Proven Green Solution for Hotels, www.newswire.com/news/on-the-heels-of-the-largest-bed-bug-lawsuit-judgement-delta-five-has-a-19990567, October 2017.
- Hoteliers Find Delta Five's Innovative Bed Bug Solution Catches Bugs Faster and More Consistently, www.newswire.com/news/hoteliers-find-delta-fives-innovative-bed-bug-solution-catches-bugs-19940513, September 2017.

- As Hoteliers Look to Combat Bed Bug Rise Delta Five Offers Researched Solution, www.newswire.com/news/as-hoteliers-look-to-combat-bed-bug-rise-delta-five-offers-researched-19846348, August 2017.
- Green Approach to Prevention and Early Detection, www.eprnews.com/delta-five-highlights-green-approach-to-prevention-and-early-detection-during-bed-bug-awareness-week-138925/, June 2017
- Delta Five Raises the Bar in Battle Against Bed Bugs, www.newswire.com/news/delta-five-raises-the-bar-in-battle-against-bed-bugs-19547330, May 2017.
- Automated Bed Bug and Insect Monitoring System, www.newswire.com/news/delta-five-launches-automated-bed-bug-and-insect-19224593, April 2017.
- “Think It, Build It, Win It: Vision-Based Robot Design Secures Teledyne a \$350M NASA Engineering Contract” H. Neale. *NASA Tech Briefs* 2013/2014.
- “Automation is Changing Pharmacy: How Reducing Repetition Behind the Counter Improves Over the Counter Care” J. Janét. October 2010. *Insight Magazine*.
- “Automate Your Profits” J. Janét. October 2009. *Insight Magazine*.
- DTIC #ABV 299170 (NATICK/TR-04/013L): “Vortex Regenerative Air Movement: Attraction and Attachment on Vertical and Inverted Surfaces— A Simple Method for Static and Mobile Robots for Climbing Walls and Ceilings” J. Janét, D. Reinfeld, B. Wiedeman. October 2003. (Contract No. DAAD16-00-C-9259; US Army Soldier Systems Command, Natick, MA)
- DTIC #AD B267 288 (NATICK/TR-01/009L): “MicroHunter Control Applications for Elimination of Anti-Personnel Landmines: Low-Cost, Minimally Guided Munitions – A Simple Method for Controlling the Trajectory of Spinning Projectiles” M. Kemp, J. Janét, and C. Pell. May 2001. (Contract No. DAAN02-98-C-4030; US Army Soldier Systems Command, Natick, MA)
- “Development of a Micro Autonomous Underwater Vehicle for Complex 3-D Sensing”, *IEEE/MTS Oceans 2001 Conference*; Honolulu, HI; Nov 2001; B. Hobson, B. Schulz, J. Janet, R. Moody, C. Pell, and H. Pinnix.
- “MicroAUVs I: Platform Design and Multi-Agent System Deployment”, *Unmanned Untethered Submersible Technology (UUST)*; August 2001; Durham, NH; B. Schulz, B. Hobson, J. Janét, M. Kemp, R. Moody, C. Pell, H. Pinnix, J. Pollard, and H. Crenshaw.
- “Assessing the Performance of Oscillating Fin Thruster Vehicles”, *Unmanned Untethered Submersible Technology (UUST)*; August 2001; Durham, NH; M. Kemp, B. Hobson, J. Janét, C. Pell, and E. Tytell.
- “Using Control Networks to Control Multiple Autonomous Mobile Robots: Biped, a Hexapod Colony, and a Complex Autonomous Mobile Robot”, *IEEE Int’l Conf. on Robotics & Automation*; Detroit, MI; May 1998; J. Janet, B. Wiseman, R. Michelli, S. Scoggins, and A. Walker.
- “Autonomous Mobile Robot Global Self-Localization Using Kohonen and Region-Feature Neural Networks”, *Jnl of Robotic Systems*; Vol. 14, No.4, 1997; J. Janet, R. Gutierrez, T. Chase, M. White, J. Sutton.
- “Combining Self-Organizing Geometric Certainty Maps with the Unscented Kalman Filter”, *Proc. of IEEE Int’l Conf. on Robotics & Automation*; Leuven, Belgium; May 1998; J. Janét, J. Brickley, M. Kay, M. White, and J. Sutton.
- “Modeling of Sonar Sensors for Localization of Autonomous Mobile Robots”, *IEEE Transactions on Industrial Electronics*; October 1998; R. Gutierrez, J. Janet, and R. Luo.
- “Autonomous Mobile Robot Global Motion Planning and Geometric Beacon Collection Using Traversability Vectors”, *IEEE Trans on Robotics & Automation*; Vol.13, No.1, 1997, Pages:132–140; J. Janét, M. Kay, and R. Luo.

