

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VOLKSWAGEN GROUP OF AMERICA, INC.,
Petitioner,

v.

YECHEZKAL EVAN SPERO,
Patent Owner.

U.S. Patent No. 10,894,503 to Spero

Case No.: IPR2023-00197

SECOND DECLARATION OF MATTHEW A. TURK PhD

TABLE OF CONTENTS

List of Exhibits.....	6
I. Qualifications and Professional Experience.....	9
II. Relevant Legal Standards	15
III. State of the Art as of 2002	16
A. POSA Considerations for LED Forward Lighting.....	16
B. Regulations and Standards	17
C. Design Tradeoffs	23
D. Hardware	28
E. Optical System	29
F. Spatial Light Modulator	32
G. Heat management.....	36
H. Packaging	38
I. Cost.....	39
IV. Overview of the ‘503 Patent.....	40
V. Qualifications of one of ordinary skill in the art	46
VI. Proposed Claim Constructions	47
VII. Overview of the Prior Art.....	48
A. Beam: U.S. Patent No. 6,144,158	48
B. Thominet: U.S. Application Pub. No. 2001/0019486.....	54
C. Kobayashi: U.S. Patent No. 6,049,749.....	56
D. Stam: WIPO Publication No. 2001/1070538.....	60
E. Karlsson: PCT Application Pub. No. WO1998/054030	61
1. Karlsson’s Window 50 Depicts Illumination Being Reduced for Situational Glare.....	62
2. The Base Device That Karlsson Improves Takes A Similar Approach To Situationally Reducing Full Emission.....	68
F. Harbers: WIPO Publication No. 2001/001038	69
G. Gotou: U.S. Patent No. 5,588,733.....	72
VIII. Petitioner Asserts Alternate Combinations	76
IX. Missing Elements.....	76
I. The Challenged Claims are Patentable.....	77

A.	Grounds 1A-1E: The Proffered Combination Fails to Teach the Aiming Limitations in [20.2]	77
B.	Grounds 1A-1B: Beam Does Not Teach Directional Light Sources Having Different Aimings	78
C.	Grounds 1C-1E: Even Combined, Beam and Thominet Fail to Teach the Aiming Limitation	82
	1. Sub-ground 1C does not meet the limitations of the claims	83
	2. Petitioner’s Motivation to Combine is Flawed for 1C.....	83
	3. The Ground 1C Combination Is Unsuitable As It Reduces Forward Illumination.....	85
	4. Ground 1D- Absent Thominet’s Software, the Combination Is Incapable of Achieving Segmentation	85
	5. Grounds 1D-1E- The Petition Offers No Rationale For the Addition of Thominet’s Optional Curved Array	86
D.	Grounds 1A-1E: Neither Beam Nor Beam-Thominet Teach the Detected Vehicle Limitations of Claims 20/59.....	93
	1. Grounds 1A-1E Lack the Ability to Detect or Identify a Vehicle	93
E.	Grounds 1A-1E: The Proffered Combinations Fail to Teach the Detected Vehicle Limitations in [20.9-20.10] and the Output Limitations in [20.11-20.13]	98
F.	Ground 1- Dependent claim 25	99
G.	Ground 2: Even combined, Beam, Thominet, and Stam Fail to Teach the “Predefined Illuminance” Limitation in Claims 59 and 63-64, And Beam’s Failings Further Render the Proofs Deficient	100
	1. Sub-grounds 2A and 2D Inherit Deficiencies of Sub-ground 1C.....	100
	2. Sub-grounds 2B and 2E Inherit Deficiencies of Sub-ground 1D	100
	3. Sub-grounds 2C and 2F Inherit Deficiencies of Sub-ground 1E.....	100
	4. Sub-grounds 2A-2F All Inherit Beam’s Failures.....	100
	5. Grounds 2D-2F: There Is No Motivation to Combine Blanked Subsections With A Predefined Illuminance Level.....	101
	6. Petitioner Fails to Prove at Least Limitations 58.8-58.9	102

H.	Ground 3: Dependent Claims 21-23 The Beam-Thominet-Kobayashi Combination Does Not Teach All Claim Limitations	103
1.	Grounds 3A-3I Inherit Deficiencies of Sub-grounds 1C-1E	104
2.	Sub-grounds 3A-3I All Inherit Beam’s Failures	104
3.	Beam-Thominet-Kobayashi Is Never Shown to “Increase” Illumination as Required in Claims 21-23	104
I.	Ground 4: Even Combined, Beam, Thominet, Stam and Kobayashi Fail to Teach Claims 60-62	106
1.	Sub-grounds 4A-4I Inherit Deficiencies of Sub-grounds 1C-1E	106
2.	4A-4I Are Duplicative of Ground 2, Sections 1-3.....	106
3.	The Ground 4 Argument Omits Material Limitations in Claims 60-62	107
J.	Ground 5- Karlsson or Karlsson-Harbers Applied to Claims 20-25 and 59-64.....	107
1.	Grounds 5F-5G There is no Motivation to Merely Use the Curve of Harbers	107
2.	Absent Harbers’ Software, Ground 5E Lacks the Ability to Segment and Presents Color-Shifting Issues.....	107
3.	Grounds 5C-5D/5F Are Unmotivated Combinations Due to the Unaddressed Issues Arising From Conflicting Control Strategies.....	108
4.	Ground 5F Lacks Necessary Particularity	109
5.	Karlsson’s Failings Alone Are Sufficient To Defeat All Proposed Grounds Utilized Against Claims 20-25 and 59-64	109
6.	Grounds 5A-5B, 5F-5G: Karlsson Does Not Teach Directional Light Sources Having Different Aimings.....	110
7.	Grounds 5C-5G: Even Combined, Karlsson and Harbers Fail to Teach the Aiming Limitation in All Claims.....	112
8.	Ground 5A-5G: Karlsson Fails to Teach the Detected Vehicle Limitation	115
K.	Ground 6 – Even Combined, Karlsson, Harbers, and Gotou Fail to Teach Claims 21-23 and 60-62.....	116
1.	Grounds 6A-6E inherit issues from 5C-5G	117
2.	Grounds 6A-6E inherit issues from Proofs of Claims 20 and 59 Reliant On Karlsson	117

3.	Combining Gotou with 6A, 6B, 6D Results in Multiple, Incompatible Control Functions	117
4.	Ground 6E Has No Directional Control	119
5.	Grounds 6B-6C Suffer From Color Shifting Issues	119
II.	Conclusion	120

List of Exhibits

Exhibit No.	Description
2001	Declaration of Matthew A. Turk, PhD
2002	Curriculum Vitae of Matthew A. Turk, PhD
2003	Best Practices and FAQs for Filing Requests for Reexamination Compliant with 37 CFR 1.510 and 1.915, PTAB, May 2010
2004	Petition challenging U.S. Patent No. 10,894,503, <i>Volkswagen Group of America, Inc. v. Yechezkal Evan Spero</i> , IPR2023-00197, Paper 1, November 30, 2022
2005	Petition challenging U.S. Patent No. 10,894,503, <i>Volkswagen Group of America, Inc. v. Yechezkal Evan Spero</i> , IPR2023-00328, Paper 2, December 16, 2022
2006	Second Declaration of Matthew A. Turk, PhD
2007	Transcript of Deposition of Jianzhong Jiao, Ph.D. taken on August 2, 2023, <i>Volkswagen Group of America, Inc. v. Torchlight Technologies LLC</i> , IPR2023-01586
2008	Petition challenging U.S. Patent No. 9,995,551, <i>Volkswagen Group of America, Inc. v. Torchlight Technologies LLC</i> IPR2023-00318, Paper 2, December 22, 2022
2009	Declaration of Dr. Jiao, <i>Volkswagen Group of America, Inc. v. Torchlight Technologies LLC</i> IPR2023-00318, Exhibit 1003.
2010	Jianzhong Jiao and Ben Wang, “Etendue Concern for Automotive Headlamp Using LEDs,” SPIE Proceedings Vol. 5187, (January 2004) (Available at https://www.spiedigitallibrary.org/conference-proceedings-of-spie/5187/0000/Etendue-concerns-for-automotive-headlamps-using-white-LEDs/10.1117/12.504363.short)
2011	Michael Bass, <i>Handbook of Optics</i> 3 RD Edition Volume II, (McGraw-Hill, 2010) (Available at https://www.worldcat.org/title/555545456)
2012	Ben Wang and Jianzhong Jiao “Studies for Headlamp Optical Design Using LEDs,” SAE Technical Paper Series 2004-01-0434, (March 2004) (Available at https://www.sae.org/publications/technical-papers/content/2004-01-0434/)
2013	Ben Wang and Jianzhong Jiao “Optical Transform Limitations in Headlamp Photometric Performance,” SAE Technical Paper Series

