

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HESAI TECHNOLOGY CO., LTD.

Petitioner

v.

OUSTER, INC.

Patent Owner

U.S. Patent No. 11,175,405

Inter Partes Review No. 2023-01421

**PETITION FOR *INTER PARTES* REVIEW
UNDER 35 U.S.C. § 312 AND 37 C.F.R. § 42.104**

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	MANDATORY NOTICES	2
	A. Real Party-In-Interest	2
	B. Related Matters.....	2
	C. Lead and Backup Counsel and Service Information.....	3
III.	STANDING	4
IV.	PAYMENT OF FEES	4
V.	IDENTIFICATION OF CHALLENGE AND RELIEF REQUESTED	4
VI.	TECHNOLOGY BACKGROUND.....	5
VII.	THE ‘405 PATENT	8
	A. Overview	8
	B. Specification.....	9
	C. Prosecution History	11
	D. Claims.....	12
VIII.	LEVEL OF ORDINARY SKILL IN THE ART	12
IX.	CLAIM CONSTRUCTION	12
X.	GROUND 1: PACALA AND DROZ RENDER OBVIOUS CLAIMS 21, 23, 26-31, AND 34	13
	A. U.S. Patent Pub. No. 2014/0211194 (“Pacala”).....	13
	B. U.S. Patent No. 10,605,984 (“Droz”).....	15

C.	The Pacala-Droz Combination	17
XI.	GROUND 2: PACALA, DROZ, AND VILLENUEVE RENDER OBVIOUS CLAIMS 24-25 AND 32-33	37
A.	U.S. Patent No. 10,520,602 (“Villeneuve”)	37
B.	The Pacala-Droz-Villeneuve Combination	39
XII.	GROUND 3: HALL, BOROWSKI, AND SPECTOR RENDER OBVIOUS CLAIMS 21 AND 23-34	44
A.	U.S. Patent No. 9,983,297 (“Hall”)	44
B.	U.S. Patent Pub. No. 2013/0300840 (“Borowski”)	47
C.	U.S. Patent No. 10,473,766 (“Spector”)	48
D.	The Hall-Borowski-Spector Combination	55
XIII.	GROUND 4: HALL, BOROWSKI, SPECTOR, AND DROZ RENDER OBVIOUS CLAIM 34	76
A.	The Hall-Borowski-Spector-Droz Combination	76
B.	Secondary Considerations	78
XIV.	DISCRETIONARY FACTORS	78
A.	35 U.S.C. §314	78
B.	35 U.S.C. §325(d)	79
XV.	CONCLUSION	81

TABLE OF AUTHORITIES

	<u>Page</u>
<u>Cases</u>	
<i>Amazon.com, Inc. v. M2M Sols. LLC</i> , IPR2019-01205 (PTAB Jan. 27, 2020)	79
<i>Apple Inc. v. Fintiv, Inc.</i> , IPR2020-00019 (PTAB Mar. 20, 2020)	78
<i>Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.</i> , 800 F.3d 1375 (Fed. Cir. 2015)	49
<i>KCJ Corp. v. Kinetic Concepts, Inc.</i> , 223 F. 3d 1351, 1356 (Fed. Cir. 2000)	33
<i>Ex Parte Mann</i> , 2016 WL 7487271 (PTAB Dec. 21, 2016).....	49, 50
<i>Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.</i> , 868 F.3d 1013 (Fed. Cir. 2017)	12
<u>Statutes</u>	
35 U.S.C. § 102	<i>passim</i>
35 U.S.C. § 112	49
35 U.S.C. § 314	77, 78
35 U.S.C. § 315	4
35 U.S.C. § 325	77, 78, 79, 80
<u>Rules and Regulations</u>	
37 C.F.R. § 42.8	2, 3
37 C.F.R. § 42.15	4

EXHIBIT LIST

No.	Short Name	Exhibit
1001	‘405 Patent	U.S. Patent No. 11,175,405 to Pacala <i>et al.</i>
1002	‘405 Prosecution History	Prosecution history for U.S. Patent No. 11,175,405
1003	Shanley Declaration	Expert Declaration of Dr. James F. Shanley.
1004	Pacala	U.S. Patent Pub. No. 2014/0211194 to Pacala <i>et al.</i>
1005	Spector	U.S. Patent No. 10,473,766 to Spector
1006	Droz	U.S. Patent No. 10,605,984 to Droz <i>et al.</i>
1007	Villeneuve	U.S. Patent No. 10,520,602 to Villeneuve <i>et al.</i>
1008	Hall	U.S. Patent No. 9,983,297 to Hall <i>et al.</i>
1009	Borowski	U.S. Patent Pub. No. 2013/0300840 to Borowski
1010	Spector Provisional	U.S. Provisional Appl. No. 62/470,706 to Spector
1011	NIST	<i>Performance Analysis of Next-Generation LADAR for Manufacturing, Construction, and Mobility</i> , National Institute of Standards and Technology (2004)
1012	NOAA	Younkin <i>et al.</i> , <i>Velodyne VLP-16 Laser Scanner Acceptance</i> , NOAA Report, May 2016
1013	Pacala-2016	U.S. Patent Pub. No. 2016/0047901 to Pacala <i>et al.</i>
1014	Pacala-803	U.S. Patent No. 10,036,803 to Pacala <i>et al.</i>
1015	Hall-672	U.S. Patent No. RE46,672 to Hall

No.	Short Name	Exhibit
1016	ITC Complaint	Complaint in ITC Inv. No. 337-TA-1363
1017	Delaware Complaint	Complaint in <i>Ouster, Inc. v. Hesai Group et al.</i> , No. 23-cv-00406 (D. Del.)
1018	Stay Order	Order Granting Stay in <i>Ouster, Inc. v. Hesai Group et al.</i> , No. 23-cv-00406 (D. Del.)
1019	Joint Claim Construction Chart	Joint Claim Construction Chart in ITC Inv. No. 337-TA-1363 (July 7, 2023)
1020	Termination ID	ITC Inv. No. 337-TA-1363, EDIS Document Detail for Docket Entry: “Initial Determination Granting Respondents’ Motion for Termination of Investigation...”
1021	Shanley CV	<i>Curriculum Vitae</i> of James F. Shanley
1022	Sensors 2020	Lee <i>et al.</i> , “Accuracy-Power Controllable LiDAR Sensor System with 3D Object Recognition for Autonomous Vehicle,” in <i>Sensors</i> , Vol. 20, Iss. 19 (Oct. 2020)
1023	Hipp-747	U.S. Patent No. 6,747,747 to Hipp
1024	Weimer	U.S. Patent No. 8,736,818 to Weimer <i>et al.</i>
1025	Borowski-838	U.S. Patent Pub. No. 2013/0300838 to Borowski
1026	DGC	<i>Report to Congress: DARPA Prize Authority</i> (2006)
1027	Team DAD	Hall <i>et al.</i> , <i>Team DAD Technical Paper</i> , DARPA Grand Challenge (2005)

No.	Short Name	Exhibit
1028	Marino	Marino <i>et al.</i> , <i>A compact 3D imaging laser radar system using Geiger-mode APD arrays: system and measurements</i> , MIT Lincoln Lab (2003)
1029	Matsubara	Matsubara <i>et al.</i> , <i>Development of Next Generation LiDAR</i> , R&D Review of Toyota CRDL (2012)
1030	Hall-877	U.S. Patent No. 10,393,877 to Hall <i>et al.</i>

CHALLENGED CLAIMS

Claim 21	
21(a)	An optical system for performing distance measurements, the optical system comprising:
21(b)	a stationary housing having a base, a top and an optically transparent window disposed between the base and the top and extending fully around a periphery of the stationary housing;
21(c)	a light ranging device disposed within the housing and comprising:
21(d)	a platform;
21(e)	a light transmission module coupled to the platform and comprising a bulk transmitter optic and a plurality of optical emitters, each optical emitter in the plurality of optical emitters configured to generate and transmit pulses of radiation through the bulk transmitter optic and through the optically transparent window into a field external to the optical system; and
21(f)	a light sensing module coupled to the platform and comprising a bulk receiver optic, an aperture layer comprising a plurality of apertures separated by a stop region, a plurality of photosensors operable to detect photons emitted from the plurality of optical emitters and received through the bulk receiver optic after being reflected from surfaces within the field, and an optical filter disposed between the bulk receiver optic and the plurality of photosensors and configured to allow a band of radiation, including an operating wavelength of the plurality of optical emitters, to pass through the filter to the plurality of photosensors while blocking radiation outside the band from reaching the plurality of photosensors; and
21(g)	a motor disposed within the housing and operatively coupled to spin the platform and the light ranging device within the housing;
21(h)	wherein: each photosensor in the plurality of photosensors comprises a plurality of single photon avalanche diodes (SPADs);
21(i)	the plurality of apertures comprises at least first, second, third and fourth apertures;

21(j)	the plurality of photosensors comprises at least first, second, third and fourth photosensors; and the light sensing module includes a first optical path to the first photosensor through the first aperture, a second optical path to the second photosensor through the second aperture, a third optical path to the third photosensor through the third aperture, and a fourth optical path to the fourth photosensor through the fourth aperture.
Claim 23	
23	The optical system for performing distance measurements according to claim 21 wherein the system generates distance data based on times between transmission of pulses of light from the plurality of optical emitters and detection of photons from the pulses of light by the plurality of photosensors.
Claim 24	
24	The optical system for performing distance measurements according to claim 21 wherein the plurality of optical emitters are arranged to form a plurality of emitter channels having non-overlapping fields of view, and the plurality of photosensors are arranged to form a plurality of receiver channels having non-overlapping the fields of view and having a one-to-one relationship with the plurality of emitter channels such that the field of view for each receiver channel is coincident with the field of view of a corresponding emitter channel.
Claim 25	
25	The optical system for performing distance measurements according to claim 21 wherein the plurality of emitters are configured to project a plurality of illuminating beams in the field external to 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 photosensors.
Claim 26	
26(a)	An optical system for performing distance measurements, the optical system comprising:
26(b)	a stationary housing having a base, a top and an optically transparent window disposed between the base and the top and extending fully around a periphery of the stationary housing;
26(c)	a light ranging device disposed within the housing and comprising:

26(d)	a platform;
26(e)	a light transmission module coupled to the platform and comprising a bulk transmitter optic and a plurality of optical emitters, each optical emitter in the plurality of optical emitters configured to generate and transmit pulses of radiation through the bulk transmitter optic and through the optically transparent window into a field external to the optical system; and
26(f)	a light sensing module coupled to the platform and comprising a bulk receiver optic, an aperture layer comprising a plurality of apertures separated by a stop region, a plurality of photosensors operable to detect photons emitted from the plurality of optical emitters and received through the bulk receiver optic after being reflected from surfaces within the field, and one or more optical filters disposed between the bulk receiver optic and the plurality of photosensors, each of the one or more optical filters configured to allow a set of wavelengths of radiation, including an operating wavelength of the plurality of optical emitters, to pass through the one or more optical filters while blocking radiation outside that set; and
26(g)	a motor disposed within the housing and operatively coupled to spin the platform and the light ranging device within the housing;
26(h)	wherein: each photosensor in the plurality of photosensors comprises a plurality of single photon avalanche diodes (SPADs);
26(i)	the plurality of apertures comprises at least first, second, third and fourth apertures;
26(j)	the plurality of photosensors comprises at least first, second, third and fourth photosensors; and the light sensing module includes a first optical path to the first photosensor through the first aperture, a second optical path to the second photosensor through the second aperture, a third optical path to the third photosensor through the third aperture, and a fourth optical path to the fourth photosensor through the fourth aperture.
Claim 27	
27	The optical system for performing distance measurements set forth in claim 26 wherein the one or more optical filters comprise a bandpass filter.

Claim 28	
28	The optical system for performing distance measurements set forth in claim 26 wherein the one or more optical filters comprise a plurality of optical filters.
Claim 29	
29	The optical system for performing distance measurements set forth in claim 28 wherein each of the plurality of optical filters is supported by an optically transparent substrate.
Claim 30	
30	The optical system for performing distance measurements set forth in claim 29 wherein the plurality of optical filters are disposed in the first optical path.
Claim 31	
31	The optical system for performing distance measurements according to claim 26 wherein the system generates distance data based on times between transmission of pulses of light from the plurality of optical emitters and detection of photons from the pulses of light by the plurality of photosensors.
Claim 32	
32	The optical system for performing distance measurements according to claim 26 wherein the plurality of optical emitters are arranged to form a plurality of emitter channels having non-overlapping fields of view, and the plurality of photosensors are arranged to form a plurality of receiver channels having non-overlapping fields of view and having a one-to-one relationship with the plurality of emitter channels such that the field of view for each receiver channel is coincident with the field of view of a corresponding emitter channel.
Claim 33	
33	The optical system for performing distance measurements according to claim 26 wherein the plurality of emitters are configured to project a plurality of illuminating beams in the field external to 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 photosensors.

Claim 34	
34	The optical system for performing distance measurements according to claim 26 wherein the one or more optical filters comprises a first optical filter disposed in the first optical path between the first photosensor and the first aperture, a second optical filter disposed in the second optical path between the second photosensor and the second aperture, a third optical filter disposed in the third optical path between the third photosensor and the third aperture, and a fourth optical filter disposed in the fourth optical path between the fourth photosensor and the fourth aperture.

I. INTRODUCTION

Petitioner Hesai Technology Co., Ltd. (“Hesai”) requests that the Board institute *inter partes* review (“IPR”) and cancel claims 21 and 23-34 of U.S. Patent No. 11,175,405 (the “‘405 Patent”), assigned to Patent Owner Ouster, Inc. (“Ouster”).

The challenged claims are directed to an arrangement of optical components in light detection and ranging (“LiDAR”) devices. LiDAR has been known for decades as a technique to measure distance using reflected light. Years before the priority date of the ‘405 Patent, those skilled in the art realized that LiDAR would be beneficial for navigation of autonomous vehicles (“AV”). To generate the dense point clouds needed for AV applications, LiDAR devices were designed with multiple emitter-detector pairs mounted on a rotating platform.

However, rotating LiDAR devices used in automotive applications were sensitive to noise and interference. Among other things, light from background sources (*e.g.*, the sun) or from adjacent detector channels (commonly referred to as “cross-talk”) could lead to inaccurate readings. Those skilled in the art thus developed techniques to reduce noise and interference, including the use of optical filters to selectively allow only wavelengths of light corresponding to the LiDAR emitters to pass through to the LiDAR detectors, and the addition of a layer of light-absorbing material separating a plurality of apertures to minimize cross-talk.

The challenged claims of the ‘405 Patent describe these same basic features, incorporated into a conventional rotating LiDAR structure. The claims merely recite a combination of these well-known techniques, used for their conventional purpose with predictable results. Accordingly, as detailed below, a POSITA would have found the challenged claims obvious based on the teachings of the prior art and basic design choices.

For these reasons—as set forth in detail below—Hesai requests that the Board institute *inter partes* review and cancel the challenged claims.

II. MANDATORY NOTICES

A. Real Party-In-Interest

Pursuant to 37 C.F.R. §42.8(b)(1), Hesai Group, Hesai Technology Co., Ltd., and Hesai Inc. are real parties-in-interest.

B. Related Matters

Pursuant to 37 C.F.R. §42.8(b)(2), Ouster asserted the ‘405 Patent against Hesai in parallel complaints filed on April 11, 2023 in the U.S. District Court for the District of Delaware and the U.S. International Trade Commission. *Ouster, Inc. v. Hesai Group et al*, No. 23-cv-00406 (D. Del.) and *Certain LiDAR (Light Detection and Ranging) Systems and Components Thereof*, Inv. No. 337-TA-1363 (USITC). Exs. 1016, 1017. The litigation in the District of Delaware is currently stayed. Ex. 1018. In the ITC Investigation, the presiding Administrative Law Judge has issued

an initial determination granting Hesai's motion to terminate in view of an arbitration Hesai filed against Ouster. Ex. 1020.

Contemporaneous with this Petition, Hesai is also seeking institution of IPR against four other patents that Ouster asserted against Hesai in the aforementioned litigation: US11,422,236; US11,178,381; US11,190,750; and US11,287,515.

C. Lead and Backup Counsel and Service Information

Pursuant to 37 C.F.R. §42.8(b)(3) and (4), the designations of counsel and address for service are listed below. Petitioner consents to electronic service at the email addresses below.

LEAD COUNSEL	BACKUP COUNSEL
Jared W. Newton Reg. No. 65,818 jarednewton@quinnemanuel.com <u>Postal and Hand Delivery Address:</u> QUINN EMANUEL URQUHART & SULLIVAN, LLP 1300 I Street, NW, 9 th Floor Washington, DC 20005 Tel: (202) 538-8108 Fax: (202) 538-8100	James M. Glass Reg. No. 46,729 jimglass@quinnemanuel.com <u>Postal and Hand Delivery Address:</u> QUINN EMANUEL URQUHART & SULLIVAN, LLP 51 Madison Avenue, 22 nd Floor New York, NY 10010 Tel: (212) 849-7000 Fax: (212) 849-7100 Nima Hefazi Reg. No. 63,658 nimahefazi@quinnemanuel.com <u>Postal and Hand Delivery Address:</u> QUINN EMANUEL URQUHART & SULLIVAN, LLP 865 S. Figueroa Street, 10 th Floor

	Los Angeles, CA 90017 Tel: (213) 443-3000 Fax: (213) 443-3100
--	---

III. STANDING

Hesai certifies that the ‘405 Patent is available for IPR, and that Hesai is not barred or estopped from requesting review. Ouster filed a complaint alleging infringement of the ‘405 Patent on April 11, 2023, and service was effectuated no sooner than May 4, 2023. Accordingly, this Petition is timely filed pursuant to 35 U.S.C. §315(b).

IV. PAYMENT OF FEES

Petitioner authorizes the office to charge Deposit Account No. 505708 for the Petition fee set forth in 37 C.F.R. §42.15(a), and for any additional fees.