Skills Brief

- *Executive Leadership*. Provided fiscal, strategic, IP and operational leadership in application and development of heavily engineered systems for software, robotics and automation, medical, pharmacy, maritime, aviation, government, military, law enforcement, security, entertainment, hospitality, analytics, pattern analysis, and energy markets. Demonstrated ability to develop and implement business plans, integrate emerging technologies, raise capital, be an effective change agent, and transition product and client service concepts to commercial viability. Effective collaborator with companies, academic institutions, military, government and foreign entities. Experienced with legal aspects of launch, operations, equity, M&A, intellectual property & litigation. Successful manager of sales, marketing and finance including, ROI tool development, market research, prospecting, sales presentations, competitive analysis, brand development, multi-media advertising, contract negotiation, deal closure, A/P and A/R.

- *Board Member.* Effective strategic contributor and communicator on behalf of corporations (Delta Five, RxMedic, Panacea Biomatix, Lealear, and VortexHC) and an academic institution (NCSU IMSEI).
- *Engineering and Product Development.* Demonstrated ability to develop and deploy hardware and software products, including automated retrieval systems, fixed-base robots, medical systems, mobile robots, autonomous and remote-control unmanned ground robots, wall-climbing robots, hull inspection & cleaning robots, nuclear vessel inspection robots, autonomous underwater vehicles, non-destructive inspection robots, retail automation, and mine neutralization robots.

Additional

- **Security Clearance.** Personal clearance level – TOP SECRET & SCI. Facilities Security Officer (FSO) for Vortex HC. Coordinated processing of SECRET level Facility Clearances (FCL) and Personnel Clearances (PCL).
- **Institute of Electrical & Electronic Engineers (IEEE):** Robotics, Controls & Pattern Analysis.
- **Autonomous Unmanned Vehicle Systems International (AUVSI)**
- **American Society for Engineering Education (ASEE)**
- **American Society of Mechanical Engineers (ASME)**
- **PADI SCUBA:** Professional diver for underwater mobile robots, hull inspection, underwater video, counter-mine, ASW, etc.
- **Commercial Driver's License:** Class-A CDL, base registrations in North Carolina (and Virginia).
- **USPA Skydiving:** (1991 – 1997) USPA Jumpmaster certification in 1996. D-license with 400 jumps including instruction, tandem master training support, demonstrations, accuracy, and freefall relative work (RW). National collegiate RW championship team in 1994 (Richmond, IN). Carolina Sky Sports Accuracy Champion in 1993 (Louisburg, NC).
- **Pyrotechnician:** Class-A/B levels.
- **Master Mason:** Foundation of ~20 years of construction experience, primarily with ornamental stone, brick, and concrete. Experience initially gained as a youth within family-owned and operated business (Dogwood Quarries) in DC-metropolitan area; summers and school breaks from 1981 until 1997. Since 1998, all work has been *pro bono* including for Habitat for Humanity.

Computer Tools

Proficient: SalesForce, PowerPoint, Excel, Word, Project, MATLAB

Prior experience: Epicor ERP, QuickBooks, AutoCAD, SolidWorks, OrCAD, LabView, C/C++, Assembly

EXHIBIT B

ADDITIONAL MATERIALS AND INFORMATION CONSIDERED

In addition to the prior art patents and other documents discussed in my declaration, the additional documents I have considered in connection with forming my opinion are as follows:

- None.