	2005-01-0861, (April 2005) (Available at https://www.sae.org/publications/technical-papers/content/2005-01-0861/)
2014	Intentionally left blank
2015	Jianzhong Jiao and Ben Wang “High-Efficiency Reflector Optics for LED Forward Lighting,” SPIE Proceedings Vol. 6670, (September 2007) (Available at https://www.spiedigitallibrary.org/conference-proceedings-of-spie/6670/66700M/High-efficiency-reflector-optics-for-LED-automotive-forward-lighting/10.1117/12.730524.short)
2016	Navigant Consulting “Energy Saving Estimates of Light Emitting Diodes in Niche Lighting Applications” Building Technologies Program Office of Energy Efficiency and Renewable Energy U.S. Department of Energy (September 2008) (Available at Energy Savings Estimates of Light Emitting Diodes in Niche Lighting Applications (Technical Report) OSTI.GOV.)
2017	PCT Publication No. WO 86/05147 to Flaaten
2018	Transcript of Deposition of Jianzhong Jiao, Ph.D. taken on August 23, 2023, <i>Volkswagen Group of America, Inc. v. Torchlight Technologies LLC</i> , IPR2023-00315, IPR2023-00318.
2019	Intentionally left blank
2020	Michael Bass, <i>Handbook of Optics</i> 3 RD Edition Volume V, (McGraw-Hill, 2010) (Available at https://www.worldcat.org/title/557121959 .)
2021	Texas Instruments/Digikey “How DLP Technology Works,” (Available at https://www.digikey.com/en/product-highlight/t/texas-instruments/dlp-technology .) (Accessed September 12, 2023.)
2022	Texas Instruments “Introduction to +/- 12 Degree Orthogonal Digital Micromirror Devices (DMDs) (Available at https://www.ti.com/lit/an/dlpa008b/dlpa008b.pdf?HQS=dis-dk-null-digikeymode-dsf-pf-null-ww&DCM=yes&distId=10) (Accessed September 12, 2023.)
2023	Intentionally left blank.
2024	Intentionally left blank.
2025	Transcript of Deposition of Jianzhong Jiao, PhD taken on October 3, 2023, <i>Volkswagen Group of America, Inc. v. Torchlight Technologies</i> , IPR2023-00197

1. I, Matthew A. Turk, hereby declare as follows:

2. I am making this declaration at the request of Yechezkal Evan Spero in the matter of *Inter Partes* Review of U.S. Patent No. 10,894,503 (“the ’503 Patent”) to Yechezkal Evan Spero.

3. I previously prepared a declaration in this proceeding dated March 22, 2023, submitted as an exhibit (Ex. 2001) with a Patent Owner Preliminary Response of the ’503 Patent to a Petition filed on November 30, 2022 by Petitioner Volkswagen Group of America. I understand that on June 21, 2023, the Board instituted the Petition.

4. For this second declaration, I have been asked to again provide opinions on the claims of the ’503 Patent in light of the prior art, Petitioner’s arguments in the Petition and the corresponding declaration and testimony of Dr. Jiao. If called upon to do so, I would testify competently thereto. I supplement my prior declaration (Ex. 2001) with this additional declaration to do so.

5. As I indicated in my prior declaration, although I am being compensated for the time spent reviewing materials and performing my analysis of the technical issues relevant to this matter, my compensation in no way depends on the outcome of this proceeding.

6. In preparation of this declaration, I have studied the exhibits as listed in the Exhibit List shown above.

7. In forming the opinions expressed below, I have considered:
- a. The documents listed above as well as additional patents and documents referenced herein;
 - b. The relevant legal standards, including the standard for obviousness provided in *KSR International Co. v. Teleflex, Inc.*, 550 U.S. 398 (2007), and any additional documents cited in the body of this declaration; and
 - c. My knowledge and experience based upon my work and study in this area as described below.

I. Qualifications and Professional Experience

8. I am a Professor and President of the Toyota Technological Institute at Chicago (TTIC) and an Emeritus Professor of the Department of Computer Science at the University of California, Santa Barbara. I have worked and studied in the field of computer vision since 1984, as well as related areas of image processing, pattern recognition, machine learning, and human-computer interaction. The field of computer vision is concerned with determining how computers can extract, analyze and understand information from images and video and has been applied to a wide variety of applications including automotive lighting and controls such as those used in automotive adaptive forward lighting systems.

9. I received my doctorate degree in Media Arts and Sciences from the Massachusetts Institute of Technology (MIT) in 1991. My doctoral work was in the area of computer vision, specifically concerning automatic face recognition. I received my Master of Science degree in Electrical and Computer Engineering from Carnegie Mellon University in 1984. My Master's work was in the area of robot fine motion planning. I received my Bachelor of Science degree in Electrical Engineering from Virginia Tech (VPI&SU) in Blacksburg, Virginia in 1982, where my senior honors thesis was on image processing.

10. In 1991, I published the paper "Eigenfaces for Recognition," which I co-authored with my Ph.D. advisor, Dr. Alex Pentland. The research reported in this paper helped lead to practical automated face recognition systems that are used in today's security and surveillance systems, as well as in consumer applications. My work on Eigenfaces has received several awards, including an IEEE Computer Society Outstanding Paper award at the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) in 1991 and a "Most Influential Paper of the Decade" award from the International Association for Pattern Recognition (IAPR) Workshop on Machine Vision Applications (MVA 2000).

11. Along with my co-authors, I have received several other awards at professional conferences and workshops for my work in computer vision, image processing, and augmented reality, including several best paper awards and

winning the ACM Multimedia Open Source Competition in 2015.

12. My industry experience includes working for Martin Marietta Denver Aerospace from 1984 to 1987, where I worked primarily on computer vision for autonomous vehicle navigation as part of the Defense Advanced Research Projects Agency's Autonomous Land Vehicle program, the precursor to the later DARPA Grand Challenge events and subsequent advances in self-driving automobiles. In 1992, I was a visiting researcher at LIFIA/ENSIMAG in Grenoble, France and from 1993 to 1994, I worked for Teleos Research in Palo Alto, CA; in both of those positions, I worked on computer vision methods for recognizing human faces, gestures, and activity. From 1994 to 2000, I was a researcher for Microsoft Research, where I was a founding member of the Vision Technology Research Group and conducted research in vision-based human computer interaction and other related areas.

13. In 2000, I joined the faculty of the University of California, Santa Barbara, as an Associate Professor. In 2005, I was promoted to Full Professor and served as the Chair of the Media Arts and Technology Graduate Program from 2005 to 2010. In 2017, I was appointed as Chair of the Department of Computer Science. At UCSB, I taught graduate and undergraduate courses related to computer vision, computer imaging, human computer interaction, probabilistic models and methods, artificial intelligence, computer graphics, machine learning,

and other areas. My Computer Imaging, Mobile Imaging, Computer Vision, Computer Graphics, and Computational Illumination courses covered the fundamentals of light and optics, camera sensors, imaging geometry, infrared imaging, optical filtering, image processing, 3D imaging, scene understanding, and structured lighting.

14. I co-founded (in 2003) and co-directed the Four Eyes Lab at UCSB, where the research focus is on the “four I’s” of Imaging, Interaction, and Innovative Interfaces. The Four Eyes Lab researches a variety of topics, including computer vision, pattern recognition, virtual and augmented reality, and face processing technologies such as face recognition and facial expression analysis. I worked on and supervised many research projects in these areas, including (1) visual recognition of automobiles and (2) multi-flash imaging, which used multiple image sources and special optics to infer 3D scene structure from images.

15. In 2014, I co-founded a startup company, Caugnate, to commercialize computer vision and augmented reality technology for remote collaboration. Caugnate was acquired by PTC Inc., in 2016, and now forms the core of the Vuforia Chalk augmented reality product.

16. In 2019, I became President of the Toyota Technological Institute at Chicago, an independent graduate research institute, where the research and education focus of the faculty and Ph.D. students is on computer science theory,

machine learning, artificial intelligence, and related areas such as computer vision, speech and language processing, robotics, and computational biology.

17. As a result of my work and research, I am a named inventor of U.S. Patent Number 5,164,992 entitled “Face Recognition System,” U.S. Patent Number 6,674,877 entitled “System and Method for Visually Tracking Occluded Objects in Real-time,” and U.S. Patent Number 9,495,761 entitled “Environment mapping with automatic motion model selection.”

18. I was a founding member of the Advisory Board for the International Conference on Multimodal Interfaces (ICMI), which provides a venue for disseminating recent advances in multimodal interaction research, systems, and methods, which includes combining visual modalities with audio, haptic, or other modalities. I served as the Chair of the ICMI Advisory Board from 2006 to 2009. I was also a founding member of the Advisory Board for the IEEE International Conference on Automatic Face and Gesture Recognition and served as the General Chair for the conference in 2011. I have been a primary organizer of several top research conferences, including serving as General Chair for the 2014 IEEE Conference on Computer Vision and Pattern Recognition, the primary annual conference in the field of computer vision, with over 2000 attendees, Program Chair for the 2017 IEEE Winter Conference on Applications of Computer Vision, and General Chair of the 2019 International Conference on Multimodal Interfaces

(ICMI).