V. IDENTIFICATION OF CHALLENGE AND RELIEF REQUESTED

Hesai requests cancellation of claims 21 and 23-34 of the ‘405 Patent on the following grounds:

Ground 1: Claims 21, 23, 26-31, and 34 are obvious based on U.S. Patent Pub. No. 2014/0211194 (“Pacala”) in combination with U.S. Patent No. 10,605,984 (“Droz”).

Ground 2: Claims 24-25 and 32-33 are obvious based on the combination of Pacala, Droz, and U.S. Patent No. 10,520,602 (“Villeneuve”).

Ground 3: Claims 21 and 23-33 are obvious based on U.S. Patent No. 9,983,297 (“Hall”) in combination with U.S. Patent Pub. No. 2013/0300840 (“Borowski”) and U.S. Patent No. 10,473,766 (“Spector”).

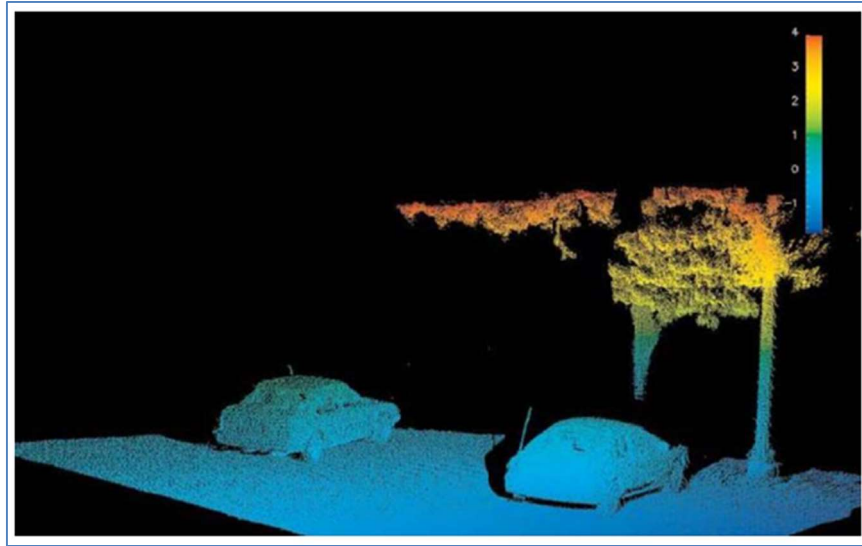
Ground 4: Claim 34 is obvious based on the combination of Hall, Borowski, Spector, and Droz.

The Petition is accompanied by the declaration of Dr. James F. Shanley, an expert in optoelectronics and LiDAR systems. Ex. 1003.

VI. TECHNOLOGY BACKGROUND

The concept of using lasers to detect objects and measure distance dates back to the 1960s, beginning primarily in military applications. Ex. 1003 ¶¶29-33. The core components of a LiDAR system are photon emitters (*e.g.*, lasers), photon detectors (*e.g.*, photodiodes), circuitry to fire the emitters and process signals generated by the detectors, and optical components (*e.g.*, lenses and mirrors) to route photons from the emitters, to the surrounding environment, and back to the detectors. *Id.* ¶¶38-39.

When multiple distance measurements are processed and combined, the result is a three-dimensional map of the surrounding environment, also known as a “point cloud”:



Ex. 1011 at Fig. 6.3; Ex. 1003 ¶40.

By 2005, LiDAR systems for autonomous vehicles had already been implemented. *Id.* ¶34. For example, a company called Velodyne Acoustics developed a LiDAR system for autonomous vehicle navigation in connection with the 2005 DARPA Grand Challenge, a government-sponsored event to incentivize development of autonomous-vehicle technology. Ex. 1026; Ex. 1027, 1-2; Ex. 1003 ¶¶34-35.

Velodyne continues to make and sell LiDAR devices incorporating well-known technological improvements in the field. For example, over one year before the priority date of the ‘405 patent, Velodyne released the VLP-16 “Puck” system, images of which are shown below, which incorporated the design and many of the features later described and claimed in the ‘405 patent. Ex. 1012; Ex. 1003 ¶35. The

implementation of this system is described in numerous Velodyne prior art patents, including U.S. Patent No. 9,983,297 (“Hall”), presented in several grounds herein.



Other companies also developed LiDAR systems for autonomous vehicles, incorporating well-known techniques that improved performance by mitigating interference and noise at the LiDAR detectors. For example, by late 2016, Waymo, the self-driving car company, had already developed a LiDAR detection module incorporating optical filters and apertures to minimize erroneous readings due to background radiation and cross-talk between adjacent detector channels—both elements that Ouster later sought to claim in the ‘405 patent. Ex. 1003 ¶¶36-37. These features were described in Waymo patents, including U.S. Patent No. 10,605,984 (“Droz”), presented herein, months before the priority date of the ‘405 patent.

The types of detectors useful for LiDAR applications were also subject to extensive research long before 2017. Ex. 1003 ¶¶44-49. Traditional LiDAR devices

employed detectors called linear-mode avalanche photodiodes (“APDs”). *Id.* ¶45. But by the relatively late time frame leading up to May 2017, it was common for LiDAR devices to instead use alternative detectors known as Geiger-mode APDs or single-photon avalanche photodiodes (“SPADs”). *Id.* ¶46. Critically here, implementing SPAD detectors in LiDAR devices was known to achieve a number of significant benefits and doing so was conventional by May 2017. *Id.* ¶¶47-49.

VII. THE ‘405 PATENT

A. Overview

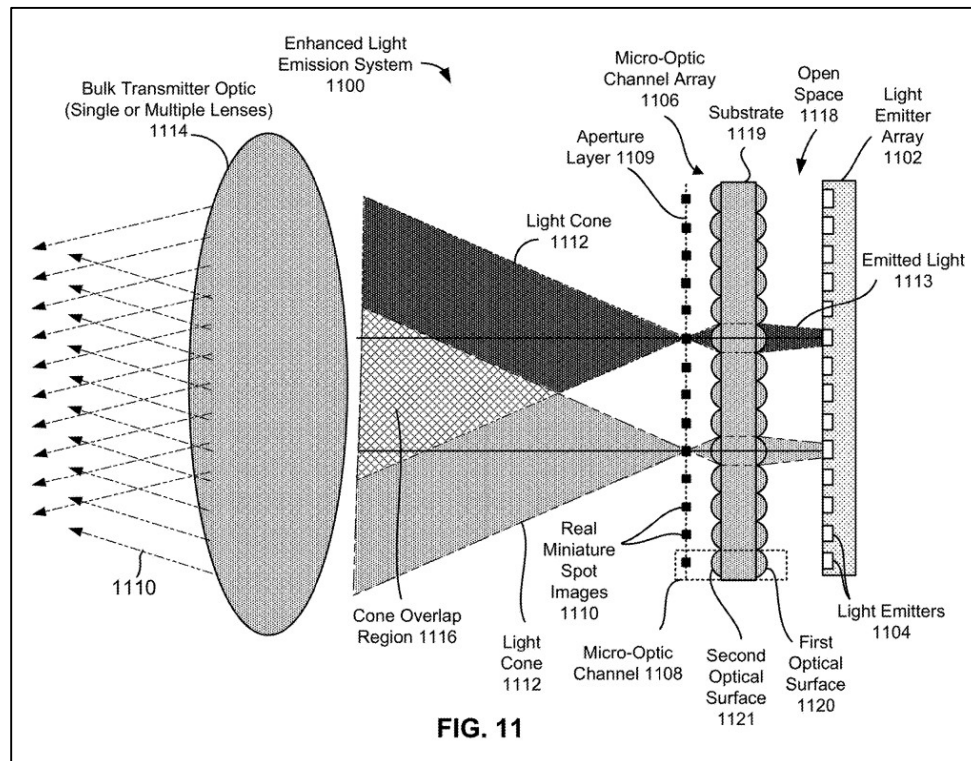
The ‘405 Patent is titled *Spinning LiDAR Unit with Micro-Optics Aligned Behind Stationary Window*. Ex. 1001. The underlying application was filed on May 14, 2018, and claims priority to four provisional applications: Provisional Application Nos. 62/506,449, 62/506,437, and 62/506,445, all filed on May 15, 2017; and Provisional Application No. 62/515,291, filed on June 5, 2017. *Id.*¹

¹ For purposes of this Petition, Hesai has used the filing date of the earliest provisional application, May 15, 2017, as the priority date. Hesai’s use of the provisional date is not a concession that any claim of the ‘405 Patent is entitled to that date for priority.

B. Specification

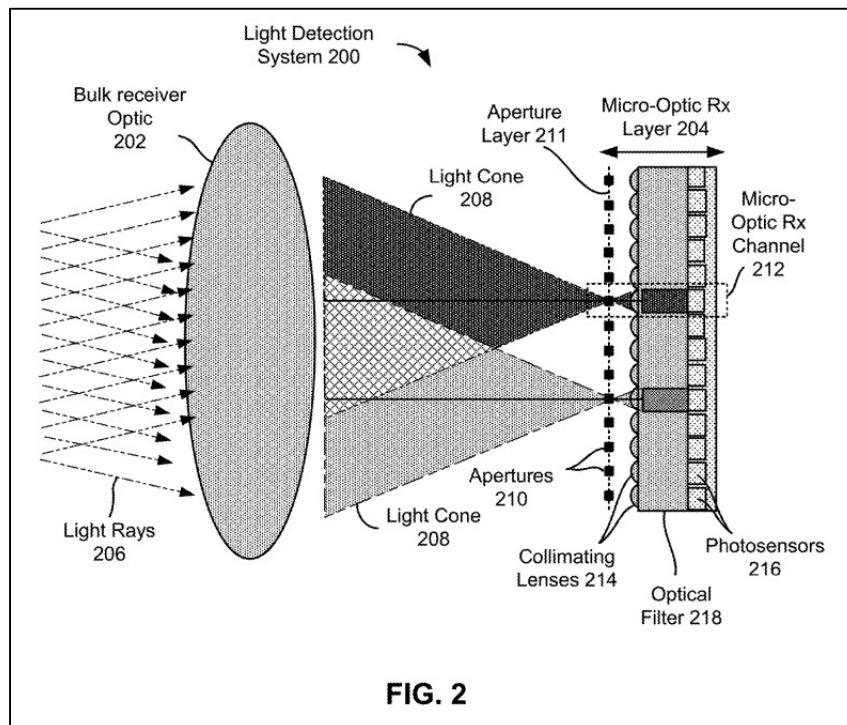
The '405 Patent is directed to a LiDAR system that pairs a light sensing module with a light transmission module that transmits light pulses to objects in a field of view. *Id.*, 16:27-36. Reflected portions of the transmitted light are detected by the light sensing module, and the delay time may be used to measure the distance to an object in the field of view. *Id.*, 16:36-39.

The light transmission module includes an array of emitters, such as laser sources, and a bulk transmitter optic. *Id.*, 16:42-47. An exemplary embodiment of the light transmission module is illustrated in Figure 11:



Id., Fig. 11.

The light sensing module comprises an array of photosensors. *Id.*, 11:37-43. Each photosensor “can include a collection of photodetectors, e.g., SPADs or the like.” *Id.*, 11:39-43. In some embodiments, the light sensing module may include several optical layers and components, including a bulk receiver optic, an aperture layer, and an optical filter. *Id.*, 11:46-53. The aperture layer and optical filter may be used to mitigate “receiver channel cross-talk,” *i.e.*, “stray light” that “bleed[s] into neighboring channels, thereby resulting in inaccurate readings of reflected light for each pixel in the field.” *Id.*, 36:53-63. An exemplary embodiment of the light sensing module is illustrated in Figure 2:



Id., Fig. 2.

C. Prosecution History

The application underlying the '405 Patent was filed on May 14, 2018, with twenty claims. Ex. 1002. None of the claims presently challenged were included in the original application. *Id.*, 1177-1181

On February 22, 2021, the Examiner issued a non-final rejection finding all then-pending claims obvious based on U.S. Patent Publication No. 2016/0282453 to Pennecot in view of U.S. Patent Publication No. 2014/0320843 to Steuber, as well as combinations thereof with several other patents and patent publications, none of which are asserted herein. *Id.*, 222-235. The Examiner also raised non-statutory double patenting rejections for a subset of the claims. *Id.*

In response, the Applicant amended each independent claim to recite an aperture layer comprising a plurality of apertures separated by a stop region, cancelled several dependent claims, and entered a terminal disclaimer to overcome the double patenting rejection. *Id.*, 187-200 The Applicant also added eight new claims, including the claims that later issued as present claims 21 and 23-25. *Id.*

On June 15, 2021, the Examiner issued a Notice of Allowance, finding all then-pending claims patentable and making several amendments discussed in a telephone interview with applicant's representative. *Id.*, 128-136. Thereafter, the Applicant submitted a Request for Continuing Examination and added nine new claims, including the claims that later issued as present claims 26-34. *Id.*, 77-89. On

September 20, 2021, the Examiner issued a second Notice of Allowance, finding all then-pending claims patentable and making a non-substantive amendment. *Id.*, 13-20. No Reasons for Allowance were provided by the Examiner in any of the Notices of Allowance.

D. Claims

Hesai challenges claims 21 and 23-34. The full text of the challenged claims is reproduced above beginning on page vii.

VIII. LEVEL OF ORDINARY SKILL IN THE ART

A POSITA as of May 15, 2017 would have had an undergraduate degree in mechanical or electrical engineering or physics and two to three years of experience in LiDAR design. Less work experience may be compensated by a higher level of education or vice versa. Ex. 1003 ¶¶75-80.

IX. CLAIM CONSTRUCTION

Petitioner does not believe any terms require construction to resolve the patentability disputes. In the ITC action, the parties (and ITC staff) exchanged preliminary constructions. Ex. 1019. Petitioner demonstrates how the prior art renders obvious the challenged claims under any proposed construction because the predictable combinations result in a configuration that is remarkably similar to the preferred embodiment of the '405 patent. In such circumstances, the Board need not

formally construe the claims. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

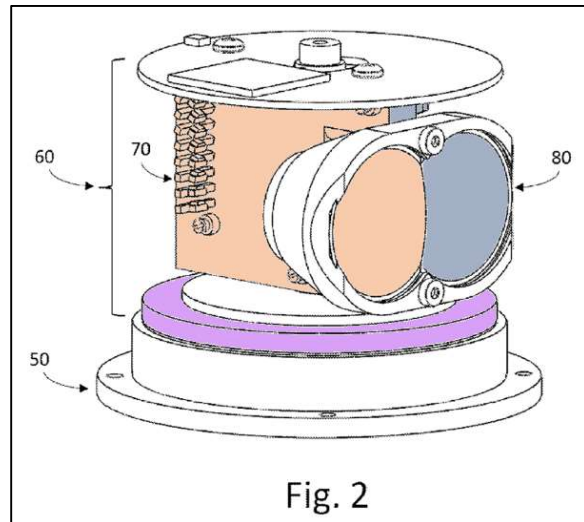
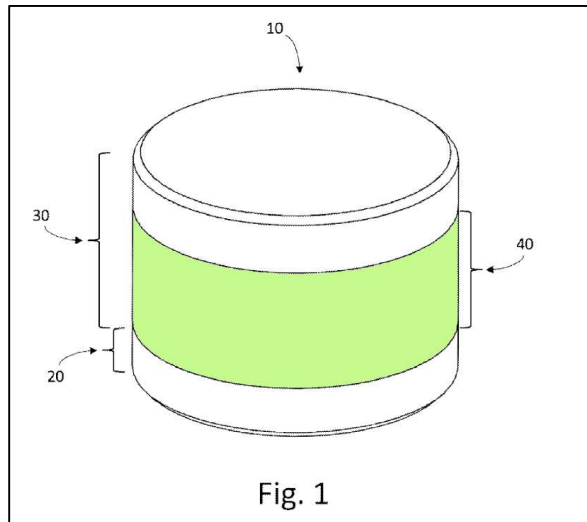
X. GROUND 1: PACALA AND DROZ RENDER OBVIOUS CLAIMS 21, 23, 26-31, AND 34

A. U.S. Patent Pub. No. 2014/0211194 (“Pacala”)

Pacala is titled *Cost-effective lidar sensor for multi-signal detection, weak signal detection and signal disambiguation and method of using same*. Ex. 1004. It was filed on January 27, 2014 and published July 31, 2014. *Id.* It therefore qualifies as prior art under 35 U.S.C. §102(a)(1)-(2).

The application underlying the Pacala reference, which ultimately went abandoned, was originally assigned to Quanergy Systems, Inc., a LiDAR company that went bankrupt in 2022. Notably, one of the three named inventors—Angus Pacala—later went on to found Ouster and is also a named inventor on the ‘405 Patent. Ex. 1001.

Pacala describes “the use of cost-effective robust time-of-flight (ToF) lidar sensors for real-time wide-field-of-view three-dimensional mapping and object detection...” Ex. 1004, [0003]. The principal embodiment is a LiDAR sensor shown in Figures 1 and 2:



Id., Figs. 1-2 (annotated).

Pacala's LiDAR sensor 10 includes a static base 20/50 and a rotating turret 60 with a platform (purple) operatively connected to the static base. *Id.*, [0012]-[0013]. Mounted on the turret are optoelectronic components 70, lenses 80, and distributed electronics. *Id.* Surrounding the rotating components on the exterior of the sensor is a transparent window 40 (green). *Id.* Pacala explains that the optoelectronic components 70 include transmitters such as lasers, and receivers such as a detector array (including a SPAD array) that comprises pixels. *Id.*, [0012]-[0014]. Pacala's transmitters and collimation lens form a light transmission module (blue) for generating and transmitting light pulses into a field, while the receivers and focusing lens form a light sensing module (orange) for detecting photons reflected from surfaces within the field. Ex. 1003 ¶88.