19. I am currently an Associate Editor of the *ACM Transactions on Intelligent and Interactive Systems* and the *International Journal of Computer Vision and Signal Processing*, and was formerly an Associate Editor of *Image and Vision Computing*. I have also served as a guest editor of several other journals related to computer vision, machine learning, and facial recognition. I have published research on lighting and optics, including research focused on automobile-related imaging, including: “Car-Rec: A real-time car recognition system,” IEEE Workshop on Applications of Computer Vision (WACV 2011), January 2011; “VITS – a vision system for autonomous land vehicle navigation,” IEEE Trans. On Pattern Analysis and Machine Intelligence, Vol. 10, No. 3, pp. 342-361, May, 1988; “Video road-following for the Autonomous Land Vehicle,” Proc. IEEE International Conference on Robotics and Automation, Raleigh, N. C., April, 1987; “Color road segmentation and video obstacle detection,” Advances in Intelligent Robotic Systems: Mobile Robots, SPIE, Cambridge, MA, 1986.

20. In 2020, I was elected a Fellow of the Association for Computing Machinery (ACM), the main professional society in the field of computer science, for “contributions to face recognition, computer vision, and multimodal interaction.” In 2013, I was elected as a Fellow of the IEEE (the Institute of Electrical and Electronics Engineers), an award conferred by the Board of

Directors of the IEEE upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest. In 2014, I was elected as a Fellow of the International Association for Pattern Recognition (IAPR). In 2022, I was named as a Fellow of the Asia-Pacific Artificial Intelligence Association. I am also the recipient of the 2011-2012 Fulbright-Nokia Distinguished Chair in Information and Communications Technologies. I have given many keynote presentations at top conferences and workshops in my fields.

21. I have provided my full background in the curriculum vitae that is attached as Exhibit 2002.

II. Relevant Legal Standards

22. I have been asked to provide opinions on the claims of the '503 Patent in light of the prior art.

23. It is my understanding that a claimed invention is unpatentable under 35 USC § 102 if a prior art reference teaches every element of the claim. Further, it is my understanding that a claimed invention is unpatentable under 35 U.S.C. § 103 if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time the alleged invention was made to a person having ordinary skill in the art to which the subject matter pertains. I also understand that an obviousness analysis takes into account factual inquiries including the level of ordinary skill in the art, the scope and

content of the prior art, and the differences between the prior art and the claimed subject matter.

24. It is my understanding that the Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of the claimed subject matter. Some of these rationales include the following: combining prior art elements according to known methods to yield predictable results; simple substitution of one known element for another to obtain predictable results; a predictable use of prior art elements according to their established functions; applying a known technique to a known device to yield predictable results; choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; and some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

III. State of the Art as of 2002

A. POSA Considerations for LED Forward Lighting

25. While LEDs were being proposed for use in vehicle forward lighting applications to replace conventional light sources such as halogen and high-intensity discharge (HID) light sources, experts in vehicle lighting were uncertain, even years later in 2004 and beyond, if or when the significant challenges

associated with use of LEDs in these applications could be overcome to meet government regulations and industry standards while satisfying vehicle design aesthetics and operational demands.

B. Regulations and Standards

26. As generally referenced in numerous vehicle forward lighting patents and publications, vehicle forward lighting is subject to various government and industry regulations. Regulations such as the Federal Motor Vehicle Safety Standards (FMVSS) in the U.S. specify requirements with respect to minimum/maximum intensity, color, and beam pattern and shape for specific types of vehicle lights, such as low beam headlamp beams (also referred to as the dipped beam or passing beam) and high beam headlamp beams (also referred to as main beam or driving beam), cornering lamp beams, fog lamp beams, and signaling lamp beams, for example. Considering the differing requirements, functions, and positions for different types of lamp beams, a POSA would not have considered combining features from lamps having different functions (such as using amber color of fog lamp beams for low beam headlamps, or having high beam and low beam fog lamps, or cornering lamp beams having the intensity of low beam headlamps, etc.) or expect such combinations to meet regulatory requirements for a different type of lamp beam.

Any automotive headlamp beam pattern, either high-beam or low-beam, is a light luminous intensity (candela) angular distribution. The candela values are specified at different vertical and horizontal angles by using test points, lines, and zones. The specifications are governed by federal laws or industry recommendations. For a low-beam headlamp, for example, the beam pattern requirement is based on several factors: A) sufficient road illumination for driver visibility and safety; B) glare light control for the oncoming vehicle drivers; C) lamp aim-ability; and D) spread and foreground light for driver's comfort. Because of these requirements, the headlamp beam pattern must be a highly non-isotropic light distribution; and its light intensity varies in a range from a few hundreds to 20,000 or more candela.

(Ex. 2010¹ at 237.)

Based on the recent development of white LEDs, it becomes feasible to design automotive headlamps using LED light sources. While these LEDs are reaching high lumen output, the uniqueness of headlamp applications has not yet been sufficiently addressed. This paper discusses the optical features of an automotive headlamp, its optical

¹ Jianzhong Jiao and Ben Wang, "Etendue Concern for Automotive Headlamp Using LEDs", SPIE Proceedings Vol. 5187, published by the international society for optics and photonics (January 2004). Ex. 2010 is a true and accurate copy of a technical paper that I understand was published by SPIE in January 2004.

design principles, light intensity distribution and concentration requirements, and safety and customer pleasing needs.

(Ex. 2010 at 234.)

27. Regulations and standards define headlamp beam patterns so that light is provided to illuminate both near and far distances while avoiding glaring. The beam pattern includes invariable characteristics (such as a step, cutoff, and hotspot) that result from the optical system including the size, position, and intensity of the light source relative to reflectors and lenses to meet the photometric requirements at designated test points.

In certain angular area where high illumination is needed, the luminous intensity is very high and light is highly concentrated or collimated. This high light intensity area is called hotspot. At the top edge of the hotspot, light intensity is rapidly reduced to form a luminous intensity gradient or cutoff line, which serves two purposes: to control the glare light and to aim the lamp visually. Contrast to hotspot, the light that spreads to left and right or foreground has much less intensity and a large diverge or spread angle instead.

(Ex. 2010 at 237.)

Cutoff is designed into the luminaire through the optics (i.e., edge-ray designs) and/or the integration of baffles. While most applications do not require cutoff classification, except for those used on the exterior, such as automotive, roadway, and landscape lighting, most designers include such to make effective lighting systems by alleviating

potential glare, trespass, and pollution concerns. Often strict cutoff guidelines are mandated by governmental standards, such as for automotive, traffic signal, and roadway lighting. The goals are to provide the required lighting level to its users, while also alleviating light pollution and light trespass.

(Ex. 2011² at 40.43.)

A typical automotive headlamp is required to provide a specific output light distribution – beam pattern. For a low-beam headlamp, for example, the beam pattern requirement is based on several factors: (1) sufficient road illumination for driver visibility and safety; (2) glare light control for the oncoming vehicle drivers; (3) lamp aim-ability; and (4) spread and foreground light for driver's comfort. When the headlamp is constructed with multiple optical units or compartments with N LED light sources, each optical unit may have a different etendue value, or provide different luminous intensity and different spread angle.

* * *

However, because **both lamp aperture and number of LEDs that can be physically packaged into the lamp aperture are limited by vehicle level restriction**, the hotspot luminous intensity level, or

² Michael Bass, *Handbook of Optics* 3RD Edition Volume II, (McGraw Hill 2010.)

Ex. 2011 is a true and accurate copy of excerpts of a book that I understand was published by McGraw Hill in 2010.

performance is highly depending on the LED's luminance, rather than its total lumen output.

(Ex. 2012³ at 6-7, emphasis added.)

One major difficulty for forming a headlamp beam pattern is to obtain sufficient candela values in the hotspot while the lamp total aperture is limited. For high-beam design, it is more difficult to form the hotspot as its candela requirement can be as high as 40,000.

(Ex. 2010 at 237-238.)

The light intensity distribution or beam pattern from a forward lighting device is regulated by federal, state and international laws for safety. The optical system design to provide such beam patterns has been largely associated with the characteristics of the tungsten halogen or HID sources. White LEDs, on the other hand, have different optical characteristics, which in turn have impacted the headlamp optical system design.

(Ex. 2010 at 234.)

28. Regulations and standards require white light for vehicle forward lighting applications. As such, light sources emitting other colors are not available

³ Ben Wang and Jianzhong Jiao, "Studies for Headlamp Optical Design Using LEDs", SAE Technical Paper Series 2004-01-0434, published by Society of Automotive Engineers (March 2004). Ex. 2012 is a true and accurate copy of a technical paper that I understand was published by SAE in March 2004.

for use in increasing output light from vehicle headlamps.

Unless both covered and unlit, a vehicle operated on the highways of this state must not be equipped with a lamp or a part designed to be a reflector unless expressly required or permitted by this chapter or that meets the standards prescribed in 49 C.F.R. § 571.108. Except as otherwise provided, a lamp or a part designed to be a reflector, if visible from the front, must display or reflect a white or amber light; if visible from either side, must display or reflect an amber or red light; and if visible from the rear, must display or reflect a red light.

Michigan Vehicle Code Act 300 of 1949 § 257.698(4)⁴

Generating white light from HB-LEDs is typically accomplished by one of two methods as depicted in Fig. 4. The first method, shown in Figs. 4a and b, utilizes an AlInGaN-LED in conjunction with one or more phosphors. When a UV-LED is used, the UV light emission is absorbed and re-emitted by a mixture of red, green, and blue phosphors.

* * *

The second method for white light emission is preferred when color tuning is necessary, such as in outdoor displays. As indicated in Fig. 4c, by using red, green, and blue LEDs, one can create white light

⁴ Available at

[http://www.legislature.mi.gov/\(S\(3uenjar05mg4e4n3udxmh5on\)\)/mileg.aspx?page=GetObject&objectName=mcl-257-698](http://www.legislature.mi.gov/(S(3uenjar05mg4e4n3udxmh5on))/mileg.aspx?page=GetObject&objectName=mcl-257-698)

when the appropriate ratio of each is selected. This RGB approach has the added benefit of allowing the user to create any color within the associated color gamut by balancing the ratio of the individual LEDs. This method also allows for active adjustment of the color temperature of white light emission which is not possible using the LED/phosphor approach.

(Ex. 2011 at 18.5.)

C. Design Tradeoffs

29. Design tradeoffs imposed significant constraints on the use of LEDs in vehicle forward lighting applications, particularly with respect to meeting the required intensity, color, beam pattern, optical efficiency, packaging size, and thermal/heat management requirements.

As shown in Fig.1, if one wants to obtain smaller spread angle to form a beam pattern, especially the hotspot of the beam pattern, the size of optical unit needs to be enlarged, so that the reflection on the reflector can occur farther from the source to get smaller reflected light spread angle. However, the smaller focus length reflector leads to higher accuracy and tolerances, which is a big challenge for LED headlamp overall design.

(Ex. 2012 at 4.)

Besides the aperture, another limitation to form an adequate headlamp beam pattern is the overall size of the optical system and depth. Because of vehicle styling and packaging needs, the depth of a headlamp is also often restricted. As a consequence, the amount of

lumen being collected and projected into the beam pattern through the optical system may not be sufficient to meet all the desires.

(Ex. 2010 at 238.)

Because of the limitations of lamp aperture, the optical system focal length, and the dimensions of the LED emitter, the total system efficiency is assumed $\eta = 0.42$, which includes reflection loss, transmitting loss, refracting loss and collecting loss (equivalent to the above tungsten halogen case).

(Ex. 2010 at 240.)

30. Years after the patent application filed by Spero, experts in vehicle forward lighting acknowledged that implementing LEDs in headlamps presented “great concerns and challenges for the optical engineers.”

With desires of high performance and compact packaging size for both high and low beams, the issues of using LED light sources regarding light collection, efficiency, beam pattern compression and optical accuracy, are great concerns and challenges for the optical engineers.

(Ex. 2012 at 3, emphasis added.)

Besides the aperture, another limitation to form an adequate headlamp beam pattern is the overall size of the optical system and depth. Because of vehicle styling and packaging needs, the depth of a headlamp is also often restricted. As a consequence, the amount of lumen being collected and projected into the beam pattern through the optical system may not be sufficient to meet all the desires.

(Ex. 2010 at 238, emphasis added.)

31. In 2004 and beyond, multiple LEDs (more than 30) were required to generate lumen output similar to a typical tungsten filament halogen bulb as “currently available white LED’s lumen output [was] around 30 lm (maximum), which [was] about 3% of the typical tungsten halogen bulb’s light flux output (1000 lm for 9006 bulb).” (Ex. 2012 at 3.) Furthermore, “the luminance of LEDs must be comparable or higher than the existing tungsten halogen light sources.” (Ex. 2012 at 3.) The significant number of LEDs required to approximate a conventional halogen or HID light source would have prevented using those LEDs for purposes other than the designated low beam and high beam to satisfy regulations. Similarly, the large number of required LEDs would have prevented adding LEDs to perform forward lighting functions due at least to heat management, cost, and packaging considerations described *infra*. Changing the position, size, number, or maximum output of a light source within a headlamp would require changing the optical system including reflectors and lenses to generate an output light beam meeting required standards or regulations.

When using a real light source such as LED with extended light emitting area A_s , light from the extended light source are diverged (or spread) by the optical system. The degree of the collimation depends on both the light source dimensions and the optical system characteristics such as focal length and aperture. If a light source size

A_s with spread angle Ω_s ($2s$ is chosen, for a given lamp aperture A_{lamp} , smaller focal length leads to higher light collection efficiency, but less collimation (a dilemma we always have to face). In addition, in a reflector system, the degree of light collimation varies at different parts of the reflector aperture, while a lens system has consistent light collimation throughout the entire aperture.

(Ex. 2010 at 238.)

When multiple LED sources are used for one headlamp, each LED may have one FFR [Free Form Reflector] unit. The headlamp then consists of several FFR units. Because of the headlamp aperture and package limitations, small FFR unit with short focal lengths, e.g., approximately 10 mm may be used. Longer focal length **multiple LEDs headlamp may take too big of package space** and may not meet lamp size requirement.

(Ex. 2012 at 4, emphasis added.)

32. Even in 2004, it was unclear whether white LEDs would have sufficient light output to generate a light beam meeting applicable regulations and standards similar in intensity to conventional halogen sources.

Although total lumen flux produced by the LEDs may be comparable to the existing light sources, e.g., incandescent bulbs, the optical and mechanical characteristics of LEDs may limit the headlamp applications.

(Ex. 2012 at 3, Abstract.)

However, the currently available white LED's lumen output is around 30 lm (maximum), which is about 3% of the typical tungsten halogen bulb's light flux output (1000 lm for 9006 bulb). **If** the LED's output increases to 100 lm in the near future, it will be 10% of the tungsten halogen bulb's output. This **could lead to an assumption** that 10 LEDs with 100 lm output of each can be used to design an adequate tungsten halogen equivalent low-beam headlamp **if** the lamp system has the same light collection efficiency.

(Ex. 2012 at 3, emphasis added.)

Although the LED current application for headlamp design is limited, because of the flexibility of how to share aperture, it opens a great opportunity and challenge to optical engineers to develop the design concepts that are more efficient. Overall, our experiences have shown that with additional losses introduced by sharing aperture, more LEDs must be added to meet the headlamp beam pattern and total aperture needs. For instance, a headlamp package with approximately 15 LEDs each has 100 lm output (again, total of 1,500 lm input) may be able to meet both performance and aperture requirements discussed in the above. However the total system efficiency is lower than tungsten halogen system.

(Ex. 2010 at 242.)

For designing an adequate (SAE) automotive headlamp low-beam, several design performance values are desired: A) total lumen within the required beam pattern is around 420 lm; B) hotspot candela value is around 25,000 cd; C) large spread angle, 1,000 cd reaches to 35°

left and right. In order to achieve the low-beam performance (420 lm inside the beam pattern, and 25,000 cd in the hotspot), **it takes 50% larger effective aperture when using LEDs that have equivalent total lumen output as a tungsten halogen bulb.**

(Ex. 2012 at 7, emphasis added.)

Similar to the low-beam, for designing an automotive high-beam headlamp that meets the SAE photometry requirements, the desired lamp photometric performance is: A) total lumen within the required beam pattern approximately 600 lm; B) hotspot candela value around 50,000 cd; C) large spread angle with 2,000 cd at 15° left and right.

* * *

In order to achieve the high-beam performance (600 lm inside the beam pattern, and 50,000 cd in the hotspot), it **takes 150% larger effective aperture when using LEDs that have equivalent total lumen output as a tungsten halogen bulb** in aperture 8,000 mm².

(Ex. 2012 at 8, emphasis added.)

D. Hardware

33. Because light output from a single LED was insufficient to satisfy vehicle forward lighting regulations, multiple LEDs were needed. However, this presented challenges with respect to collecting and directing the light from an extended source as compared to a point source to generate the required beam pattern with corresponding luminance at designated points.

Because of the principle and the design restrictions for the system aperture and package size, the luminance of LEDs must be comparable or higher than the existing tungsten halogen light sources.

(Ex. 2012 at 3.)

The limitations or difficulties of using multiple LED to design headlamp may be summaries as two major parts: (A) as the total lamp aperture is being divided into several sub-apertures, the portion of the sub-apertures $A_{(lamp,i)}$ used for LEDs to project lights into hotspot zone with smaller spread angle $\Omega_{(lamp,i)}$ is small. **As a result, there may not be enough light for hotspot;** (B) the smaller sub-structure of the lamp has much smaller focal length comparing to tungsten halogen source, it then requires higher accuracy.

(Ex. 2012 at 10.)

One major difficulty for forming a headlamp beam pattern is to obtain sufficient candela values in the hotspot while the lamp total aperture is limited.

(Ex. 2010 at 237.)

E. Optical System

34. Headlamp optical system design requires a number of design considerations that may change depending on the type of light source being a conventional filament, a linear array of LEDs, a planar array of LEDs, etc. Selection and design of conventional geometric optics or free form reflectors (FFR), passive/active baffles, shields, deflectors, light sinks, modulators, imaging

or non-imaging optics, position/focal points of extended array source including depth/distance between light source and reflectors and output lens(es), etc., all impact the resulting output light beam.