Pacala is analogous art to the '405 patent because both references are in the same field of endeavor, *i.e.*, LiDAR devices. *See* Ex. 1003 ¶¶84, 133. A POSITA would have thus looked to Pacala when considering how to implement and improve the operation of known LiDAR devices. *Id.*

B. U.S. Patent No. 10,605,984 (“Droz”)

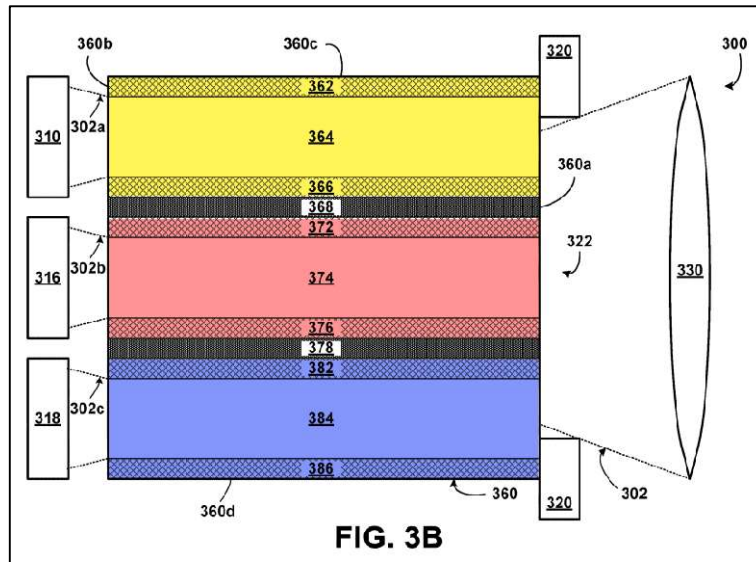
Droz is titled *Array of Waveguide Diffusers for Light Detection Using an Aperture*. Ex. 1006. It was filed on December 1, 2016. *Id.* It therefore qualifies as prior art under 35 U.S.C. §102(a)(2).

Droz teaches improvements to the detection module of a LiDAR device to increase detection sensitivity while minimizing the impact of noise and interference. Ex. 1006, 1:10-23, 3:2-7. For example, Droz discloses an “array of SPADs can be connected in parallel to one another, which may allow combining the signals from the connected SPADs to improve the sensitivity of the system.” *Id.*, 3:63-67.

The increased sensitivity of the system, however, also makes it more susceptible to noise from background light and cross-talk interference. Ex. 1003 ¶¶50-56, 91. Droz identifies two potential sources of noise that can affect the accuracy of the system. First, increased light intensity from background radiation can cause SPADs to become less reliable because “[o]nce a SPAD absorbs a single photon ... the SPAD cannot detect additional photons until the SPAD is quenched (e.g., by restoring the reverse-bias voltage).” Ex. 1006, 10:63-11:15. “If additional

photons are arriving at time intervals approaching the recovery time ... the SPAD may begin to saturate, and the measurements by the SPAD may thus become less reliable.” *Id.*, 11:7-10. Second, light reflected to the LiDAR device may “diverge and overlap prior to arriving at the array of light detectors,” “thereby reducing the SNR [signal-to-noise ratio] of the detected signal.” *Id.*, 4:12-14, 12:50-55.

Droz teaches different techniques to solve each of these problems. First, an “optical filter configured to selectively transmit light within a predefined wavelength range” may be used to “reduce ambient light or background light from adversely affecting measurements by array 110.” *Id.*, 7:51-64. Second, a waveguide array with a plurality of waveguides may be used to direct light to a particular array of light detectors corresponding to one pixel. *Id.*, 4:1-28, 13:23-54. A layer of light-absorbing material may be placed between waveguides to prevent light from leaking into adjacent waveguides. *Id.*, 13:39-43, 14:47-60. Figure 3B illustrates an exemplary arrangement of three waveguides and light detector arrays:



Id., Fig. 3B (annotated).

Droz is analogous art to the ‘405 patent because both references are in the same field of endeavor, *i.e.*, LiDAR devices. *See* Ex. 1003 ¶¶84, 133. A POSITA would have thus looked to Droz when considering how to implement and improve the operation of known LiDAR devices. *Id.*

C. The Pacala-Droz Combination

In the proposed Pacala-Droz combination, Pacala’s teachings provide the basic structure of a rotating LiDAR device, including a housing with a 360-degree window that encloses a rotating platform on which a LiDAR sensor is mounted. Ex. 1003 ¶¶125-128. The LiDAR sensor includes basic optoelectronic components detailed in Pacala, such as bulk transmitter and receiver optics, emitters, and photosensors (specifically, SPADs). *Id.* The teachings of Droz are then relied upon to improve the implementation and configuration of the detection module within

Pacala's broader system by applying well-known elements disclosed in Droz, including SPAD arrays, optical filters, and waveguide arrays, to improve Pacala's system in a predictable manner. *Id.* The Pacala-Droz combination renders claims 21, 23, 26-31, and 34 obvious.

1. Motivation to Combine

A POSITA would have been motivated to apply Droz's teachings to Pacala's LiDAR device, and would have had a reasonable expectation of success in combining the references. Ex. 1003 ¶¶129-133.

First, a POSITA would have understood that the teachings of Droz are generally applicable to LiDAR devices, including the LiDAR device of Pacala. *Id.* ¶133. Pacala was filed in early 2014 and describes many standard components of a rotating LiDAR device for autonomous vehicle applications. As rotational LiDAR technology continued to advance, however, devices like Pacala were subject to improvements in their design, operation, and components. Droz teaches several such improvements, whose benefits could be predictably and successfully applied to other LiDAR systems (including Pacala's). *Id.* Indeed, LiDAR devices had been widely studied and used by May 2017, and the state of the art confirms that a POSITA would have had a reasonable expectation of success in applying Droz's known techniques to Pacala's conventional LiDAR device using basic electrical engineering design principles. *Id.*

Second, to the extent Pacala does not disclose the use of SPAD arrays, a POSITA would have been motivated to modify Pacala to incorporate SPAD arrays in view of Droz. Ex. 1003 ¶130. Pacala teaches that conventional LiDAR devices “can miss low intensity pulses.” Ex. 1004, [0007]. Droz expressly teaches that using a plurality of interconnected SPADs to represent a pixel “improve[s] the sensitivity of the system,” thereby “enhancing the[] detection qualities” of the system. Ex. 1006, 1:10-23, 3:63-67. Further, Droz discloses (and a POSITA would have known) that once an individual SPAD absorbs a photon, it “cannot detect additional photons until the SPAD is quenched”—a period of time “referred to as the recovery time.” *Id.*, 11:2-10. A POSITA would have thus understood that employing an array of SPADs beneficially reduces the likelihood of missed pulses due to an individual SPAD’s recovery time, because a plurality of SPADs is used to detect photon associated with a single pixel. Ex. 1003 ¶130.

Third, a POSITA would have been motivated to modify Pacala to incorporate optical filters in view of Droz. Ex. 1003 ¶131. Droz teaches that optical filters that “selectively transmit light within a predefined wavelength range” (*e.g.*, bandpass filters) may be used to “reduce ambient light or background light from adversely affecting measurements” by a SPAD array. Ex. 1006, 7:51-64. Droz explains that the “reduction in light intensity” is “particularly beneficial” for SPAD arrays because “reducing the light power incident on” the individual SPADs increases the

accuracy of each individual SPAD in the array. *Id.*, 10:63-11:15. A POSITA would further have known that the particular positioning of the optical filters within the system is a design choice, and that the filter may be positioned in any number of locations between the bulk optics and the detectors to achieve the intended function. Ex. 1003 ¶131.

Fourth, a POSITA would have been motivated to modify Pacala to use waveguides as taught by Droz. Ex. 1003 ¶132. Droz teaches that waveguides increase “the number of light detectors able to fit into a detection area,” and thus allow for more SPADs within the SPAD array, increasing sensitivity and detection quality as discussed above. Ex. 1006, 3:34-67. Droz also teaches that waveguides prevent received light from “diverg[ing] and overlap[ping] prior to arriving at the array of light detectors,” and thus allow for more precise detection even when the distance between adjacent detectors is small—particularly when a light-absorbing material is included between adjacent waveguides. *Id.*, 4:1-28, 4:4-48, 13:39-43, 14:47-60.

2. Claim 21

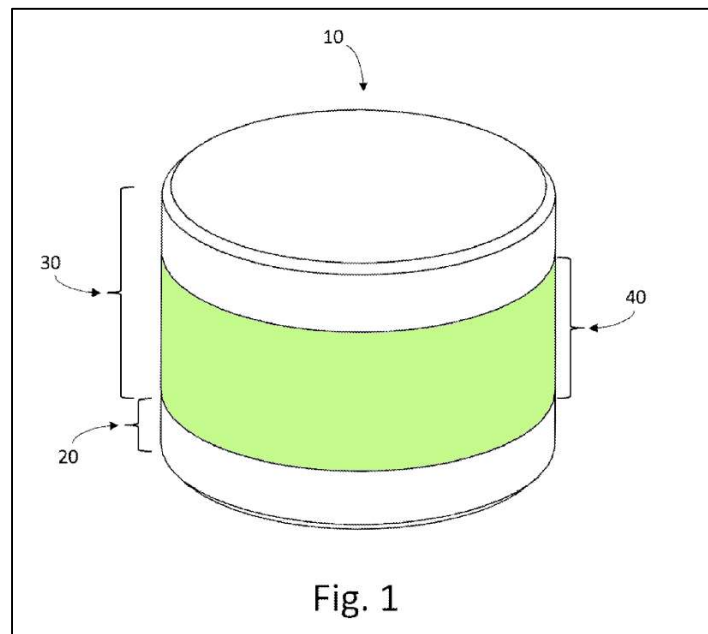
a) Limitation 21(a): “An optical system...”

To the extent the preamble is limiting, Pacala discloses limitation 21(a). Ex. 1003 ¶135-136. Pacala teaches a “lidar-based apparatus and method.” Ex. 1004,

Abstract. Pacala also teaches that a “lidar sensor ... can measure the distance to a target or objects in a landscape.” *Id.*, [0004].

b) Limitation 21(b): “a stationary housing...”

Pacala discloses limitation 21(b). Ex. 1003 ¶¶137-138. Pacala teaches that lidar sensor 10 includes a “static base 20 and a static head assembly 30 that includes a window 40 that is transparent at the wavelength of the laser used in each transmitter.” Ex. 1004, [0012]. As illustrated in Figure 1, the window (green) is disposed between the static base and the top of the static head assembly:



Ex. 1004, Fig. 1 (annotated). A POSITA would have understood and it would have been obvious that Pacala’s window extends fully around the periphery of the stationary housing comprising the static base and static head assembly. Ex. 1003

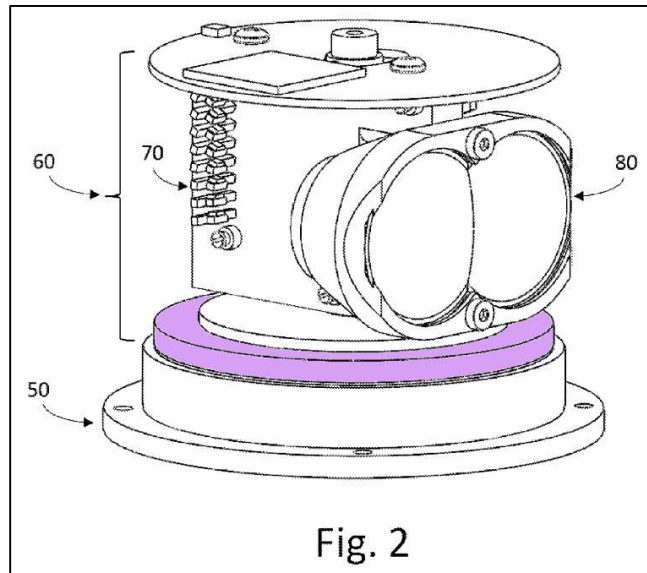
¶138. Related patent references corroborate this understanding. *Id.*; Ex. 1013, [0014], [0017], [0021], Fig. 1, cl. 12.

c) Limitation 21(c): “a light ranging device...”

Pacala discloses limitation 21(c). Ex. 1003 ¶139. Pacala teaches that its system is a “lidar sensor,” which is a “light detection and ranging sensor.” Ex. 1004, [0004], [0011]-[0012], Figs. 1-2. Figure 1 provides an “external view” of the system; accordingly, the “light ranging” components are disposed internal to (*i.e.*, within) the housing depicted in Figure 1. Pacala teaches that this “internal” portion of its lidar sensor includes a “a spinning turret 60 that contains optoelectronic components 70 (including optical transmitters and receivers), collimation and focusing lenses 80 and distributed electronics,” which are standard components in a lidar-based light ranging device. *Id.*, [0013].

d) Limitation 21(d): “a platform”

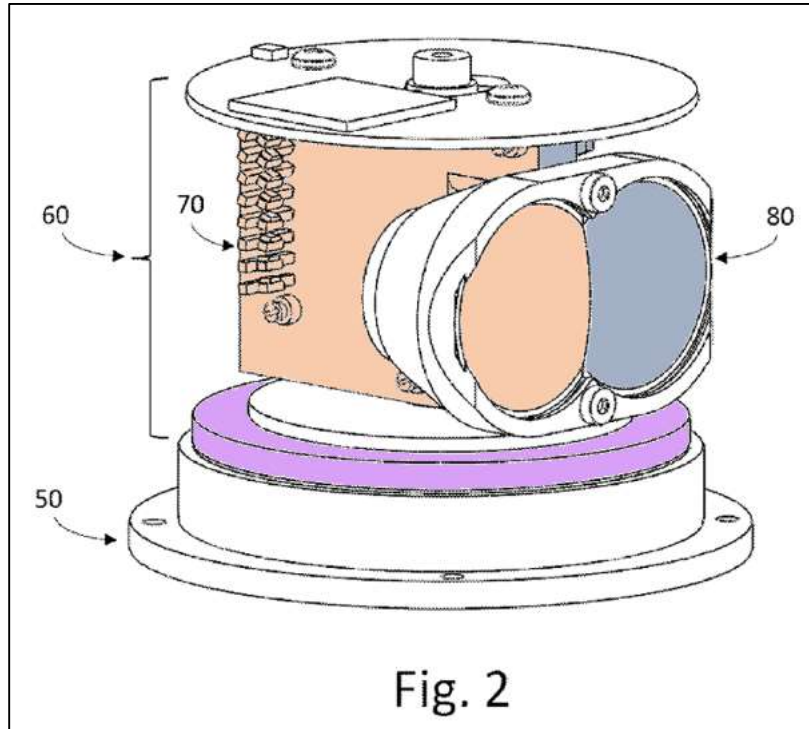
Pacala discloses and renders obvious limitation 21(d). Ex. 1003 ¶¶140-141. Pacala teaches that its lidar sensor includes a spinning turret 60 that contains “optoelectronic components 70 ..., collimation and focusing lenses 80 and distributed electronics.” Ex. 1004, [0013]. As shown in Figure 2, the base of the spinning turret includes a platform (purple) on which the optical, electronic, and optoelectronic components are mounted:



Ex. 1004, Fig. 2 (annotated). Related patent references corroborate that Pacala's transmitters and receivers are mounted to a rotating platform. Ex. 1003 ¶141; Ex. 1013, cl. 11.

e) Limitation 21(e): “a light transmission module...”

Pacala discloses and renders obvious limitation 21(e). Ex. 1003 ¶¶142-145. Pacala teaches that its spinning turret 60 contains “optoelectronic components 70 (including optical transmitters and receivers), collimation and focusing lenses 80 and distributed electronics.” Ex. 1004, [0013]. As illustrated in Figure 2, the optical, electronic, and optoelectronic components of spinning turret 60 are coupled to the platform at its base:



Ex. 1004, Fig. 2 (annotated). A POSITA would have understood and it would have been obvious that Pacala's spinning turret 60 comprises two modules coupled to the turret platform (purple): a light transmission module (blue) and a light sensing module (orange). Ex. 1003 ¶143. Related patent references corroborate this understanding. *Id.*; Ex. 1014, 3:19-27, Figs. 2-3.

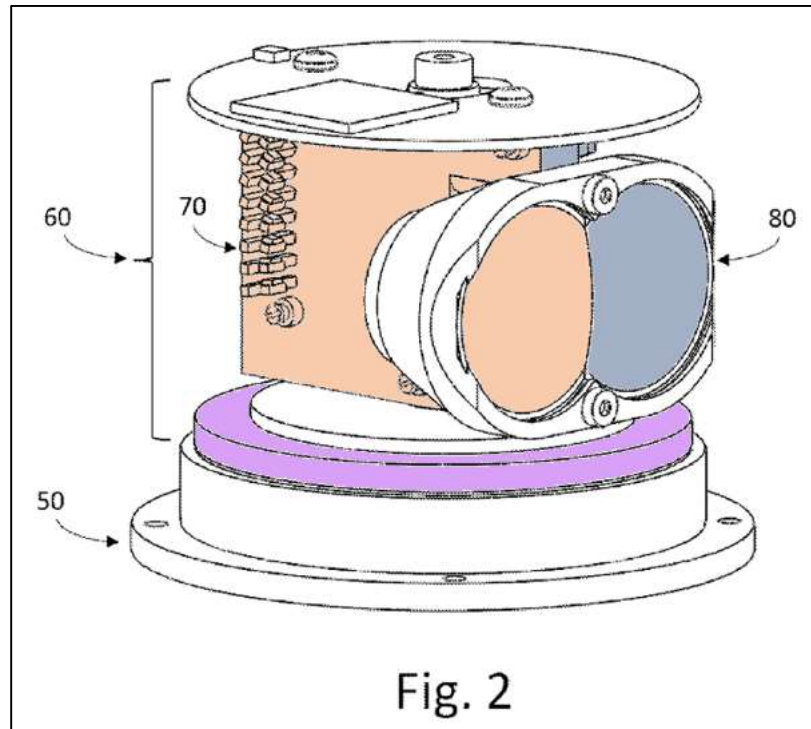
Pacala further discloses and renders obvious a bulk transmitter optic. Ex. 1003 ¶144. For example, Pacala teaches that spinning turret 60 contains "collimation and focusing lenses 80." Ex. 1004, [0013]. A POSITA would have understood and it would have been obvious that these refer to two different lenses, and that the collimation lens is a bulk transmitter optic. Ex. 1003 ¶144. The '405

patent confirms that the bulk transmitter optic can be a “lens” that “outputs a collimated beam.” Ex. 1001, 30:20-22, 31:15-16.

Pacala further discloses and renders obvious a plurality of optical emitters. Ex. 1003 ¶145. For example, Pacala discloses “optical transmitters” (plural) that “irradiat[e] [a] target or landscape with light, using pulses.” Ex. 1004, [0004], [0013]. A POSITA would have understood and it would have been obvious that because Pacala’s transmitters are positioned behind the collimation lens (the blue lens of lenses 80 in Figure 2, shown above) and are internal to the exterior housing and window (in Figure 1), light transmitted onto a target or landscape field will pass through the lens and window. Ex. 1003 ¶145.

f) Limitation 21(f): “a light sensing module...”

The combined teachings of Pacala and Droz render limitation 21(f) obvious. Ex. 1003 ¶¶146-153. As discussed in Section X.C.2(e), Pacala’s turret 60 contains a light sensing module (orange) coupled to the turret platform (purple):



Ex. 1004, Fig. 2 (annotated), [0013].

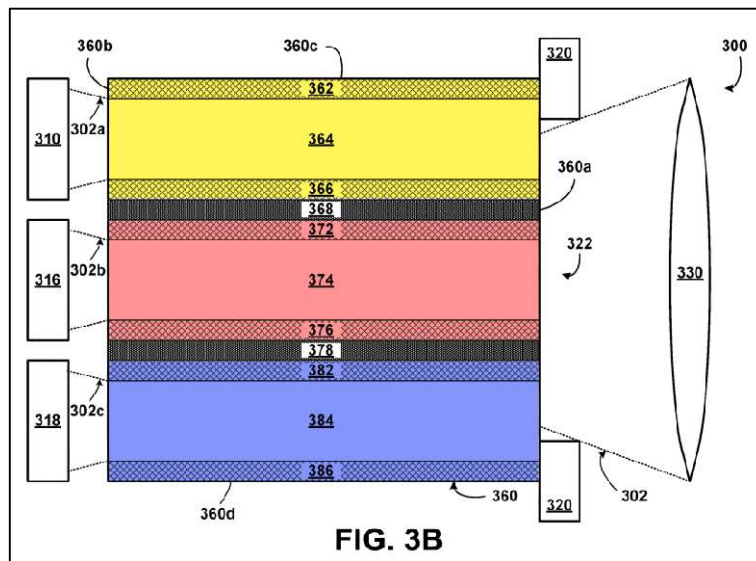
Pacala further discloses and renders obvious a bulk receiver optic. Ex. 1003 ¶147. A POSITA would have understood and it would have been obvious that Pacala’s “focusing lens[]” is a bulk receiver optic. Ex. 1004, [0013]. The ‘405 Patent confirms that “light rays” are “focused by bulk receiver optic 202.” Ex. 1001, 30:20-22, 31:15-16.

Pacala further discloses and renders obvious a plurality of photosensors. Ex. 1003 ¶148. For example, Pacala discloses “optical ... receivers” that detect photons that “travel to [a] target or landscape and return after reflection.” Ex. 1004, [0004], [0013]. A POSITA would have understood and it would have been obvious that because Pacala’s receivers are positioned behind the focusing lens (the orange lens

of lenses 80 in Figure 2, shown above), reflected photons will pass through the focusing lens before they are detected at the receivers. Ex. 1003 ¶148.

Pacala does not expressly teach an aperture layer or optical filters. However, as discussed above, it would have been obvious to POSITA to modify Pacala to include these elements in view of Droz. Ex. 1003 ¶149.

First, Droz teaches a waveguide array 360 that includes a plurality of waveguides, which collectively comprise an aperture layer. Ex. 1006, 13:23-26. Each waveguide includes an optically transparent core layer (*e.g.*, core layers 364, 374, and 384), surrounded by cladding layers (*e.g.*, cladding layers 362, 366, 372, 376, 382, and 386) designed to reflect light at the edge of a core layer and guide it through the waveguide. *Id.*, 13:27-54. Figure 3B illustrates an exemplary arrangement of three waveguides:



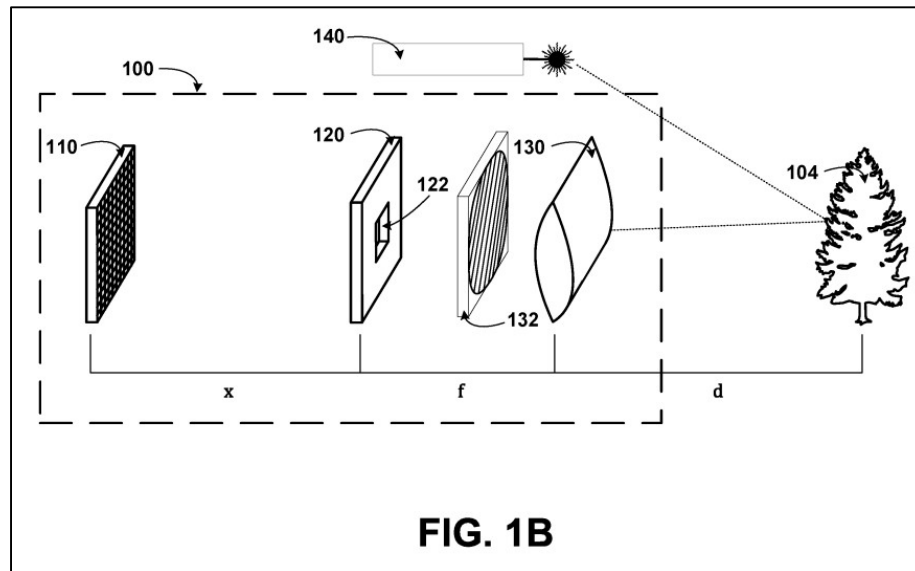
Id., Fig. 3B (annotated).

Each waveguide receives a portion of light 302 on an input side of the waveguide (side 360a) and guides the light toward and out of an output end of the waveguide (side 360b). *Id.*, 14:4-17. Light detectors (*e.g.*, light detector arrays 310, 316, and 318) are “positioned adjacent to the output end” of a waveguide “to intercept and detect” light guided through that waveguide. *Id.*, 14:11-17. “[E]ach respective input end of the waveguides in array 360 may correspond to a respective aperture of system 300.” *Id.*, 16:18-21. When applied to Pacala’s LiDAR device, Droz’s waveguide array would provide a plurality of apertures (the input ends of the waveguides). Ex. 1003 ¶¶150-151. Droz also teaches that a layer of light-absorbing material (*e.g.*, absorbing layers 368 and 378) is provided between waveguides to absorb leakage from one waveguide to an adjacent waveguide. Ex. 1006, 13:39-43, 14:47-60. The light-absorbing material comprises a stop region separating the apertures. Ex. 1003 ¶151.

Second, Droz teaches an optical filter 132 disposed between a bulk receiver optic and a plurality of photosensors. Ex. 1006, 7:50-8:10. The optical filter 132 “may be located in various positions relative to [light detector] array 110,” including between a lens and an aperture, between the aperture and the light detector array, on the surface of the light detector array, or on the surface of the lens. *Id.*, 7:65-8:10. Droz’s optical filter is “configured to selectively transmit light within a predefined wavelength range” and “may be configured to divert light of particular wavelengths

away from the array 110,” such as light “that is not of the wavelength range emitted by emitter 140.” *Id.*, 7:51-61.

Figure 1B illustrates one arrangement in which optical filter 132 is disposed between the lens 130 and light detector array 110:

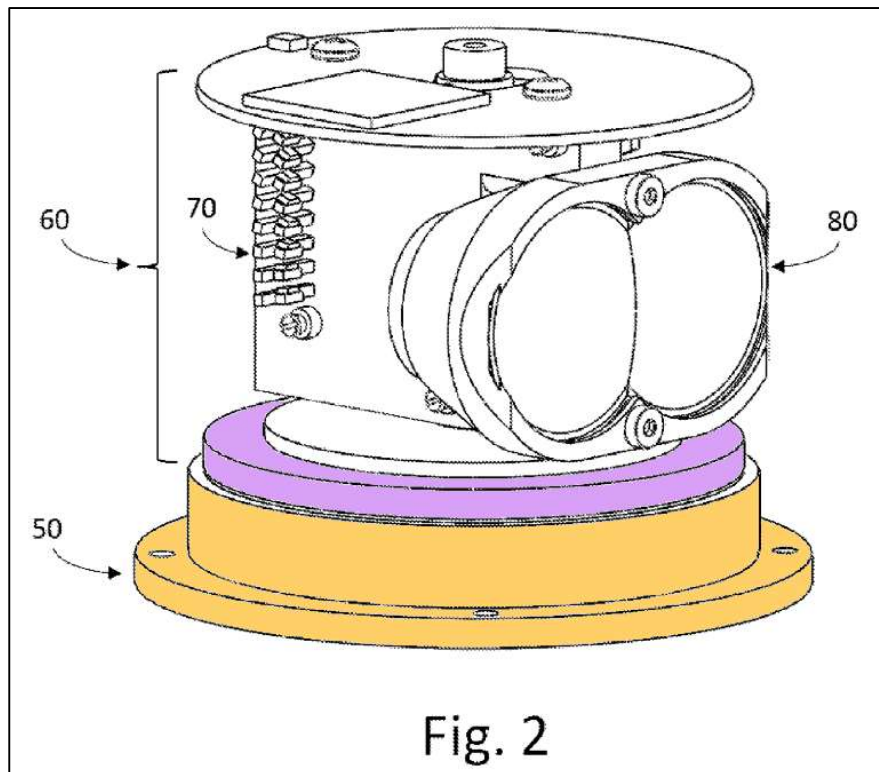


Id., Fig. 1B. When applied to Pacala’s system, Droz’s optical filter would be positioned between Pacala’s bulk receiver optic (a lens) and Pacala’s optical receivers (photosensors), and would filter background light so that only a band of radiation including the wavelength of the emitters passes through the filter. Ex. 1003 ¶152.

As detailed in Section X.C.1, a POSITA would have been motivated to use a waveguide array and optical filters as disclosed in Droz to reduce cross-talk interference and interference from background sources of light in Pacala’s LiDAR device. The resulting structure would meet the elements of limitation 21(f).

g) *Limitation 21(g): “a motor...”*

Pacala discloses and renders obvious limitation 21(g). Ex. 1003 ¶153. Pacala teaches that static base 50 of its housing “contains a motor.” Ex. 1004, [0013]. A POSITA would have understood and it would have been obvious that the platform of spinning turret 60 (as shown in Figure 2) is operatively coupled to the motor of static base 50 to spin the platform and its light ranging device (implemented in the optical, electronic, and optoelectronic components of spinning turret 60).



Id., Fig. 2. Because static base 50 is static, spinning turret 60 must be coupled to the motor within static base 50 to spin. Ex. 1003 ¶153.

h) Limitation 21(h): “wherein: each photosensor...”

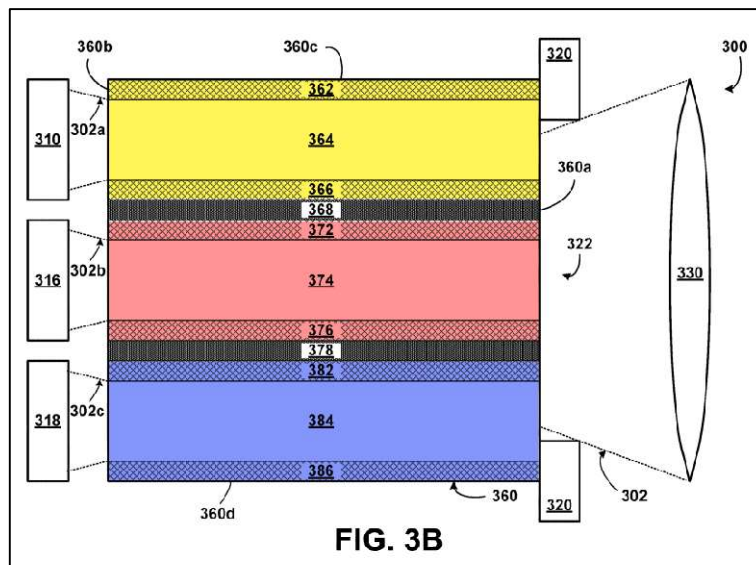
The combined teachings of Pacala and Droz render limitation 21(f) obvious. Ex. 1003 ¶¶154-155. Pacala discloses that its optical receivers may be “a detector array” such as a SPAD array. Ex. 1004, [0014]. A POSITA would have understood and it would have been obvious that each photosensor (*e.g.*, each pixel) in Pacala comprises a SPAD array with a plurality of SPADs. Ex. 1003 ¶154; Ex. 1001, 11:39-43 (teaching that a “photosensor” may be “referred to by one skilled in the art as a ‘pixel’”). Related patent references corroborate this understanding. Ex. 1003 ¶154; Ex. 1014, 2:51-57, 4:22-25.

Alternatively, Droz teaches a plurality of light detector arrays, where each light detector array “correspond[s] to an image pixel.” Ex. 1006, 13:1-3, 14:37-40; *see also id.*, 4:9-11 (“[E]ach array of light detectors can be connected in parallel to provide a combined output that represents a single image pixel of the scene.”). Droz further teaches that each light detector array “may include a plurality of light detectors,” such as a plurality of SPADs. *Id.*, 13:3-6, 5:28-29, 18:55-57. To the extent Pacala does not disclose that each photosensor comprises a plurality of SPADs, it would have been obvious to POSITA to modify Pacala to use a plurality of SPADs for each pixel, as taught by Droz. Ex. 1003 ¶155.

i) *Limitation 21(i): “the plurality of apertures...”*

The combined teachings of Pacala and Droz render limitation 21(i) obvious.

Ex. 1003 ¶156. As discussed above, a POSITA would be motivated to modify Pacala to use waveguides as taught by Droz, and Droz's waveguide array comprises an aperture layer (*i.e.*, the input end of each waveguide is an aperture). *See* Sections X.C.1, X.C.2(f); Ex. 1006, 16:19-21. In an exemplary embodiment (illustrated in Figure 3B), the waveguide array includes three waveguides (and thus three apertures):



Ex. 1006, Fig. 3B (annotated), 13:48-54. However, Droz expressly teaches that the waveguide array “may include fewer *or more* than the three waveguides shown.”

Ex. 1006, 16:54-55. The number of waveguides corresponds to the number of photosensors; Pacala includes more than three optical receivers, and thus the

combined system includes at least first, second, third, and fourth apertures. Ex. 1003 ¶156.

j) Limitations 21(j): “the plurality of photosensors...”

The combined teachings of Pacala and Droz render limitation 21(j) obvious. Ex. 1003 ¶¶157-158. Droz teaches that each waveguide may guide a portion of light toward a different one of the plurality of light detector arrays (*e.g.*, light detector arrays 310, 316, and 318 in Fig. 3B). Ex. 1006, 14:4-17. In addition, an absorbing layer may be provided between each pair of waveguides (*e.g.*, absorbing layers 368 and 378 in Figure 3B) to prevent leakage of light between adjacent waveguides. *Id.*, 14:47-60. When applied to Pacala’s system, each waveguide (*i.e.*, each aperture) would thus provide an optical path to its corresponding light detector array. Ex. 1003 ¶158. Thus, for four or more waveguides (*see* Section X.C.2(i)), each of the four waveguides will have an associated light detector array and a corresponding optical path through the waveguide. Ex. 1003 ¶¶157-158.

3. Claim 23

Pacala in view of Droz renders obvious claim 23. Ex. 1003 ¶159. Pacala teaches that LiDAR sensors “can measure the distance to a target or objects in a landscape” by “irradiating the target or landscape with light, using pulses ... from a laser, and measuring the time it takes photons to travel to said target or landscape and return after reflection to a receiver in the lidar module.” Ex. 1004, [0004].

4. Claim 26

a) Limitations 26(a)-26(e)

Limitations 26(a)-26(e) are identical to limitations 21(a)-21(e), and are disclosed by Pacala for the reasons set forth above with respect to claim 21. *See* Sections X.C.2(a)-(e).

b) Limitation 26(f): “a light sensing module...”

The combined teachings of Pacala and Droz render limitation 26(f) obvious. Limitation 26(f) is substantially identical to limitation 21(f), and is largely rendered obvious for the reasons set forth above with respect to claim 21. *See* Section X.C.2(f).

While limitation 21(f) requires “an optical filter” configured to allow a “band of radiation” to pass through the filter while “blocking radiation outside the band,” limitation 26(f) requires “one or more optical filters” that allow a “set of wavelengths of radiation” to pass through the filters while “blocking radiation outside that set.” To the extent these differences are deemed substantive,² Droz also discloses one or

² The indefinite articles “a” or “an” mean “one or more” in open-ended “comprising” claims. *KCJ Corp. v. Kinetic Concepts, Inc.*, 223 F. 3d 1351, 1356 (Fed. Cir. 2000). Accordingly, absent a “clear intent” to limit the article to the singular, there is no difference in claim scope between “an optical filter” in claim 21

more optical filters. Ex. 1003 ¶¶163-165. For example, Droz teaches that optical filter 132 may be implemented such that “each of the light detectors in array 110 may individually be covered by a separate optical filter.” Ex. 1006, 8:4-6. Droz further teaches that optical filter 132 “can be configured to selectively transmit light within a predefined wavelength range,” such as “a visible wavelength range, an infrared wavelength range, or any other wavelength range” emitted by a light emitter. *Id.*, 7:51-57.

c) Limitations 26(g)-26(j)

Limitations 26(g)-26(j) are identical to limitations 21(g)-21(j), and are rendered obvious by Pacala and Droz for the reasons set forth above with respect to claim 21. *See* Sections X.C.2(g)-(j).