Although there are several typical optical systems to form a headlamp beam pattern such as reflector system, lens system, projector system, and others, the size of the effective aperture is essential for ensure the desired photometry performance.

(Ex. 2010 at 240.)

In order to maintain the system collection efficiency, one can shorten the focal length of the optical unit used for the LED source. However, smaller focal length system leads to larger light source images as well as higher system accuracy required. Both will be adding difficulties to the headlamp design and manufacturing.

(Ex. 2012 at 3.)

In both tungsten halogen and HID cases, the light emitting area is contained in small dimensions, and the light intensity distributions are in general, Lambertian. The light intensity distribution or beam pattern from a forward lighting device is regulated by federal, state and international laws for safety. The optical system design to provide such beam patterns has been largely associated with the characteristics of the tungsten halogen or HID sources. White LEDs, on the other hand, have different optical characteristics, which in turn have impacted the headlamp optical system design. In addition, the lumen output per LED is still much less than that the exiting tungsten

halogen or HID sources provide, multiple LED sources must be used for one head lamp.

(Ex. 2010 at 234.)

[F]ive basic optical transforms used in the automotive lamp optical design have been discussed.

* * *

The limitations for these transforms are based on the etendue conservation. These limitations are the intrinsic properties of the optical systems used in the illumination applications including automotive lamps.

* * *

[T]he overall balance between the total lumen and luminance of the LEDs and the headlamp optical structure is controlled by these limitations.

* * *

[T]o achieve high performance for a headlamp, when the system losses caused by manufacturing . . . are not avoidable, sufficient lumen and luminance of the light sources and sufficient optical systems are always necessary and important.

(Ex. 2013⁵ at 10.)

⁵ Ben Wang and Jianzhong Jiao “Optical Transform Limitations in Headlamp Photometric Performance”, SAE Technical Paper Series 2005-01-0861, published

In the design of the above prototype LED headlamp, because the plastic dome of the LED magnifies the chip image, each LED emitter then has effective size of 1.5 mm X 1.5 mm. As shown in the Fig. 11A & 11B, **the hotpots [sic] intensity of both low-beam and high-beam pattern are not high enough to provide sufficient down-the-road light.**

(Ex. 2012 at 10, emphasis added.)

When designing the low-beam headlamp using tungsten halogen bulb with FFR, the filament is in an axial orientation along the optical axis of the FFR. With such arrangement, it is quite natural to form the desired hotspot horizontal angular spread. Regardless what aspect ratio or shape of the LED chip could be, it is important to realize that one of the chip demission must be small, or comparable to the size of the tungsten halogen filament diameter unless the LED emitter has extremely high luminance.

(Ex. 2012 at 11.)

F. Spatial Light Modulator

35. A POSA would have understood a spatial light modulator (SLM), such as described by Beam (Ex. 1005) or Karlsson (Ex. 1010), to be an array of

by Society of Automotive Engineers (April 2005). Ex 2013 is a true and accurate copy of a technical paper that I understand was published by SAE in April 2005.

individually electrically controllable elements each operable as an optical switch. A transmissive SLM may be constructed using optical elements such as liquid crystals (LCs) that selectively transmit light in a first state (ON, for example) and selectively block light in a second state (OFF, for example). (Ex. 2020⁶, 8.29-8.30, pp. 342-343.) Alternatively, a reflective SLM, such as a digital light processor (DLP) used in projectors, may be constructed using optical elements such as micromirrors that reflect light at predetermined first/second angles depending on whether the switch is ON/OFF. (Ex. 2021⁷.) Light reflected at the first angle exits the device, while light reflected at the second angle is blocked by the device. (Ex. 2022⁸.)

⁶ Michael Bass, *Handbook of Optics* 3RD Edition Volume V, (McGraw-Hill, 2010.) Ex. 2020 is a true and accurate copy of excerpts of a book that I understand was published by McGraw Hill in 2010.

⁷ Texas Instruments/Digikey “How DLP Technology Works.” Ex. 2021 is a true and accurate copy of a Digikey webpage (<https://www.digikey.com/en/product-highlight/t/texas-instruments/dlp-technology>) that was accessed on September 12, 2023.

⁸ Texas Instruments “Introduction to +/- 12 Degree Orthogonal Digital Micromirror Devices (DMDs).” Ex. 2022 is a true and accurate copy of a Texas

36. An SLM is used by Beam and Karlsson to convert a light beam generated by a light source, such as an incandescent halogen bulb, for example, to multiple separate and individually controllable smaller light beams (microbeams as described by Beam, or spotlight beams as described by Karlsson) so that the smaller light beams can be individually blanked or blocked and do not exit the headlamp. (*See e.g.*, Ex. 1005 at 4:36-41; Ex. 1010, 5:4-15.)

37. In addition to embodiments that use a single light source with an SLM to generate the multiple controllable microbeams or spotlight beams, Beam and Karlsson also describe alternative embodiments that replace the single light source and SLM with multiple individually controllable light sources, such as LEDs, that may be individually switched ON/OFF to generate the multiple controllable microbeams or spotlight beams without an SLM. (*See e.g.*, Ex. 1005, Figs. 4, 6; Ex. 1010, Fig. 14.)

38. As described by Beam and Karlsson, and as would be recognized by a POSA, in view of the redundant functionality there is no reason to use an SLM in combination with individually controllable light sources such as LEDs for adaptive

Instruments Document that was revised in February 2018 and is available online at (<https://www.ti.com/lit/an/dlpa008b/dlpa008b.pdf?HQS=dis-dk-null-digikeymode-dsf-pf-null-ww&DCM=yes&distId=10>) (Accessed September 12, 2023.)

headlamp applications. On the contrary, for a POSA there are numerous reasons associated with cost and complexity that counsel against such a combination. For example:

- additional assembly and corresponding control complexity would be introduced in aligning positions of the LEDs within an array with corresponding SLM elements and determining which LEDs and SLM switches to control in combination;
- due to losses inherent to each optical element (SLM, lens, reflector, etc.) positioned in the path of a light beam, and the relatively low luminous flux generating ability of available LEDs at the time, light output from the LEDs would be further reduced by an SLM even while being operated in a transmitting state;
- use of an SLM to blank/block light being generated by one or more LEDs would result in increased power consumption and heat generation as compared to simply turning the corresponding LEDs off; and
- packaging considerations of placing a redundant device having multiple electrical connections with proper positioning relative to other optical elements of the headlamp, such as reflectors, lenses, etc.

39. For at least the reasons described herein, a POSA would not use an

SLM in combination with a light source, such as an LED array, that already has the ability to individually control portions of the generated light beam to provide adaptive headlamp functionality because the functionality of the two components is redundant, and thus unnecessary.

40. Intentionally left blank.

41. Intentionally left blank.

G. Heat management

42. The light output from an LED source varies with temperature and decreases as temperature increases. Similarly, the spectral characteristics or color of the light emitted by the LED varies with temperature. As such, heat management was an important consideration with respect to meeting regulations during operation of an LED headlamp. Furthermore, heat management imposed an additional design constraint such that POSAs were attempting to minimize the number of LEDs and/or maximize the efficiency of light output from the headlamp and would not be motivated to add LEDs to an array to provide additional functionality.

LED, in principle, is a temperature-dependent light source. In all cases, the higher the temperature, the lower the luminous flux output from LED is. As such, managing the heat generated in the LED, or heat from external environment of LED lamp, has been challenging because LED light output reduced when the temperature goes up.

(Ex. 2007, 50:2-9.)

When multiple chips are arranged linearly, such as 2 or 4 1mm x 1mm chips lined up inside of the LED package, if the current density of the package is assumed the same for the above chip arrangement, higher temperature or high heat is generated for the LED packages with larger chip numbers. In practice, the heat dissipation may not be linearly related to the power of the LED packages, thus, due to the junction temperature dependence, the luminous flux of the LEDs is not linearly related to the chip numbers.

(Ex. 2015⁹ at 7.)

In recent years the push for solid-state white lighting has resulted in a transition to larger HB-LED chip sizes and an increase in the operating current densities. The latter brings new constraints to packaging due to the increased need for thermal management in an effort to keep the junction temperature of the HB-LED as low as possible. While the traditional packaging formats have proven very effective for standard drive current use, they are not suitable for high

⁹ Jianzhong Jiao and Ben Wang “High-Efficiency Reflector Optics for LED Forward Lighting”, SPIE Proceedings Vol. 6670, published by the International Society for Optics and Photonics (September 2007). Ex. 2015 is a true and accurate copy of a technical paper that I understand was published by SPIE in September 2007.

drive current applications using large area HB-LEDs since they do not provide adequate thermal management.

* * *

Most HB-LEDs use sapphire substrates that provide very poor heat dissipation from the LED junction due to the low thermal conductivity of sapphire.

* * *

Standard clear epoxies that are used in conventional packages typically cannot withstand temperatures much above 100°C. In flip chip high drive packages this can be easily exceeded and would cause thermal damage to conventional epoxies.

(Ex. 2011, at 18.6.)