5. Claim 27

Pacala and Droz render claim 27 obvious. Ex. 1003 ¶167. Droz teaches alternatively using a single or a plurality of optical filters configured to allow a band of radiation to pass through the filter(s) while blocking radiation outside the band. *See* Section X.C.4(b). Droz also expressly teaches that the one or more optical filters may be a “bandpass optical filter.” Ex. 1006, 9:18-19.

and “one or more optical filters” in claim 26. *Id.* Nevertheless, as described above, Droz discloses both a singular optical filter and a plurality of optical filters.

6. Claim 28

Pacala and Droz render claim 28 obvious. Ex. 1003 ¶168. As discussed above in connection with limitation 26(f), Droz expressly teaches that “each of the light detectors in array 110 may individually be covered by a separate optical filter,” such that a plurality of optical filters is provided for the plurality of photosensors. Ex. 1006, 8:4-6; Ex. 1003 ¶168

7. Claim 29

Pacala and Droz render claim 29 obvious. Ex. 1003 ¶169. Droz teaches that its optical filters “may be located in various positions,” including on a “surface screen” of the light detector array or a “surface screen” of the lens. Ex. 1006, 7:65-8:10. A POSITA would have understood and it would have been obvious that such a “surface screen” is a transparent substrate, because light must pass through the screen to be received at and detected by the light detector array. Ex. 1003 ¶169.

8. Claim 30

Pacala and Droz render claim 30 obvious. Ex. 1003 ¶170. Droz teaches an embodiment in which “each of the light detectors in array 110 may individually be covered by a separate optical filter.” Ex. 1006, 8:4-6. Further, each array of light detectors corresponds to a single photosensor, and thus to a single optical path. *See* Section X.C.2(h), (i). Accordingly, when applied to Pacala’s system, each optical

path (including the first optical path) would have a plurality of optical filters (one for light detector in the corresponding array) disposed in that path. Ex. 1003 ¶170.

9. Claim 31

The additional limitation of claim 31 is identical to the additional limitation of claim 23, and is disclosed by Pacala for the reasons set forth above with respect to claim 23. *See* Section X.C.3.

10. Claim 34

Pacala and Droz render claim 34 obvious. Ex. 1003 ¶172. As described above in connection with claim 30, Droz teaches an embodiment in which each optical path between a photosensor and an aperture has a plurality of optical filters disposed in that path—one for each of the plurality of light detectors (*i.e.*, SPADs) in the particular photosensor. *See* Section X.C.8.

XI. GROUND 2: PACALA, DROZ, AND VILLENUEVE RENDER OBVIOUS CLAIMS 24-25 AND 32-33

A. U.S. Patent No. 10,520,602 (“Villeneuve”)

Villeneuve is titled, *Pulsed laser for lidar system*. Ex. 1007. It was filed on November 12, 2013. It thus qualifies as prior art under 35 U.S.C. §102(a)(2).

Villeneuve teaches a LiDAR system with one or more “sensor heads,” each of which is configured to emit pulses of light. Ex. 1007, 14:12-17, 15:6-13, 16:57-65. To improve the performance of the system across a range of distances (up to a maximum distance), Villeneuve teaches aligning the field of view of a light source

(FOV_L) and the field of view of a receiver (FOV_R). *Id.*, 55:37-56:52. More specifically, Villeneuve explains that light emitted by the light source will be sent in the direction of FOV_L, and reflected light within the FOV_R may be detected at the receiver. *Id.*, 55:47-55.

To ensure that emitted light is detected at the receiver across different ranges, Villeneuve teaches that the angular size of the FOV_L and FOV_R, each of which defines a cone-shaped region, may be “approximately equal.” *Id.*, 55:41-47, 56:10-15, 56:31-33. Villeneuve further teaches that the FOV_L and FOV_R “may be substantially coincident with one another and may have an angular overlap of approximately 100%.” *Id.*, 57:4-7. For example, in Figure 34, reproduced below, the two fields of view “are approximately the same size and have an angular overlap of approximately 90%”:

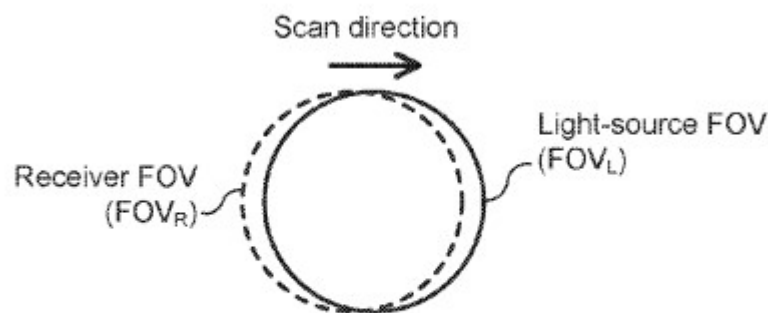


Figure 34

Id., Fig. 34, 57:4-9. By aligning the fields of view in this manner, Villeneuve teaches that the receiver may detect reflected light at a range of distances up to the maximum range of the system. *Id.*, 57:31-59.

Villeneuve is analogous art to the '405 patent because both references are in the same field of endeavor, *i.e.*, LiDAR devices. *See* Ex. 1003 ¶84. A POSITA would have thus looked to Villeneuve when considering how to implement and improve the operation of known LiDAR devices. *Id.*

B. The Pacala-Droz-Villeneuve Combination

In the proposed Pacala-Droz-Villeneuve combination, Pacala and Droz are combined as set forth in Ground 1. *See* Section X.C. The combined system would then be further modified in view of Villeneuve to use emitter and receiver channels having a one-to-one relationship and non-overlapping fields of view. Ex. 1003 ¶¶173-174. The Pacala-Droz-Villeneuve combination renders claims 24-25 and 33-34.

1. Motivation to Combine

A POSITA would have been motivated to combine the teachings of Pacala and Droz for the reasons described in Section X.C.1. A POSITA would also be motivated to further combine Pacala and Droz with Villeneuve. Ex. 1003 ¶¶175-177.

First, a POSITA would have understood that the teachings of Villeneuve are directly applicable to the LiDAR device of Pacala (as modified by Droz). *Id.* ¶177. Villeneuve teaches specific improvements that are applicable to LiDAR devices generally and designed to improve their detection capabilities, and thus shares the same goal as Pacala and Droz. *Id.* Villeneuve also expressly discloses that its improvements may be applied to systems with multiple emitters and detectors (*i.e.*, multiple sensor heads), and systems where a plurality of detectors (including SPADs) correspond to a single emitter. Ex. 1007, 14:12-21, 15:6-13, 16:57-65, 59:55-60:15, 65:5-21.

Second, a POSITA would have been motivated to modify the Pacala-Droz combination to align the emitters and detectors to have fields of view that are substantially coincident. Ex. 1003 ¶176. Villeneuve teaches that such alignment beneficially ensures that light emitted by an emitter will be received at the corresponding detector at a range of distances. Ex. 1007, 55:57-57:59, Figs. 33-35. Villeneuve also teaches that this alignment improves detection capability over a range of distances up to a maximum range. *Id.*, 57:31-59. Further, by May 2017 it was well known in the art that narrow fields of view at the detectors improve the signal to noise ratio, and thus the performance of the detectors. Ex. 1003 ¶176. Villeneuve teaches how to practically align emitters and detectors (and their corresponding fields of view) and achieve specific angular extents (*i.e.*, sizes) by

selecting, for example, an aperture size for the emitter, and an active region for the detector. *Id.*, 55:6-10, 59:9-12. A POSITA could thus readily apply Villeneuve's alignment techniques to improve the Pacala-Droz combination with a reasonable expectation of success. Ex. 1003 ¶177. This is particularly true because neither Pacala nor Droz limit the type of emitter used, and thus can readily be modified to implement Villeneuve's emitter alignment techniques. *Id.* ¶177. A POSITA would also have been capable of applying Villeneuve's teachings to size the detector arrays and corresponding waveguides in the Pacala-Droz combination, with predictable results. *Id.* ¶177.

2. Claim 24

Pacala and Droz in view of Villeneuve render obvious claim 24. Ex. 1003 ¶¶178-179. In the Pacala-Droz combination, Pacala's optical receivers (as modified by Droz to include waveguides) have non-overlapping fields of view because the "input ends of the waveguides" are "disposed parallel to the focal plane of lens 330." Ex. 1006, 15:58-60. Droz's waveguides thus divide the field of view of the LiDAR device into a plurality of non-overlapping fields of view for each pixel. Ex. 1003 ¶179.

Neither Pacala nor Droz expressly describe the emitter implementation and emitter fields of view. However, as discussed above, it would have been obvious to POSITA to configure the emitters in the Pacala-Droz combination in view of

Villeneuve to have non-overlapping fields of view with a one-to-one, coincident relationship with the fields of view of the optical receivers. Ex. 1003 ¶178.

Villeneuve teaches a plurality of “sensor heads” with emitters that emit pulses of light and receivers “configured to detect at least a portion of the scanned pulses of light scattered or reflected by a target 130.” Ex. 1007, 14:12-21, 15:6-13, 16:57-65. Villeneuve teaches that the field of view of an emitter may be “approximately equal” to the field of view of a receiver—*i.e.*, they are “substantially coincident” and “have an angular overlap of approximately 100%.” *Id.*, 55:41-47, 56:10-15, 56:31-33, 57:4-7. For example, Figure 34 illustrates an embodiment where the fields of view “have an angular overlap of approximately 90%”:

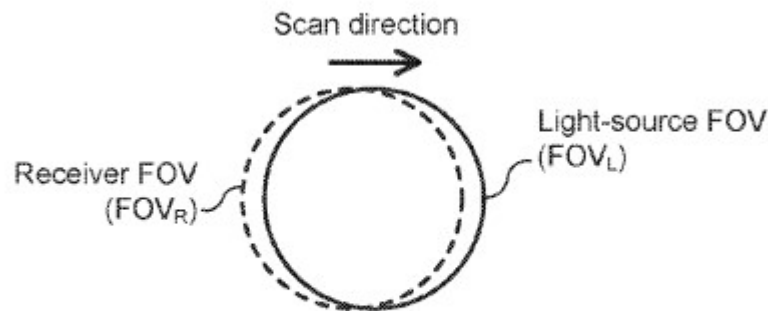


Figure 34

Id., Fig. 34, 57:4-9.

When applied to the Pacala-Droz combination, Villeneuve’s teachings would modify the combined system to configure each emitter to have a field of view

substantially coincident with and in a one-to-one relationship with one waveguide and one light detector array (as taught by Droz). Ex. 1003 ¶178. Further, because Droz's light detector arrays define non-overlapping fields of view, the fields of view of the corresponding emitters in a one-to-one relationship with the light detector arrays would also be non-overlapping. *Id.* ¶179.

3. Claim 25

Pacala and Droz in view of Villeneuve render obvious claim 25. Ex. 1003 ¶¶180-181. Villeneuve, as applied to the Pacala-Droz combination, aligns emitter fields of view with corresponding receiver fields of view, such that the illumination pattern of the emitted beams substantially matches the fields of view of the corresponding photosensors. Ex. 1007, 14:12-17, 15:6-13, 16:57-65; *see also* Section XI.B.2. Villeneuve further teaches that each emitted beam may match the size and geometry (i.e., a cone-shaped region of an “approximately equal” size) of the field of view of its corresponding photosensor. Ex. 1007, 55:41-47, 56:10-15, 56:31-33. That the size and geometry of the fields of view substantially match is illustrated in Figure 34:

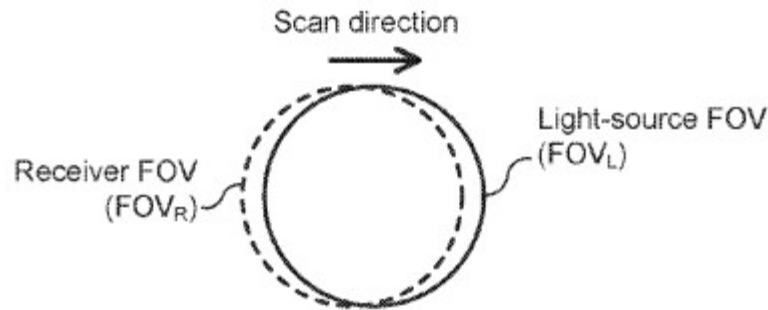


Figure 34

Id., Fig. 34, 57:4-9. Villeneuve further teaches that its implementation may be used to align the fields of view between emitter and receiver over a range of operating distances. *Id.*, 57:31-59.

4. Claims 32-33

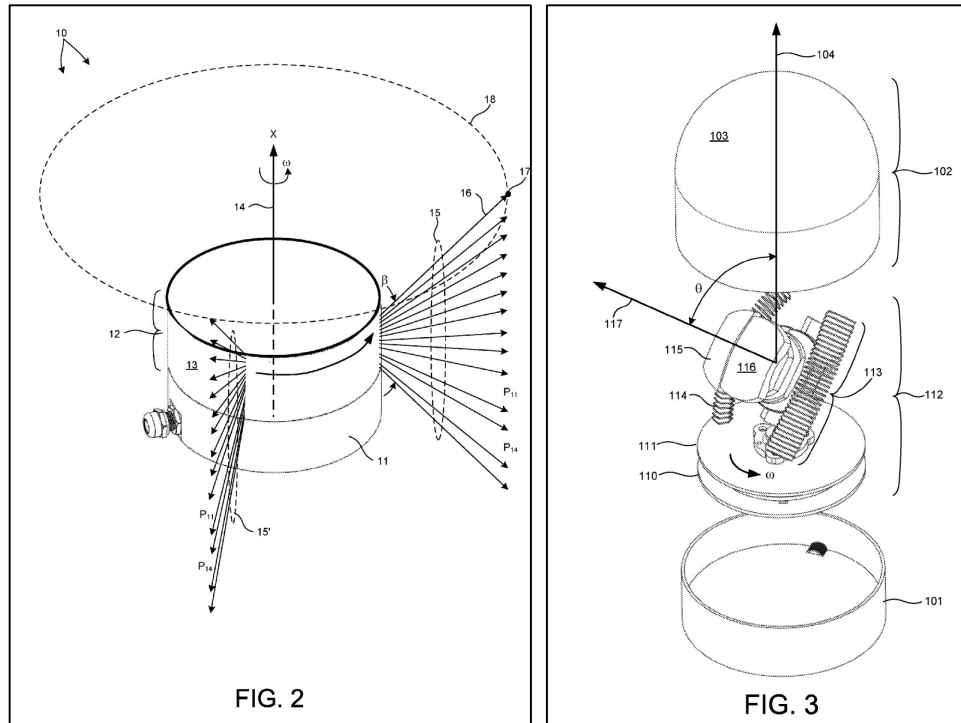
The additional limitations of claims 32 and 33 are identical to the additional limitations of claims 24 and 25, respectively, and are disclosed by Villeneuve for the reasons set forth above. *See* Sections XI.B.2-3.

XII. GROUND 3: HALL, BOROWSKI, AND SPECTOR RENDER OBVIOUS CLAIMS 21 AND 23-34

A. U.S. Patent No. 9,983,297 (“Hall”)

Hall is titled *LIDAR based 3-D imaging with varying illumination field density*. Ex. 1008. It was filed on March 20, 2017. *Id.* It therefore qualifies as prior art under 35 U.S.C. §102(a)(2).

Hall describes “LIDAR based 3-D point cloud measuring systems.” Ex. 1008, 1:16-17. Hall’s LiDAR system includes “an array of multiple laser emitters and detectors” and may be used for “autonomous vehicle application[s].” *Id.*, 1:64-2:14. Embodiments of the LiDAR system are shown in Figures 2 and 3:

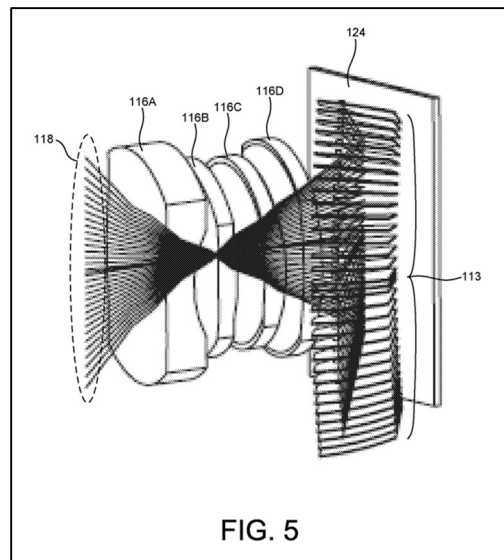


Id., Figs. 2-3.

The LiDAR system 10 includes a lower housing 11 and an upper housing 12, with a transparent cylindrical shell element 13. *Id.*, 5:41-49. The system includes a “light emission/collection engine 112” that is connected to a “rotating electronics board 111” to rotate about a central axis. *Id.*, 6:10-30. The light emission/collection engine includes “an array of light emitting elements 114 and an array of light detecting elements 113.” *Id.*, 6:31-33. Light from the emitters “passes through a

series of illumination optics 115 that collimate the emitted light” and emit the light into the environment. *Id.*, 6:33-38. The light is then “reflected from objects in the environment” and “collected by collection optics 116 ... where it is focused onto each detecting element of the array of detecting elements 113.” *Id.*, 6:41-47.

Hall’s collection optics may include multiple lens elements (*e.g.*, lens elements 116A-D) as shown in Figure 5 below:



Id., Fig. 5, 7:7-13. One or more of the lens elements may be used to filter “light outside of a predetermined wavelength range” used by the emitters in Hall’s system. *Id.*, 7:13-27.

Hall is analogous art to the ‘405 patent because both references are in the same field of endeavor, *i.e.*, LiDAR devices. *See* Ex. 1003 ¶¶84, 193. A POSITA would have thus looked to Hall when considering how to implement and improve the operation of known LiDAR devices. *Id.*

B. U.S. Patent Pub. No. 2013/0300840 (“Borowski”)

Borowski is titled *3D Landscape Real-Time Imager And Corresponding Imaging Methods*. Ex. 1009. It was published on November 14, 2013. *Id.* It therefore qualifies as prior art under 35 U.S.C. §102(a)(1).

Borowski is directed to rotating 3D landscape imagers (including LiDAR systems) that use time-of-flight principles to obtain distance measurements. *Id.*, [0001]-[0003], [0058]. Borowski teaches an imaging system with an “illuminating part” to generate laser pulses and distribute them into the surrounding environment, and a “receiving part” to detect returned photons. *Id.*, [0006]-[0007]. In particular, Borowski’s receiving part includes one or more SPAD detector arrays mounted on a rotating device. *Id.*, [0078]. The focus of Borowski’s disclosure is on the plurality of SPAD arrays, including their structure, operation, and accompanying circuitry. *See generally id.*, [0040]-[0060].

Borowski’s electronics may perform operations at the level of a group of cells (*i.e.*, macro-cell), where each macro-cell corresponds to a pixel in the image. *Id.*, [0052]. By combining multiple individual SPADs into a macro-cell, the macro-cell “acts as the equivalent of a single ‘perfect’ SPAD having no recovery time.” *Id.*, [0053], [0171], [0192]. The “combination of the 3D data of all SPAD detector arrays generates a complete image of the landscape around the 3D real-time landscape imager's available field of view.” *Id.*, [0043].

Borowski is analogous art to the ‘405 patent because both references are in the same field of endeavor, *i.e.*, LiDAR devices. *See* Ex. 1003 ¶¶84, 193. A POSITA would have thus looked to Borowski when considering how to implement and improve the operation of known LiDAR devices. *Id.*

C. U.S. Patent No. 10,473,766 (“Spector”)

1. Overview

Spector is titled *Light detection and ranging (LiDAR) system and method*. Ex. 1005. It was filed on June 27, 2017 and claims priority to Provisional Application No. 62/470,706, filed on March 13, 2017. Further, as demonstrated below, Spector is entitled to the priority date of its provisional application. It thus qualifies as prior art under 35 U.S.C. §102(a)(2).

Spector teaches a LiDAR system in which the “receiver optics” include “an array of optical detection sites” comprising a “pixelated optical sensor array 20” and “an aperture array 18 for defining the optical detection sites on the sensor array.” *Id.*, 3:32-45. The aperture array includes a “mask” that defines “a plurality of transparent apertures arranged according to the two dimensional array [of detectors.” *Id.*, 3:57-59. Spector’s receiver optics are illustrated on the righthand side of Figure 1:

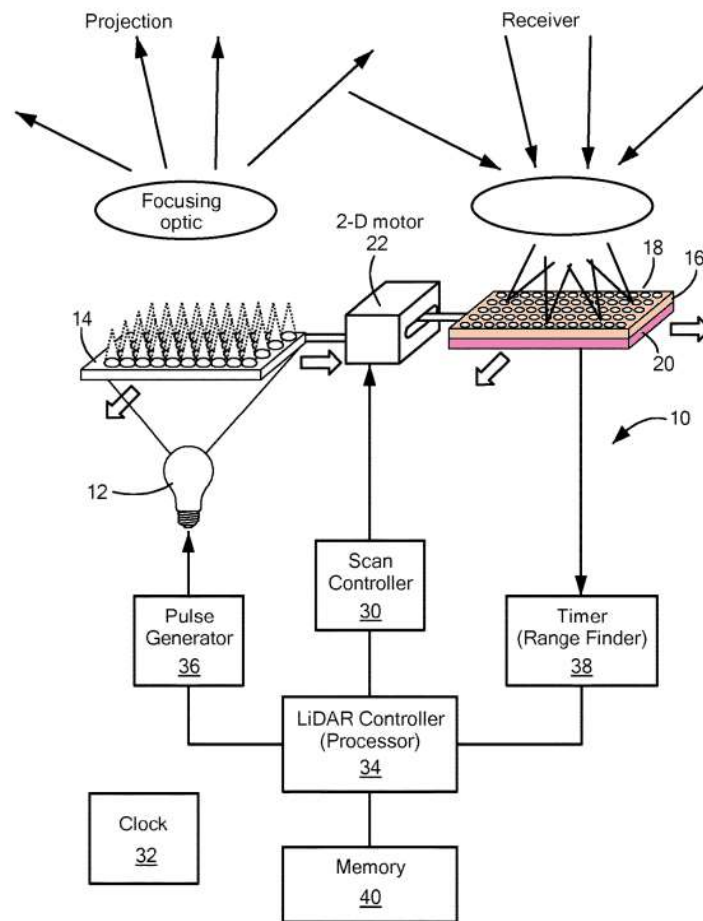


FIG. 1

Id., Fig. 1 (annotated).

Spector explains that the aperture array is “beneficial to establish the individual optical detection sites.” *Id.*, 3:54-56. Specifically, each aperture “limits visibility by each optical detection site to a single corresponding light spot” from a plurality of light spots generated by a corresponding light transmission module. *Id.*, 3:59-61; *see also id.*, 3:1-14 (describing the light transmission module). As a result, the “array of light spots” generated by the light transmission module “is received in one-to-one correspondence to the array of optical detection sites.” *Id.*, 5:33-35. By

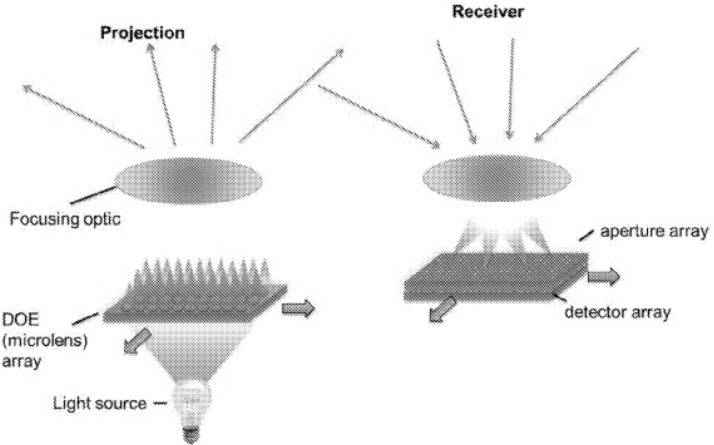
using “a two dimensional array of isolated light spots and individual optical detection sites in one-to-one correspondence with those spots,” Spector is able to reduce “cross-talk and multipath signal ... advantageously.” *Id.*, 6:12-15.

Spector is analogous art to the ‘405 patent because both references are in the same field of endeavor, *i.e.*, LiDAR devices. *See* Ex. 1003 ¶¶84, 193. A POSITA would have thus looked to Spector when considering how to implement and improve the operation of known LiDAR devices. *Id.*

2. Priority Date

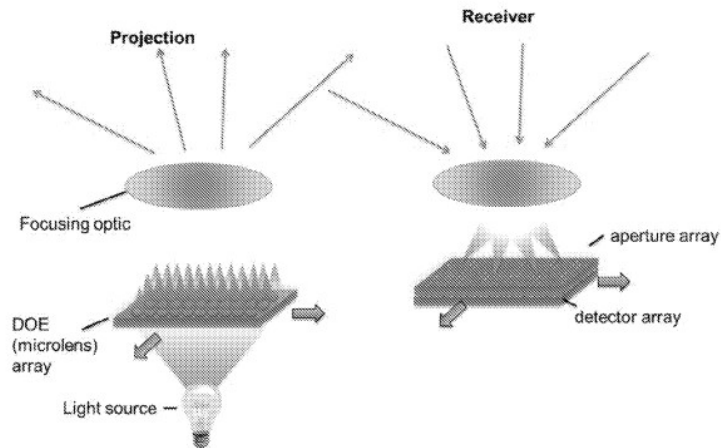
“A reference patent is only entitled to claim the benefit of the filing date of its provisional application if the disclosure of the provisional application provides support for the claims in the reference patent in compliance with §112 ¶ 1.” *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1381 (Fed. Cir. 2015). The provisional application need only provide “sufficient support for *at least one claim* in the child.” *Ex Parte Mann*, 2016 WL 7487271, at *5 (PTAB Dec. 21, 2016). “[T]he subject matter relied upon in the non-provisional” must also be “sufficiently supported in the provisional application.” *Id.*

As demonstrated in the table below, at least claims 1 and 3 of Spector are supported by the disclosures in its provisional application.³ See also Ex. 1003 ¶121.

Spector (Ex. 1005)	Provisional Appl. No. 62/470,706 (Ex. 1010)
1. A light detection and ranging (LiDAR) system comprising:	“The target application is LiDAR system....” Ex. 1010 at 12.
a light source;	 Ex. 1010 at 12 (“Light source”)
an arrayed micro-optic configured to receive light from the light source so as to produce and project a two dimensional array of light spots on a scene, wherein the two dimensions of the array includes a first	“Spots created in the imaging plane of the projector lens are projected out onto the scene. The spots can be created by methods such as ... a lens array” Ex. 1010 at 12.

³ The “subject matter test” described in *Ex Parte Mann* is addressed in the subsequent sections through parallel citations to Spector’s provisional application for the subject matter relied upon.

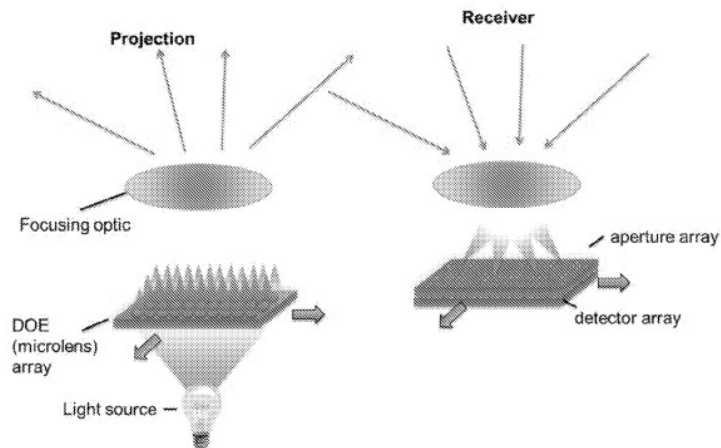
dimensional direction
and a second
dimensional direction;



Id. (“DOE (microlens) array”)

receiver optics having an
array of optical detection
sites configured so as to
be suitable for
establishing a one-to-one
correspondence between
light spots in the two
dimensional array and
optical detection sites in
the receiver optics;

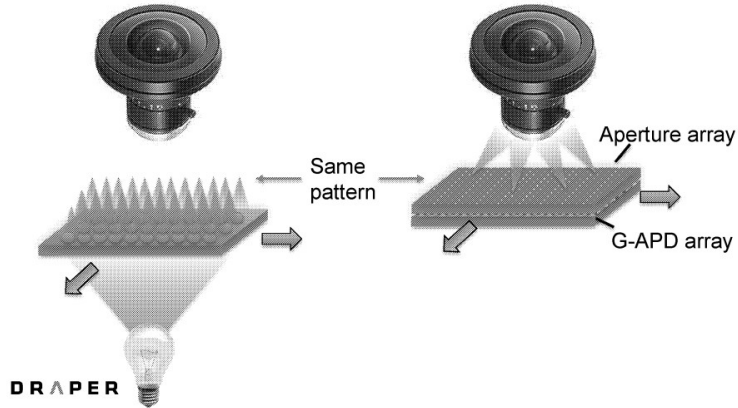
“The receive side functions much like the projector. In this case an aperture is used to select imaged light at locations that correspond to the projected light.” Ex. 1010 at 12



Id. (“aperture array” and “detector array”)

“At the receiver a matching aperture is also scanned....” *Id.* at 13.

“Aperture array on receiver --Symmetric with focused spots on emitter.” *Id.* at 19.



Id.

a scanner configured to physically oscillate the arrayed micro-optic and the receiver optics synchronously to scan: (a) the two dimensional array of light spots and (b) the receiver optics so as to maintain the one-to-one correspondence; and

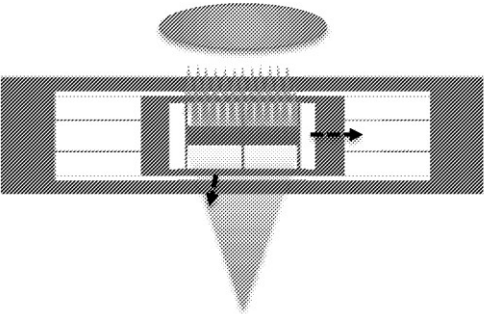
“Measurements are made while these spots are scanned to fill the area in the scene. ... The scanning can be done by moving the diffractive optic (or other device) creating the spots, by moving the lens.... One example method would be to scan a lens array using a miniature x-y stage driven by a voice coil.” Ex. 1010 at 12.

“The same scanning method and optics can be used [for the receive side].” *Id.*

“At the receiver a matching aperture is also scanned....” *Id.* at 13.

“A small stage can be used to move the projected spots on the projector and the aperture on the receiver.” *Id.*

“Synchronized scanning” *Id.* at 19

	Flexure Stage (voice-coil driven)  <i>Id.</i> at 21 (illustrated as a possible scanning mechanism)
a scan controller operable to cause the scanner to move the array of light spots back and forth so as to complete a scan of the scene wherein the spots traverse the scene in the first dimensional direction and in the second dimensional direction no more than 150% of the distance between adjacent spots in the first dimensional direction and in the second dimensional direction, respectively.	“Measurements are made while these spots are scanned to fill the area in the scene. ... The scanning can be done by moving the diffractive optic (or other device) creating the spots, by moving the lens.... One example method would be to scan a lens array using a miniature x-y stage driven by a voice coil.” Ex. 1010 at 12. “A small stage can be used to move the projected spots on the projector and the aperture on the receiver.” <i>Id.</i> at 13. “The scanning range is minimal, as only the distance between the spots needs to be covered.” <i>Id.</i> at 12. “A much smaller scanning motion is required. To fill the scene, the illumination and detector aperture only have to be scanned the distance between illumination spots.” <i>Id.</i> at 13.
3. The LiDAR system according to claim 1 wherein the scan controller is operable to cause the scanner to move the array of light spots back and forth so	“A much smaller scanning motion is required. To fill the scene, the illumination and detector aperture only have to be scanned the distance between illumination spots.” Ex. 1010 at 13.

as to complete a scan of the scene wherein the spots traverse the scene in the first dimensional direction and in the second dimensional direction no more than the distance between adjacent spots in the first dimensional direction and in the second dimensional direction, respectively.	
---	--

D. The Hall-Borowski-Spector Combination

In the proposed Hall-Borowski-Spector combination, Hall's teachings provide the basic structure of a rotating LiDAR device, including a housing with a cylindrical window that encloses a rotating platform on which a light emission/collection engine is mounted. Ex. 1003 ¶¶186-187. The light emission/collection engine includes the bulk transmitter and receiver optics, optical filters, emitters, and detectors. *Id.* Hall's detector implementation is then improved by applying Borowski's teachings regarding the benefits and application of SPAD arrays, to improve Hall in a predictable manner. *Id.* Spector's aperture array is further incorporated to reduce cross-talk within the system. *Id.* The Hall-Borowski-Spector combination renders claims 21, 23, 26-31, and 34 obvious.

1. Motivation to Combine

A POSITA would have been motivated to combine the teachings of Hall, Borowski, and Spector, and would have had a reasonable expectation of success in combining the references. Ex. 1003 ¶¶188-195.

First, a POSITA would have understood that the teachings of Spector and Borowski are generally applicable to LiDAR devices, including Hall's LiDAR system. *Id.* ¶192. Hall describes many standard components of a rotating LiDAR device for autonomous vehicle applications, but also provides little detail regarding the low-level implementation of its emitters and receivers. *Id.* A POSITA would have thus looked to other references in the field, such as Borowski and Spector, to implement and improve the emitters and detectors within Hall's LiDAR system. *Id.* Borowski specifically teaches an improved detector implementation using SPAD arrays, which could predictably and beneficially be applied to Hall's system with a reasonable expectation of success, and Spector teaches adding an aperture array to detectors to improve a conventional LiDAR system by reducing crosstalk and multipath signals. *Id.* These improvements could be predictably and beneficially applied to Hall's system, and the state of the art confirms that a POSITA would have had a reasonable expectation of success in applying these known techniques to Hall's standard LiDAR components using basic electrical engineering design principles. *Id.* ¶¶193-195.

Second, a POSITA would have been motivated to modify Hall to incorporate SPAD arrays in view of Borowski. Ex. 1003 ¶¶189-190. Hall acknowledges that in existing LiDAR systems, the “detection of return signals includes significant sources of measurement noise that are exacerbated as measurement ranges are extended,” and that conventional solutions required “increasing laser pulse intensity.” Ex 1008, 2:27-33. Improvements are thus needed for “power management ... while maintaining sufficiently high levels of imaging resolution and range.” *Id.*, 2:46-48. Borowski teaches that SPADs can solve problems with light intensity because they “provide[] significant carrier amplification.” Ex. 1009, [0035]. Borowski further teaches that using a “cluster” of SPAD detector cells whose outputs are multiplexed and averaged is advantageous because the “programmed macro-cell ... acts as the equivalent of a single ‘perfect’ SPAD having no recovery time.” *Id.*, [0053]. A POSITA would have thus understood that using clusters of SPADs for LiDAR detection can improve detection at longer ranges and at lower light intensities. Ex. 1003 ¶¶189-190.