H. Packaging

43. Packaging considerations for automotive headlamps presented challenges even years after the earliest priority date of '503 Patent. These included the depth required based on longer focal lengths associated with LEDs, multiple LEDs required to achieve required light output at reduced collection efficiency due to extended array, sufficient heat sinks, driver electronics, and other components required for operation while meeting vehicle design aesthetic requirements.

One major difficulty for forming a headlamp beam pattern is to obtain sufficient candela values in the hotspot while the lamp total aperture is limited.

(Ex. 2010 at 237.)

With desires of high performance and compact packaging sizes for both high and low beam headlamps, using LED light sources is a great challenge for the headlamp design optical engineers for light collecting efficiency, beam pattern compression and optical accuracy.

(Ex. 2012 at 3.)

Besides the aperture, another limitation to form an adequate headlamp beam pattern is the overall size of the optical system and depth. Because of vehicle styling and packaging needs, the depth of a headlamp is also often restricted. As a consequence, the amount of lumen being collected and projected into the beam pattern through the optical system may not be sufficient to meet all the desires.

(Ex. 2010 at 238.)

I. Cost

44. The higher cost associated with LEDs to provide similar illumination relative to conventional light sources such as halogen or HID sources was another factor that contributed to the uncertainty of whether LEDs were, even if feasible, a suitable replacement for conventional light sources in vehicle forward lighting applications.

[T]he added cost of solid-state white lighting has slowed the market acceptance. A common cost comparison is the first cost of a light source, typically measured in terms of the cost per kilolumen (klm). Incandescent and fluorescent light sources fall in the \$0.5 to \$3.00 per

klm, while current light emitting diode sources fall easily in the \$20 to \$30 per klm range.

(Ex. 2011 at 18.5.)

[T]he LED light source can be more than 20 times as expensive as the incandescent light source it replaces.

(Ex. 2016¹⁰ at 66.)

45. Intentionally left blank.

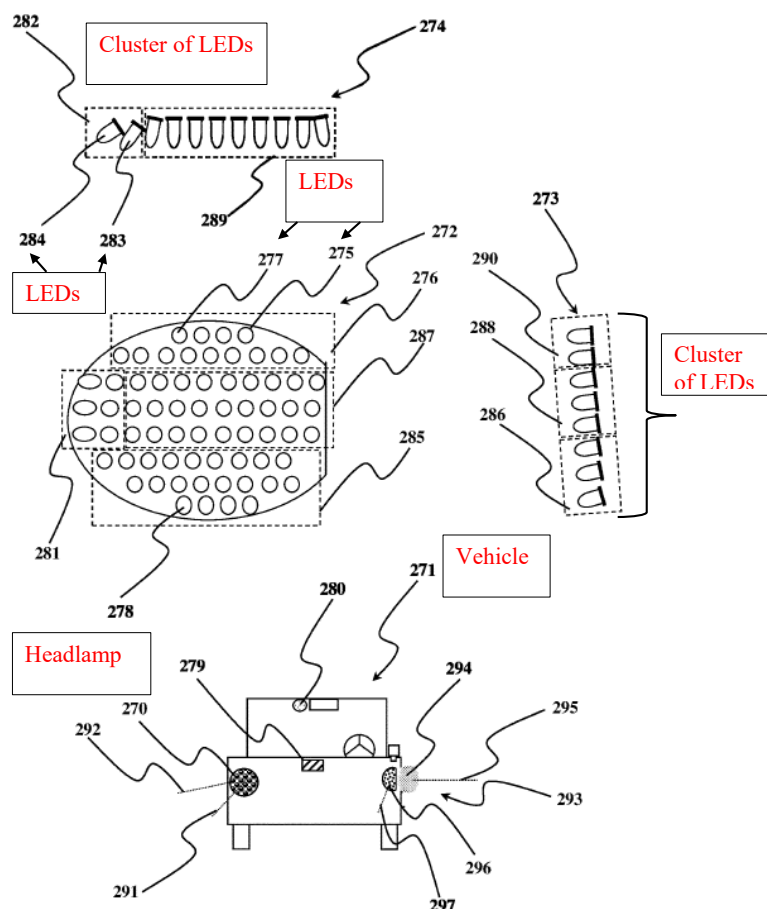
46. Intentionally left blank.

IV. Overview of the ‘503 Patent

47. The ‘503 Patent is directed to “a novel multi-light source approach to the design and construction of solid-state lighting fixtures (vs. solid state lamps), which is termed a ‘Digital Lighting Fixture’, due to the control of individual lighting element ‘digits’ to provide the ‘correct’ lighting solution for the situation at hand.” (Ex.1001, 11:11-16.) The ‘503 Patent further explains that “[t]he terminology ‘digital’ as used herein refers to the discrete nature of the multiple

¹⁰ Ex. 2016 Navigant Consulting “Energy Saving Estimates of Light Emitting Diodes in Niche Lighting Applications” Building Technologies Program Office of Energy Efficiency and Renewable Energy U.S. Department of Energy (September 2008). Ex. 2016 is a true and accurate copy of a technical paper that I understand was published by the DOE in September 2008.

LED lamps provided in the luminaire, whereby, ‘digital’ control results from the individual control of the discrete, i.e., ‘digital’ lighting elements, the LEDs, in the luminaire.” (Id., 2:67-3:5.)



(Ex. 1001, Fig. 15, Annotated)

48. “The added controllability offered by breaking the total light output up into discrete (‘digital’) specifically aimable and dimmable elements which can be addressed by control electronics to effect intensity, spectrum and spatial distribution of intensity and spectrum, yields a lighting fixture (vs. lamp) of unparalleled performance.” (Ex.1001, 11:61-67, emphasis added.) The ’503 Patent

describes using a digital light fixture (DLF) to provide multiple functions, for example “[i]n a DLF it is possible to combine a task light having a very narrow ‘spot’ beam at the correct aiming with a general area lighting ‘flood’ beam into one fixture.” (Id., 22:18-20.)

49. More specifically, the ‘503 Patent describes methods of using a multi-LED light source to segment a field of view and deliver varied, optimized illumination to the different segments within the field of view based on the presence of a detected object therein, “covering a wide scope of applications”, including transportation. (Ex.1001, 11:18-21, 4:20-24, 50:40-41.)

50. In the context of headlights,

[a]dditional features can include an optional very narrow flashlight type of beam. . . Such a beam at the correct narrow aiming can continue to illuminate far ahead (in high beam) without blinding oncoming traffic. Analysis by a detector or an imaging system of the oncoming vehicles position (using its headlights for example) can be used to determine which exact aiming is the maximum allowable for any given traffic situation and road layout.

(Ex.1001, 52:58-53:2.)

51. Additionally, a spatially differentiated illumination pattern can be determined to differently illuminate segments of a field of view based on the detection of an object:

Using color and pattern recognition techniques it is possible to determine what is a sign. It is then possible to provide the equivalent of “task lighting” and use the controller and properly aimed SLS to follow and illuminate distant overhead and roadside signs for a longer time, yet not blind oncoming traffic due to the narrow beam.

(Ex.1001, 53:3-8.)

52. The claimed invention of the ‘503 Patent is thus directed to multi-LED headlight systems that precisely determine anti-glaring illumination output to optimize illumination for the vehicle operator under a myriad of driving situations, whilst reducing glaring illumination for oncoming vehicles.

53. The Challenged Claims include independent claims 20 and 59, which are reproduced below with claim identifiers:

[20.P] A vehicle headlight system, comprising:
[20.1] one or more headlamps affixed to a vehicle,
[20.2] each headlamp including at least three directional light sources aimed at different angles relative to the vehicle,
[20.3] the light sources configured to have one or more controllable light characteristics
[20.4] wherein a first light source of the more than one light sources at a first angle is less visually disturbing to traffic than a second light source of

the more than one light sources aimed at a second angle, different from the first angle;
[20.5] control circuitry configured to adjust the at least one light characteristic of at least one of the directional light sources;
[20.6] one or more sensors configured to sense information
[20.7] defined as pertinent to determining illumination output from the one or more headlamps and
[20.8] communicating the sensed information to a processor as sensor data;
[20.9] the processor, in communication with at least the sensors and the control circuitry, configured to: process the sensor data to determine, within a field-of-view, at least a first subsection including a detected vehicle and
[20.10] at least a second subsection not including the detected vehicle,
[20.11] determine optimal use of the differently aimed directional light sources to maximize vehicle operator visibility in at least the second subsection,
[20.12] while minimizing a disturbing effect, resulting from the illumination output, on the vision of other traffic in at least the first subsection, and
[20.13] direct the control circuitry to adjust the directional light sources to achieve the determined optimal use.