Third, a POSITA would have been motivated to modify Hall to incorporate an arrayed micro-optic (on the emitter side) and an aperture array (on the detector side) as taught by Spector. Ex. 1003 ¶191. Hall acknowledges that there is a need to “avoid cross-talk” in LiDAR systems with multiple emitters. Ex. 1008, 9:13-25. Spector teaches an arrayed micro-optic used to “project a two dimensional array of

light spots on a scene.” Ex. 1005, 3:1-14. Spector also teaches an aperture array that “establish[es] ... individual optical detection sites.” *Id.*, 3:54-61. The array of isolated light spots generated by the arrayed micro-optic, in combination with the individual optical detection sites, in a one-to-one correspondence, reduce cross-talk and multipath signals. *Id.*, 6:12-15. A POSITA would have thus understood that applying Spector’s aperture array within Hall’s system would reduce cross-talk and associated errors, and improve the accuracy of the LiDAR system. Ex. 1003 ¶191. Spector’s system also provides additional advantages, such as permitting “smaller and/or simpler and less expensive scanning mechanisms.” Ex. 1005, 6:15-20.

2. Claim 21

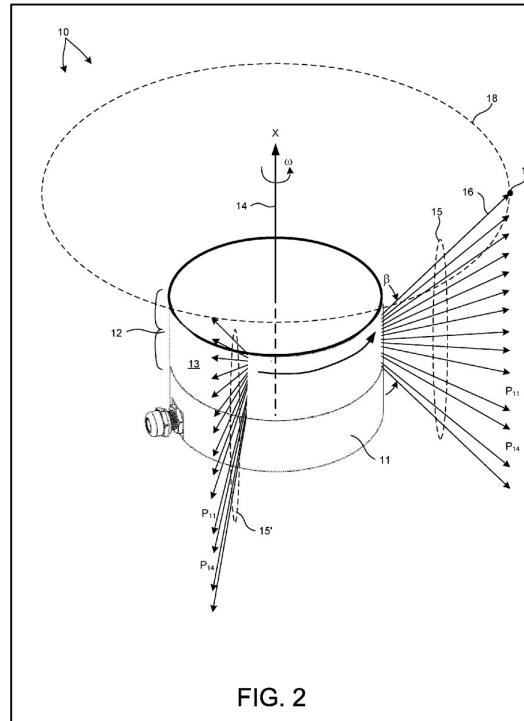
a) Limitation 21(a)

To the extent the preamble is limiting, Hall discloses limitation 21(a). Ex. 1003 ¶¶197-198. Hall teaches a “LIDAR based 3-D point cloud measuring system.” Ex. 1008, 1:16-17. Hall also teaches that LiDAR systems “employ pulses of light to measure distance to an object.” *Id.*, 1:21-23.

b) Limitation 21(b)

Hall discloses limitation 21(b). Ex. 1003 ¶¶199-200. Hall teaches that a 3-D LiDAR system 10 includes a “lower housing 11 and an upper housing 12 that includes a cylindrical shell element 13 constructed from a material that is transparent to infrared light.” Ex. 1008, 5:41-47. As illustrated in Figure 2, the cylindrical shell

element (*i.e.*, the window) is disposed between the upper housing 11 and the lower housing 12, and, being cylindrical in shape, extends fully around the periphery of the housing:



Id., Fig. 2. A POSITA would have understood and it would have been obvious that Hall's housing is stationary. Ex. 1003 ¶200. For example, Hall teaches that the rotating components are disposed on a rotating electronics board within the housing. Ex. 1008, 6:16-30, 6:48-7:6.

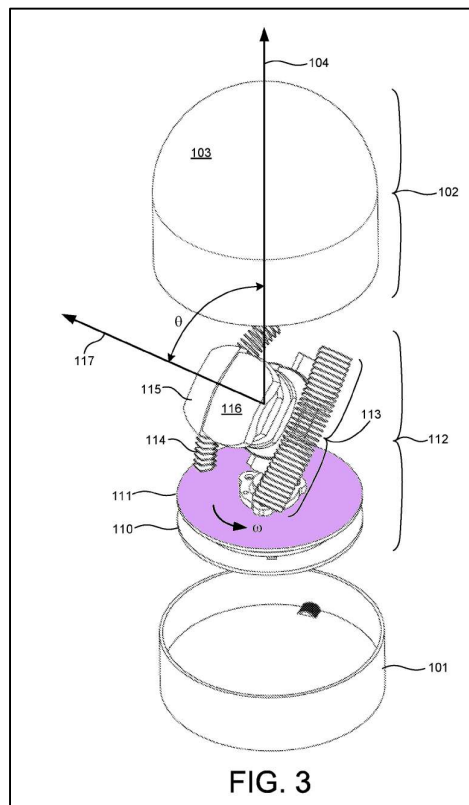
c) Limitation 21(c)

Hall discloses limitation 21(c). Ex. 1003 ¶201. Hall teaches that its system “perform[s] three dimensional LIDAR measurements” to detect “objects ... in the three dimensional environment.” Ex. 1008, 2:52-54, 3:20-41. As detailed further

below, to perform distance measurements, Hall's system includes within the housing a "light emission/collection engine" with emitters, detectors, and associated optical and electronic components, all mounted to a rotating electronics board. Ex. 1008, 6:10-7:6.

d) Limitation 21(d)

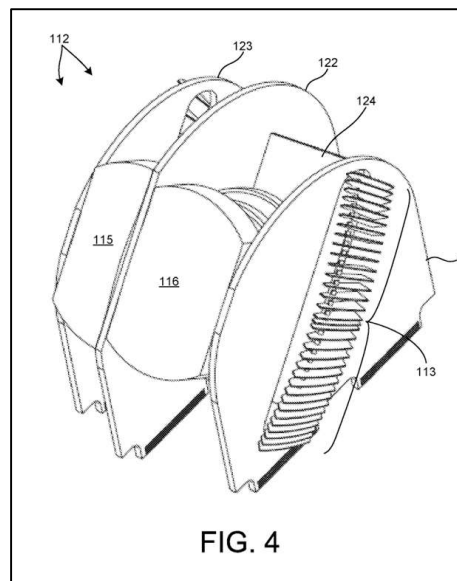
Hall discloses limitation 21(d). Ex. 1003 ¶¶202-203. Hall teaches that its light emission/collection engine is "fixedly positioned" on a "rotating electronics board 111, and thus rotates about central axis 104." Ex. 1008, 6:27-30, 6:48-7:6. The rotating electronics board (purple) is disposed above a stationary electronics board in a fixed position within the housing, as shown in Figure 3:



Id., Fig. 3 (annotated).

e) Limitation 21(e)

Hall discloses limitation 21(e). Ex. 1003 ¶¶204-205. Hall teaches that its light emission/collection engine is mounted on the rotating electronics board. Ex. 1008, 6:27-30, 6:48-7:6. The light emission/collection engine includes “an array of light emitting elements 114” (a plurality of optical emitters) and “a series of illumination optics 115” (bulk transmitter optic) that “collimate the emitted light into an array of beams” which are emitted from the 3-D LiDAR system into an external field. *Id.*, 6:31-38. The light emitting elements and illumination optics may be physically separated from the collection/detection elements and optics (described further below) by intermediate circuit boards directly connected to the rotating electronics board, as shown in Figure 4, forming a light transmission module and a light sensing module:

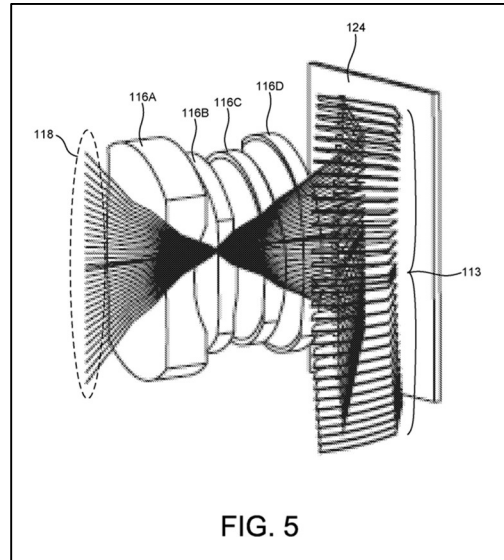


Id., Fig. 4, 6:48-7:6.

f) Limitation 21(f)

The combined teachings of Hall and Spector render limitation 21(f) obvious. Ex. 1003 ¶¶206-212. Hall's light emission/collection engine is mounted on the rotating electronics board and includes separate light emitting/illumination elements (light transmission module) and light collection/detection elements (light sensing module). *See* Section XII.D.2(e). The light collection/detection elements include "collection optics 116" (bulk receiver optic), which collects light reflected from objects in the environment and focus it onto an "array of detecting elements 113" (a plurality of photosensors). Ex. 1008, 6:41-47.

Hall further discloses and renders obvious an optical filter disposed between the bulk receiver optic and the plurality of photosensors. Ex. 1003 ¶¶208-209. Hall's collection optics may include multiple lens elements 116A-D through which collected light is focused onto the array of detecting elements, as shown in Figure 5:



Ex. 1008, Fig. 5, 7:7-13. Instead of functioning as a bulk receiver optic, “one or more of the optical elements of collection optics 116” may function as an optical filter by being “constructed from one or more materials that absorb light outside of ... the wavelengths of light emitted by” Hall’s emitters. *Id.*, 7:13-27. A POSITA would have understood and it would have been obvious that range of wavelengths emitted by the emitters corresponds to a band of radiation, and that Hall’s filters would thus block light outside of that band from reaching the array of detecting elements. Ex. 1003 ¶208. Further, a POSITA would have understood and it would have been obvious that if, as in one possible configuration according to Hall’s disclosure, element 116A functions as a bulk receiver optic, and elements 116B-D are constructed as optical filters, then the optical filters will be disposed between the bulk receiver optic (116A) and the light detecting elements. *Id.* ¶209

Hall does not expressly teach an aperture layer. However, as discussed above, it would have been obvious to POSITA to modify Hall to include an aperture layer in view of Spector. Ex. 1003 ¶210.

Spector teaches an “aperture array 18 for defining the optical detection sites on [a] sensor array,” including a “mask” that defines “a plurality of transparent apertures arranged according to the two dimensional array [of detectors].” Ex. 1005, 3:32-59; *see also* Ex. 1010 at 12 (illustrating an “aperture array” where “an aperture is used to select imaged light at location corresponding to the projected light”). Spector’s aperture layer (orange) and sensor array (red) are illustrated on the righthand side of Figure 1, as annotated below:

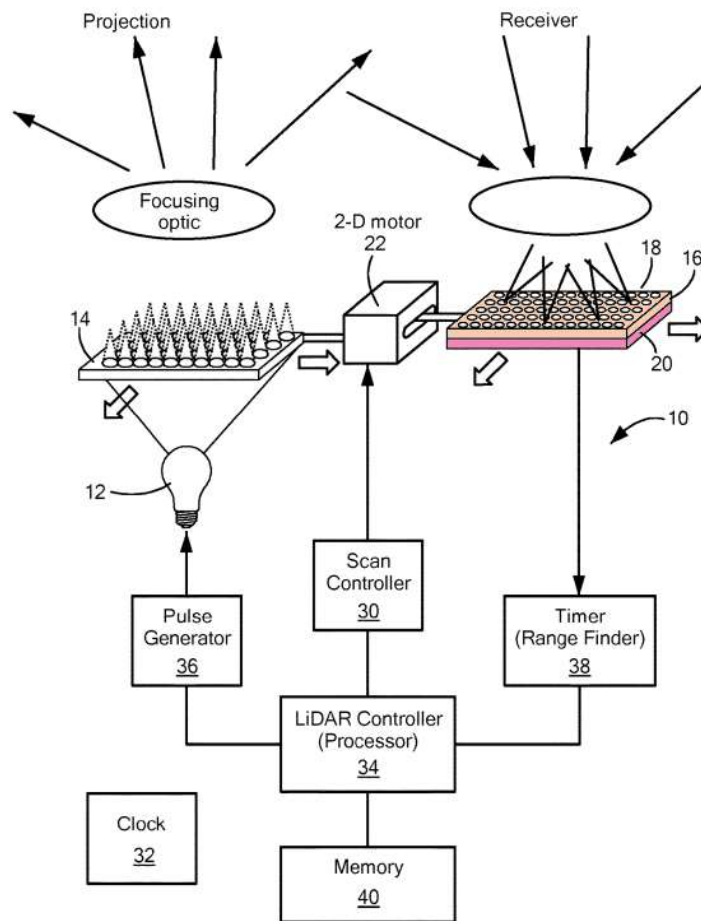


FIG. 1

Ex. 1005, Fig. 1 (annotated); *see also* Ex. 1010 at 12, 19. A POSITA would have understood and it would have been obvious that Spector's mask functions as a stop region that restricts the passage of light, particularly in view of Spector's teaching that the plurality of apertures "limits visibility by each optical detection site to a single corresponding light spot." Ex. 1005, 3:59-61; *see also* Ex. 1010 at 13 (each emitted light spot has a "matching detector ... so that only the illuminated spots are visible to the detector"), 20 (illustrating aperture array); Ex. 1003 ¶212.

g) Limitation 21(g)

Hall discloses and renders obvious limitation 21(g). Ex. 1003 ¶¶213-214. Hall teaches that its rotating electronics board 111 is “configured to rotate with respect to stationary electronics board 111.” Ex. 1008, 6:18-22. A POSITA would have understood and it would have been obvious that a motor coupled to the rotating electronics board is used to effect this rotation. Ex. 1003 ¶¶213-214. Related patent references, such as older Velodyne patents, corroborate that a motor is used to rotate emitters/detectors in a rotating LiDAR system. *Id.* ¶214; Ex. 1015, 5:5-7.

h) Limitation 21(h)

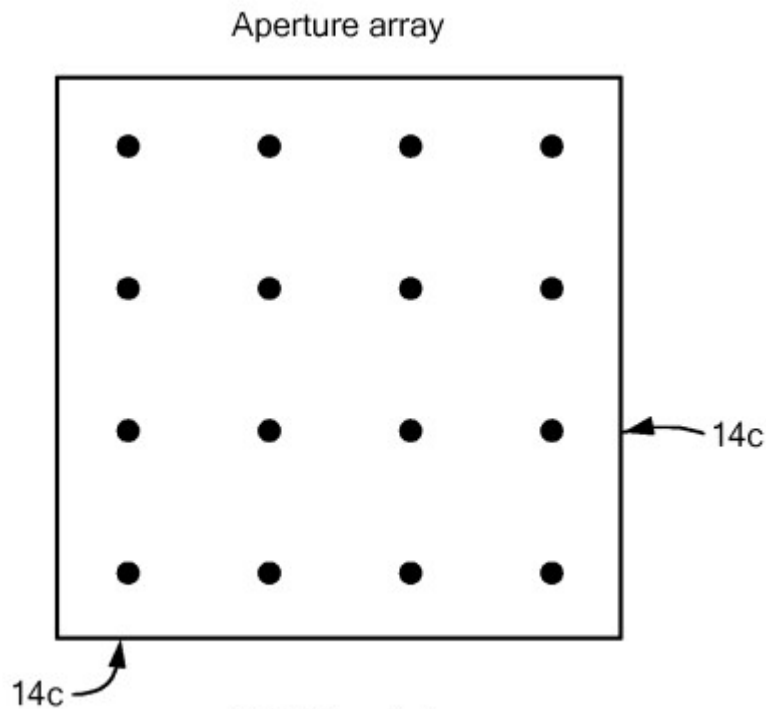
The combined teachings of Hall and Borowski render limitation 21(f) obvious. Ex. 1003 ¶¶215-216. Hall discloses an “array of light detecting elements 113,” but does not specify the type of light detecting elements used or their configuration within the array. Ex. 1008, 6:31-33. However, as discussed above, it would have been obvious to POSITA to use an array of SPADs for each of Hall’s light detecting elements in view of Borowski. Ex. 1003 ¶215.

Borowski teaches a “receiving part” in a LiDAR device that includes a “plurality of SPAD detector arrays.” Ex. 1009, [0078]. Borowski further teaches that each SPAD array “comprises a plurality of SPAD detector cells,” and that the plurality of SPAD cells is clustered into macro-cells, such that each cluster or macro-

cell functions as a photosensor, *i.e.*, “the equivalent of a single ‘perfect’ SPAD having no recovery time.” *Id.*, [0053], [0171], [0192].

i) Limitation 21(i)

Hall, Borowski, and Spector render limitation 21(i) obvious. Ex. 1003 ¶¶217-218. The Hall-Borowski-Spector combination includes an aperture array with a plurality of apertures, as taught by Spector. *See* Section XII.D.2(f). In one exemplary embodiment, illustrated in Figure 4A, the aperture array includes a 4x4 grid of apertures, and thus comprises sixteen apertures:



Ex. 1005, Fig. 4A; *see also id.* Figs. 1, 5A-5B (showing other configurations); Ex. 1010 at 19-20 (illustrating aperture arrays with more than four apertures).

j) Limitation 21(j)

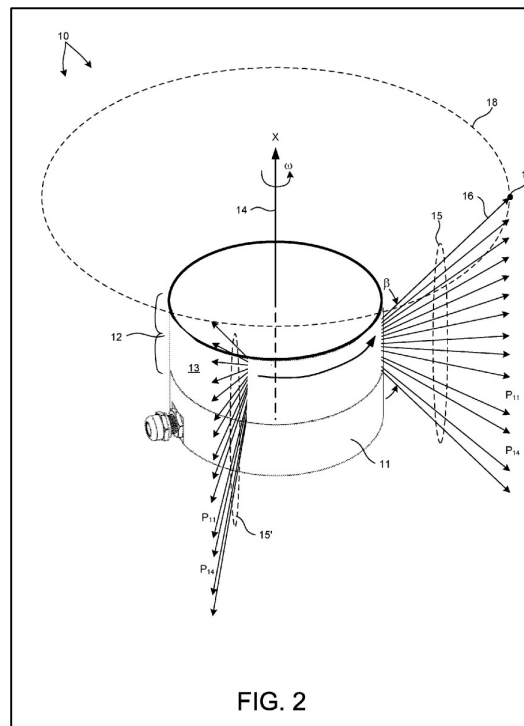
Hall, Borowski, and Spector render limitation 21(j) obvious. Ex. 1003 ¶¶219-220. The Hall-Borowski-Spector combination includes an aperture array with at least four apertures, as taught by Spector, each of which corresponds to an optical detection site (*i.e.*, a photosensor). *See* Sections XII.D.2(f), (i); Ex. 1005, 3:57-59 (the “plurality of transparent apertures” is “arranged according to the two-dimensional array” of optical sensors); Ex. 1010 at 12-13. Spector further teaches that each aperture “limit[s] visibility by each optical detection site to a single corresponding light spot” from the light transmission module. Ex. 1005, 2:4-6; Ex. 1010 at 12 (“[A]n aperture is used to select imaged light at locations that correspond to the projected light.”). A POSITA would have thus understood and it would have been obvious that each of the at least four apertures provides an optical path to its corresponding optical detection site through the aperture. Ex. 1003 ¶¶219-220.

3. Claim 23

Hall in view of Borowski and Spector renders obvious claim 23. Ex. 1003 ¶221. Hall teaches that LiDAR systems “employ pulses of light to measure distance to an object based on the time of flight (TOF) of each pulse of light.” Ex. 1008, 1:21-23. The time of flight is “the time elapsed between emission of the pulse of light and detection of the returned pulse of light,” and is used to measure distance. *Id.*, 1:26-28.

4. Claim 24

Hall, Spector, and Borowski render obvious claim 24. Ex. 1003 ¶¶222-227. As described above, Hall teaches a LiDAR system that includes optical transmitters (emitters) and optical receivers. *See* Section XII.D.2(e)-(f). Hall discloses that the emitters emit beams of light “in a plurality of different directions,” as shown by beams 16 in Figure 2:



Id., Fig. 2, 5:50-56. In this manner, the beams are “projected onto a plane ... at a plurality of different locations.” *Id.*, 5:28-31. A POSITA would have understood and it would have been obvious that each of Hall’s emitters defines an emitter channel with a non-overlapping field of view. Ex. 1003 ¶¶222-223. Related patent references corroborate this understanding. *Id.*; Ex. 1030, 8:12-10:30, Figs. 5-7.

Hall further discloses that each emitter has a corresponding detector, and that the emitters and detectors together “comprise a LIDAR measurement channel.” Ex. 1008, 7:53-57, 8:57-62. Each of the plurality of measurement channels emits a beam of light in a different direction. *Id.*, 8:63-9:7. A POSITA would have thus understood and it would have been obvious that each of Hall’s detectors corresponds to a different, non-overlapping receiver channel, and has a one-to-one relationship and is coincident with a corresponding emitter. Ex. 1003 ¶224.

To the extent Hall does not disclose this limitation, it would have been obvious to POSITA to modify Hall to include an arrayed micro-optic and aperture layer and as taught by Spector. Ex. 1003 ¶225.

Spector teaches the use of an “arrayed micro-optic” to “project a two-dimensional array of light spots on a scene.” Ex. 1005, 3:1-3; *see also* Ex. 1010 at 12 (describing “spots” of light created using a “simple aperture array”). Further, each light spot is “isolated” from other light spots. Ex. 1005, 6:12-15; Ex. 1010 at 13. A POSITA would have understood and it would have been obvious that each isolated light spot corresponds to an emitter channel with a non-overlapping field of view. Ex. 1003 ¶226.

Spector also teaches the use of an aperture array at the receiver optics. *See* Section XII.D.2(f). Each aperture at the receiver optics “limits visibility by each optical detection site to a single corresponding light spot,” thereby defining a

receiver channel with a non-overlapping field of view. Ex. 1005, 3:59-61; *see also* Ex. 1010 at 13; Ex. 1003 ¶227. Spector further teaches that the receiver channels (*i.e.*, the apertures at Spector’s receiver optics and their corresponding optical detection sites) have a “one-to-one correspondence” with the light spots generated by the emitter channels. Ex. 1005, 3:34-37; *see also id.*, 3:59-61, 5:33-35, 6:12-15; Ex. 1010 at 12 (“[A]n aperture is used to select imaged light at locations that correspond to the projected light.”). A person of ordinary skill in the art would have understood and it would have been obvious that each paired light spot and its corresponding optical detection site have coincident fields of view. Ex. 1003 ¶227.

5. Claim 25

Hall, Spector, and Borowski render obvious claim 25. Ex. 1003 ¶¶228-229. As discussed above in connection with claim 24, it would have been obvious to POSITA to modify Hall to include an arrayed micro-optic and aperture array as taught by Spector. Ex. 1003 ¶228. Spector teaches the use of an “arrayed micro-optic” to “project a two-dimensional array of light spots on a scene.” Ex. 1005, 3:1-3; *see also* Ex. 1010 at 12. Spector further teaches that the light spots projected from its arrayed micro-optic are “focused on the individual optical detection sites.” Ex. 1005, 3:38-41; *see also id.*, 3:59-61 (apertures “limit[] visibility by each optical detection site to a single corresponding light spot”); Ex. 1010 at 12 (apertures “select imaged light at locations that correspond to the projected light”), 13 (“only the

illuminated spots are visible to the detector”), 19 (emitters and detectors have “same pattern”). A POSITA would have understood and it would have been obvious that Spector’s arrayed micro-optic and aperture array would result in an emitted illumination pattern that substantially matches the size and geometry of the optical detection sites across a range of distances. Ex. 1003 ¶229. Indeed, Spector expressly teaches that the relative positioning of the receiver optics and the arrayed micro-optic “can be chosen to give the best performance at all ranges of interest.” Ex. 1005, 4:21-27.

6. Claim 26

a) Limitations 26(a)-26(e)

Limitations 26(a)-26(e) are identical to limitations 21(a)-21(e), and are disclosed by Hall for the reasons set forth above with respect to claim 21. *See* Sections XII.D.2(a)-(e).

b) Limitation 26(f): “a light sensing module...”

The combined teachings of Hall and Spector render limitation 26(f) obvious. Limitation 26(f) is substantially identical to limitation 21(f), and is largely rendered obvious for the reasons set forth above with respect to claim 21. *See* Section XII.D.2(f).

While limitation 21(f) requires “an optical filter,” limitation 26(f) requires “one or more optical filters.” To the extent these differences are deemed

substantive,⁴ Hall discloses one or more optical filters. Ex. 1003 ¶¶232-234. For example, Hall teaches that “*one or more* of the optical elements of collection optics 116 [116A-116D]” may be “constructed from one or more materials that absorb light,” and that each such element filters light “outside of ... the wavelengths” emitted by Hall’s emitters. Ex. 1008, 7:13-23.

c) Limitations 26(g)-26(j)

Limitations 26(g)-26(j) are identical to limitations 21(g)-21(j), and are rendered obvious by Hall, Spector, and Borowski for the reasons set forth above with respect to claim 21. *See* Sections XII.D.2(g)-(j).

7. Claim 27

Hall discloses and renders obvious claim 27. Ex. 1003 ¶¶236. As discussed above, Hall teaches that its collection optics may include one or more optical filters. *See* Section XII.D.2(f), XII.D.6(b). Hall’s filters absorb (filter) light “outside of a predetermined wavelength range.” Ex. 1008, 7:13-19. A POSITA would have understood and it would have been obvious that Hall’s filters thus may be constructed to pass through a band of wavelengths corresponding to the operating wavelengths of Hall’s emitters. Ex. 1003 ¶236. A POSITA would have understood and it would have been obvious that filtering light outside of a desired band of

⁴ *See supra* note 2.

wavelengths is or may be accomplished using standard, well-known band-pass filters. *Id.*

8. Claim 28

Hall discloses and renders obvious claim 28. Ex. 1003 ¶237. As discussed above in connection with limitation 26(f), Hall expressly teaches that “***one or more*** of the optical elements of collection optics 116 [116A-116D]” may be an optical filter. Ex. 1008, 7:13-23; *see also* Section XII.D.2.6(b). Thus, for example, if lens elements 116B-D are constructed as filters, the resulting system includes a plurality of optical filters disposed between the bulk receiver optic and the plurality of photosensors. Ex. 1003 ¶237.

9. Claim 29

Hall discloses and renders obvious claim 29. Ex. 1003 ¶238. As discussed above in connection with limitation 26(f), Hall expressly teaches that collection optics 116 may comprise four lens elements 116A-D, one or more of which may be constructed as an optical filter. Ex. 1008, 7:7-23. A POSITA would have understood and it would have been obvious that the filter elements are supported at least in part by the transparent lens element(s). Ex. 1003 ¶238. For example, if lens elements 116B and 116D are filters, then each filter is connected to and supported by one or more optically transparent substrates (*e.g.*, filter 116B would be supported

by transparent lens elements 116A and 116C, and filter 116D would be supported by transparent lens element 116C). *Id.*

10. Claim 30

Hall discloses and renders obvious claim 30. Ex. 1003 ¶239. As discussed above in connection with limitation 21(f), a POSITA would have understood and it would have been obvious that Hall's optical filters are disposed between the bulk receiver optic and the light detecting elements. *See* Section XII.D.2(f). Further, each optical path passes through Hall's collection optics before arriving at the light detecting elements. Ex. 1008, 6:41-47. When a plurality of optical filters is used (as in claim 28, *see* Section XII.D.8), the plurality of optical filters will thus be disposed in each optical path. Ex. 1003 ¶239.

11. Claim 31

The additional limitation of claim 31 is identical to the additional limitation of claim 23, and is disclosed by Hall for the reasons set forth above with respect to claim 23. *See* Section X.D.3.

12. Claim 32

The additional limitation of claim 32 is identical to the additional limitation of claim 24, and is disclosed by Hall, Spector, and Borowski for the reasons set forth above with respect to claim 24. *See* Section XII.D.4 *supra*.

13. Claim 33

The additional limitation of claim 33 is identical to the additional limitation of claim 25, and is disclosed by Hall, Spector, and Borowski for the reasons set forth above with respect to claim 25. *See* Section XII.D.5 *supra*.

XIII. GROUND 4: HALL, BOROWSKI, SPECTOR, AND DROZ RENDER OBVIOUS CLAIM 34

A. The Hall-Borowski-Spector-Droz Combination

The proposed Hall-Borowski-Spector combination is described in Section XII.D. The teachings of Droz are further applied to that combination enable the optical filters to be located in various positions within the LiDAR system. Ex. 1003 ¶242.

1. Motivation to Combine

A POSITA would have been motivated to combine the teachings of Hall, Borowski, Spector, and Droz, and would have had a reasonable expectation of success in combining the references. Ex. 1003 ¶¶243-245.

First, as discussed above, Hall, Borowski, Spector, and Droz are all analogous art to the claimed invention and disclose LiDAR systems with transmission and detection modules. *Id.* ¶245; *see also* Sections X.C.1, XII.D.1. In addition, the teachings of Droz, Spector, and Borowski are all generally applicable to LiDAR devices, including Hall's LiDAR system. Ex. 1003 ¶245; *see also* Sections X.C.1, XII.D.1.

Second, a POSITA would have been motivated to modify Hall to incorporate the relevant teachings of Borowski and Spector for the reasons described in Ground 3. *See* Section XII.D.1.

Third, a POSITA would have been motivated to further modify Hall in view of Droz to flexibly position Hall's optical filters in various locations within the LiDAR system. Ex. 1003 ¶244. A POSITA would have understood that the position of the optical filter is a design choice that does not impact its functional benefits and advantageously provides additional flexibility in designing the LiDAR system. *Id.*

2. Claim 34

The Hall-Borowski-Spector combination renders obvious claim 26 as set forth in Ground 3. *See* Section XII.D.6. In that combination, Hall's optical filters are lens elements adjacent to the bulk receiver optic, and are thus not disposed between the apertures and the photosensors. However, as discussed above, it would have been obvious to POSITA to modify Hall to position optical filters in different locations within the system in view of Droz. Ex. 1003 ¶246.

Droz teaches an optical filter 132 that “may be located in various positions relative to [light detector] array 110,” including, in particular, covering each individual detector in an array with a separate optical filter. Ex. 1006, 7:65-8:10 (“[E]ach of the light detectors in array 110 may individually be covered by a separate optical filter.”). It would be obvious to a POSITA to try this configuration suggested

by Droz in the Hall-Borowski-Spector combination. *Id.* ¶247. When Droz’s teaching is applied in the combined system, Hall’s optical filters would be implemented to cover each SPAD within the SPAD arrays taught by Borowski, so that each optical path between an aperture and a SPAD array will include a plurality of optical filters (one for each SPAD in the array). *Id.* ¶247.

B. Secondary Considerations

Hesai is not aware of any evidence regarding secondary considerations of non-obviousness, and Ouster did not identify any such evidence in the patent specification, prosecution history, or related district court and ITC complaints. Ex. 1003 ¶248. To the extent Ouster identifies evidence of secondary considerations at a later point in the proceeding, Hesai reserves the right to address it at that time.

* * *

For the foregoing reasons, claims 21 and 23-34 of the ‘405 Patent are obvious.

XIV. DISCRETIONARY FACTORS

The Board should decline to deny institution under the discretionary factors of 35 U.S.C. §§314 and 325(d).

A. 35 U.S.C. §314

The *Fintiv* factors weigh against discretionary denial of this Petition. *See Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 at 5–6 (PTAB Mar. 20, 2020) (*precedential*).

Although Ouster filed a district court complaint in the U.S. District Court for the District of Delaware (Ex. 1017), that action was stayed before a responsive pleading was even served. *See* Ex. 1018. No trial date has been set in the district court action, and invalidity is unlikely to be resolved before a Final Written Decision in this proceeding, particularly in light of the early stay, which remains in effect. The presiding ALJ at the ITC issued an initial determination terminating the Investigation. Ex. 1020. These facts favor granting institution under the *Fintiv* framework.

B. 35 U.S.C. §325(d)

The Board should decline to deny institution under §325(d) because the PTO has not previously considered the same or substantially the same prior art and arguments Hesai presents here, and the Examiner committed error in evaluating the prior art of record.

First, it is important to note that the ‘405 Patent issued after only a limited prosecution. Ex. 1002. The challenged claims were added by amendment only *after* the Examiner issued the only substantive rejection of record. *Id.* No substantive rejection was thereafter issued regarding the claims challenged herein. And none of the references the Examiner cited in the office action initially rejecting the claims included in the original application are relied upon in the grounds of this Petition or substantially similar to the references relied upon. *Id.*

Second, although Pacala and Borowski are cited on the face of the ‘405 Patent, the references were simply identified among dozens of other references in Information Disclosure Statements Ouster filed. They were not included in a substantive office action, and there is no indication the Examiner considered their merits during prosecution. *Amazon.com, Inc. v. M2M Sols. LLC*, IPR2019-01205, Paper 14 at 15 (PTAB Jan. 27, 2020) (“The Board frequently holds that a reference that ‘was neither applied against the claims nor discussed by the Examiner’ does not weigh in favor of exercising the Board’s discretion under §325(d) to deny a petition.”).

Furthermore, it was material error for the Examiner **not** to rely on Pacala, Hall, Borowski, Droz, Villeneuve, and Spector as a basis for rejection. As detailed above, these references teach the individual elements of the claimed invention and render the challenged claims as a whole obvious when combined. Thus, the references would have been material to the patentability of the ‘405 Patent if the Examiner had properly considered them.

Third, the other references relied upon in the grounds of this Petition—Hall, Droz, Villeneuve, and Spector—were neither cited nor considered during prosecution of the ‘405 Patent. None of the cited references contain a substantially similar disclosure of a LiDAR detection system that includes a plurality of apertures separated by a stop region (Droz and Spector), optical filters (Hall and Droz), SPAD

arrays (Droz and Borowski), or precise alignment of emitters and detectors to provide sets of coincident, non-overlapping fields of view (Hall, Spector, and Villeneuve).

Thus, the Board should decline to deny institution under the discretionary authority of §325(d).

XV. CONCLUSION

For the foregoing reasons, Hesai requests that the Board institute *inter partes* review and cancel claims 21 and 23-34 of the '405 Patent.

Respectfully submitted,

Date: September 14, 2023

/s/ *Jared W. Newton*

Jared W. Newton
Reg. No. 65,818
jarednewton@quinnemanuel.com
QUINN EMANUEL URQUHART &
SULLIVAN LLP
1300 I Street NW, 9th Floor
Washington, DC 20005
Tel: (202) 538-8000
Fax: (202) 538-8100

Counsel for Petitioner Hesai

CERTIFICATION UNDER 37 C.F.R. §42.24

Under the provisions of 37 C.F.R. §42.24, the undersigned hereby certifies that the word count for the foregoing Petition for *inter partes* review totals 13,706 words, not including the table of contents, table of authorities, mandatory notices, certificates, listing of exhibits, or listing of claims, as permitted under 37 C.F.R. § 42.24(a)(i).

Date: September 14, 2023

/s/ Jared W. Newton
Jared Newton
Reg. No. 65,818
jarednewton@quinnemanuel.com
Quinn Emanuel Urquhart & Sullivan
1300 I Street NW, 9th Floor
Washington, DC 20005
Tel: (202) 538-8000
Fax: (202) 538-8100

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e), 42.105(a), the undersigned hereby certifies service on the Patent Owner of a copy of this Petition, its respective exhibits, and Petitioner's Power of Attorney at the official correspondence address for the attorney of record for the '405 Patent as shown in USPTO Patent Center via Federal Express on September 14, 2023:

Kilpatrick Townsend & Stockton LLP - West Coast
Mailstop: IP Docketing-22
1100 Peachtree Street, Suite 2800
Atlanta, GA 30309
UNITED STATES

Date: September 14, 2023

/s/ Jared W. Newton
Jared Newton
Reg. No. 65,818
jarednewton@quinnemanuel.com
Quinn Emanuel Urquhart & Sullivan
1300 I Street NW, 9th Floor
Washington, DC 20005
Tel: (202) 538-8000
Fax: (202) 538-8100