[59.P] A vehicle headlight system, comprising:
[59.1] one or more headlamps affixed to a first vehicle;
[59.2] each headlamp including at least three directional light sources having different aimings relative to the first vehicle,
[59.3] the light sources having one or more controllable illumination characteristics;
[59.4] one or more sensors configured to sense information,
[59.5] at least portion of the sensed information indicating a second vehicle, and
[59.6] communicate sensor data reflecting the sensed information to at least one processor,
[59.7] wherein the at least one processor is configured to: process the sensor data to identify a first subsection, of a field of view, that includes at least a portion of the second vehicle;
[59.8] determine light output for the headlight system that aims illumination at the first subsection;
[59.9] the illumination aimed at the first subsection substantially resulting in light below a first predefined illuminance in the first subsection, and

[59.10] that aims illumination at one or more subsections of the field of view to either side of the first subsection,

[59.11] the illumination aim at the one or more second subsections substantially resulting in light above the first predefined illuminance in the one or more second subsections; and

[59.12] instruct adjustment of one or more of the light sources to achieve the determined output.

54. The dependent claims include additional innovative features that specify illumination strategies for a myriad of driving situations.

V. Qualifications of one of ordinary skill in the art

55. I have been asked to provide my opinion as to the level of skill of a person having ordinary skill in the art (“POSA”) of the ’503 Patent at the time of the claimed invention. In determining the characteristics of a hypothetical person of ordinary skill in the art of the ’503 Patent at the time of the claimed invention, I was told to consider several factors, including the type of problems encountered in the art, the solutions to those problems, the rapidity with which innovations are made in the field, the sophistication of the technology, and the education level of active workers in the field. I also placed myself back in the time frame of the claimed invention and considered the skill level of colleagues with whom I had

worked at that time.

56. I understand that Petitioner has proposed the following level of ordinary skill:

[A] POSA at the time of the alleged invention would have had a bachelor's degree (B.S.) in mechanical engineering, electrical engineering, optical engineering, applied physics, or an equivalent field, as well as at least 2 years of industry experience in the area of automotive lighting and lighting-control systems.

(Petition at 7.)

57. I also understand that Board adopted a modified version of Petitioner's proposed level of ordinary skill that removed the "at least" qualifier:

[A] POSA at the time of the alleged invention would have had a bachelor's degree (B.S.) in mechanical engineering, electrical engineering, optical engineering, applied physics, or an equivalent field, as well as ~~at least~~ 2 years of industry experience in the area of automotive lighting and lighting-control systems.

(DI at 8.)

58. I understand that Patent Owner accepts the Board's proposed level of ordinary skill

VI. Proposed Claim Constructions

59. In order to properly evaluate these claims, I understand that the terms of the claims must first be construed. For purposes of this declaration, I am

applying the following claim construction for my analysis regarding patentability. I understand that the proposed construction of the term “light source” is “any system that is capable of receiving an electrical signal and producing light in response to the signal.”

VII. Overview of the Prior Art

A. Beam: U.S. Patent No. 6,144,158

60. Beam discloses an Adaptive Anti-Blinding Headlight (“AABH”). (Ex. 1005.) Beam recognized that existing headlight systems operated “either as a ‘high beam’ or as a ‘low beam’” often under manual control, and various unsatisfactory attempts to solve this problem included:

systems which attempt to control the intensity profile of the beam by using a reflector or lens shaped to control the output beam in some predetermined way; systems to move the headlamps in response to changes that occur to the automobile on which they are mounted; . . . movement of headlight beams in response to changes in the vehicle's steering mechanism, etc.

(Ex. 1005, 1:21-23, 1:63-2:5.)

61. Beam solves the identified problems by providing a non-moveable AABH system having a multiplicity of microbeams that “will operate at maximum intensity at all times” allowing “the driver to have the equivalent of high beam headlights or brighter on at all times, greatly enhancing the ability to see at night.”

(Ex. 1005, 6:11-12, 6:54-55, emphasis added.) Beam further discloses that:

From the viewpoint of the driver of an automobile equipped with AABH, it will be like having bright high beams on at all times but without concern that the other motorists within the extent of his headlight beam will be dazzled.

* * *

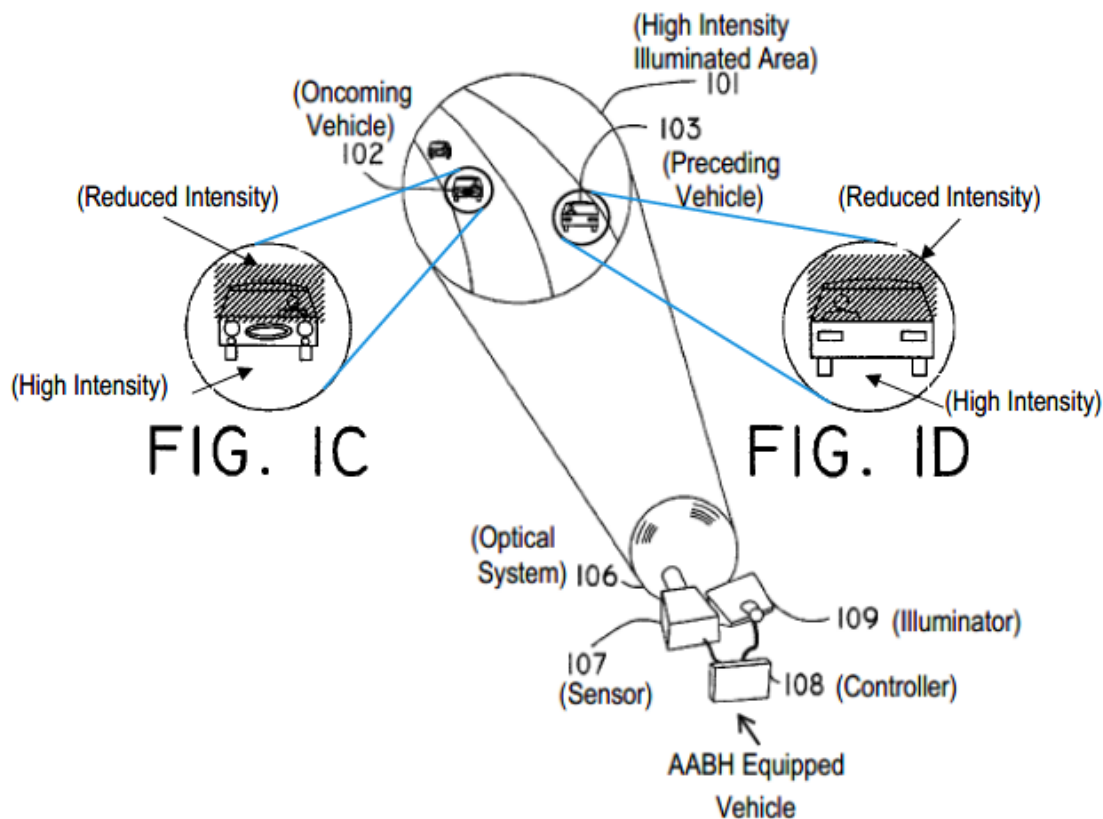
Accordingly, several objects and advantages of this invention are to provide greatly improved safety and comfort to the motoring public, in particular, and to others who may be affected by them by providing the driver of an automobile equipped with the instant invention with a far brighter headlight beam while simultaneously protecting the drivers of all vehicles ahead from being dazzled by the light.

(Ex. 1005, 6:40-44, 3:8-15.)

62. A POSA would have understood that Beam teaches providing a high beam operating at maximum intensity at all times in the illuminated region, other than any areas around detected light sources from other vehicles.

63. Beam provides significantly **reduced** illumination only in those portions of the headlight beam that would otherwise dazzle or annoy other drivers. This is accomplished by “darken[ing] those microbeams that would otherwise illuminate areas near to the source of the impinging beam, thus eliminating the blinding of a driver in an oncoming vehicle, while continuing to provide intense forward illumination.” (Ex. 1005, 1:15-19, Claims 4, 5, emphasis added.) While

Beam discloses blanking or darkening microbeams that would otherwise dazzle other drivers, it does not disclose or teach changing direction of any microbeams exiting the lamp.

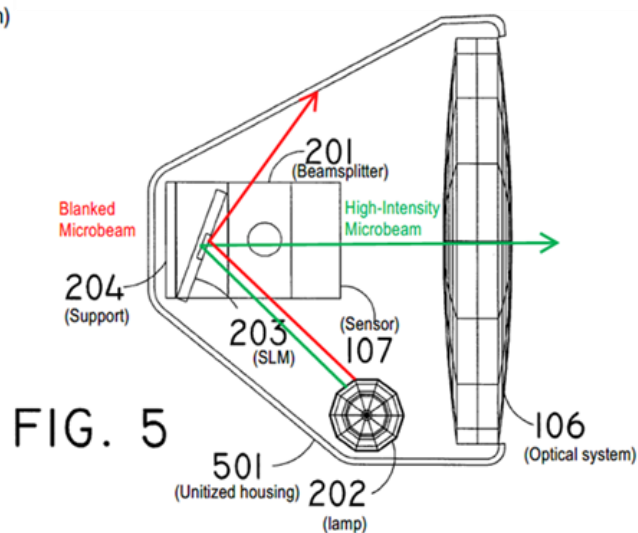
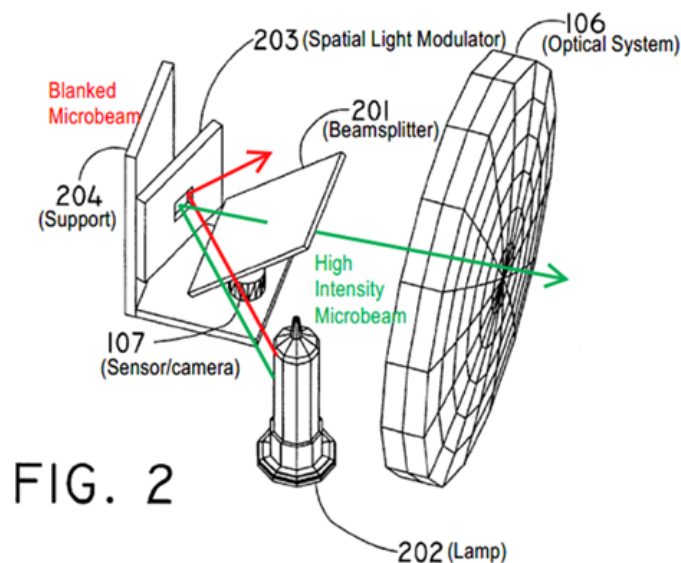


(Ex. 1005, FIG. 1C, 1D, Annotated)

64. In the AABH system, illuminator 109 projects individually controlled narrow-angle microbeams to provide high-intensity illumination of illuminated area 101. Headlights of an oncoming vehicle 102 and/or taillights of a preceding vehicle 103 are transmitted through optical system 106 and detected by a sensor (camera) 107. Data from sensor 107 is used by controller 108 to map the “angular position of the vehicles ahead” to a corresponding position/size of microbeams that

must be significantly reduced in intensity corresponding to the shaded areas shown for oncoming vehicle 102 in Fig. 1C, and preceding vehicle 103 in Fig. 1D. (Ex. 1005, 4:9-24, 53-59, 62-64.)

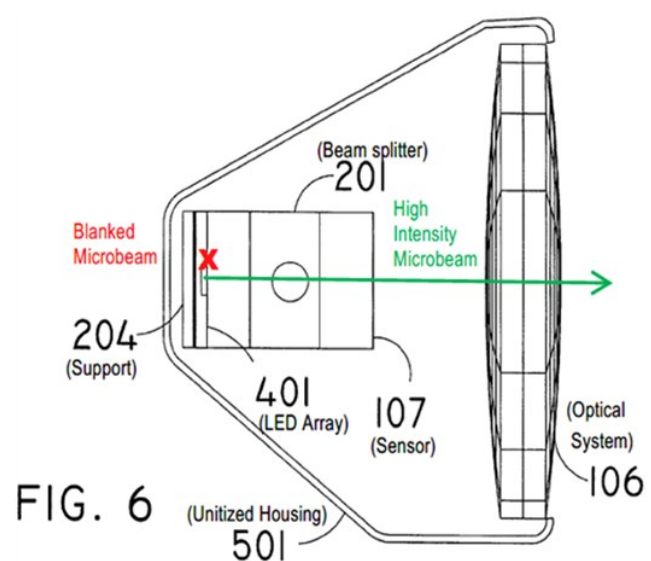
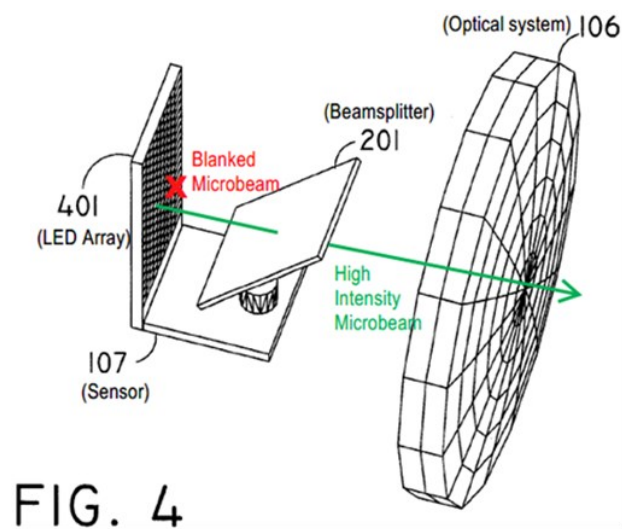
65. Beam describes two distinct embodiments using alternative components that significantly reduce illumination intensity of individual microbeams in response to detecting incoming headlights/taillights or other light sources. However, neither embodiment discloses increasing intensity beyond the maximum intensity for any microbeams, or changing direction of any of the microbeams exiting the lamp.



(Ex. 1005, FIGs. 2, 5, Annotated)

66. In the first embodiment illustrated in Fig. 2 (perspective view) and Fig. 5 (top view), light from lamp 202 falls on spatial light modulator (SLM) 203, which is controlled so that the associated individual microbeams are either 1)

reflected by SLM 203 at full intensity through beam splitter 201 and out through headlamp optical system 106, or 2) “blanked (attenuated by being either absorbed or deflected [by SLM 203] to an absorbing surface” so that they do not exit the headlamp optical system 106. (Ex. 1005, 4:36-40, 5:65-66, emphasis added.) While SLM 203 blanks one or more microbeams by deflecting the blanked microbeams to an internal absorbing surface of the headlamp 501, it does not change direction or angular position of the headlamp beam exiting optical system 106 because the blanked microbeams are “diverted or attenuated at the source” and never exit the headlamp optical system 106. (*Id.* at 5:66.) The Beam SLM 203 appears to work in a similar fashion as a digital light processing (DLP) chip that was in existence on or before the time of filing of the Beam Patent and is used in DLP projectors.



(Ex. 1005, FIGs. 4, 6, Annotated)

67. The second embodiment is illustrated and described with respect to Fig. 4 (perspective view) and Fig. 6 (top view). The second embodiment replaces both SLM 203 and lamp 202 used to generate and modulate (reduce) intensity of the microbeams of the first embodiment, with an array of light sources 401, such as an LED array, that generates the narrow-angle microbeams. Microbeam blanking is accomplished by dimming one or more of the LEDs making the modulator of the first embodiment superfluous, and it is thus omitted from the second embodiment.

68. In operation, light from oncoming/preceding vehicles or other sources enters through optical system 106 and is reflected by beamsplitter 201 to sensor 107. The sensor signals corresponding to the angular position (azimuth/elevation) or spatial location of the detected light are mapped by controller 108 to associated microbeams to determine the size (number) and location of the LEDs within LED array 401 to be blanked or dimmed to prevent blinding/dazzling other drivers. The output of the active LEDs creates the high-intensity microbeams projected out through optical system 106. (Ex. 1005, 3:62-64, 4:53-5:16.)

69. Beam's AABH system eliminates moving components to overcome the problems identified with the prior art. The AABH system generates a high-intensity beam formed by non-moveable microbeams with individual microbeams blanked, attenuated, or otherwise dimmed in response to detected incoming light to darken portions of the high-intensity illumination and prevent blinding of other

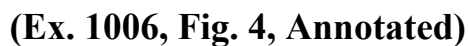
drivers.

70. Intentionally left blank.

B. Thominet: U.S. Application Pub. No. 2001/0019486

71. Thominet discloses an array of LEDs with independently controllable intensity. However, unlike the simpler Beam AABH system that uses the entire LED array to provide high beam illumination across the field of view (other than in areas of detected incoming light), Thominet discloses the concept of assigning different LEDs within the LED array to provide different illumination functions (low beam, high beam). More specifically, the different illumination functions in Thominet are provided by LEDs “arranged in partial quantities in different defined partial regions of the matrix” and these partial regions are “operatable independently from one another.” (Ex. 1006, claim 1; Abstract, ¶20.) As such, Thominet improves upon prior art implementations having an LED array that has only one function (such as the Stam reference described below) by assigning the LEDs within a single array different functions e.g. to produce light of different colors (for a signal function and a headlight), a concentric high beam, a horizontally dispersed light beam with wider front illumination or to provide “one side oriented light”. (Ex. 1006, ¶¶ 2, 4-9, 25.) All embodiments teach LEDs arranged in functionally predefined regions actuated as a group to achieve an associated illumination function.

73. Thominet teaches using a screen 16 to create a bright-dark limit, which blocks a portion of light from light sources 10, creating illumination patterns similar to conventional high beam/low beam patterns. (Ex. 1006, ¶22.)

**SPERO EX. 2006**

illumination patterns as shown in Fig. 4. Rather, predefined groups of LEDs are actuated depending on the associated desired functions to be operated. A POSA would also understand that by segmenting the LED array into sections with different functions, the intensity of the resulting beam is necessarily reduced relative to a maximum attainable intensity associated with actuation of the entire array of LEDs.

75. Separate from the lower attainable intensity and coarser control provided by the segmented groups, use of a screen to create a bright-dark limit blocks light generated by the actuated group of LEDs, further reducing intensity of the beam exiting the headlamp above the bright-dark limit.

76. A POSA would also understand that Thominet describes conceptual arrangements and generalized automatic switching between illumination functions based on parameters such as speed, steering wheel action, wiper system, or a sensor system for recognizing counter traffic without describing any processing strategies to actuate one or more of the predefined functional groups of LEDs in response to a particular parameter to implement the different functions.

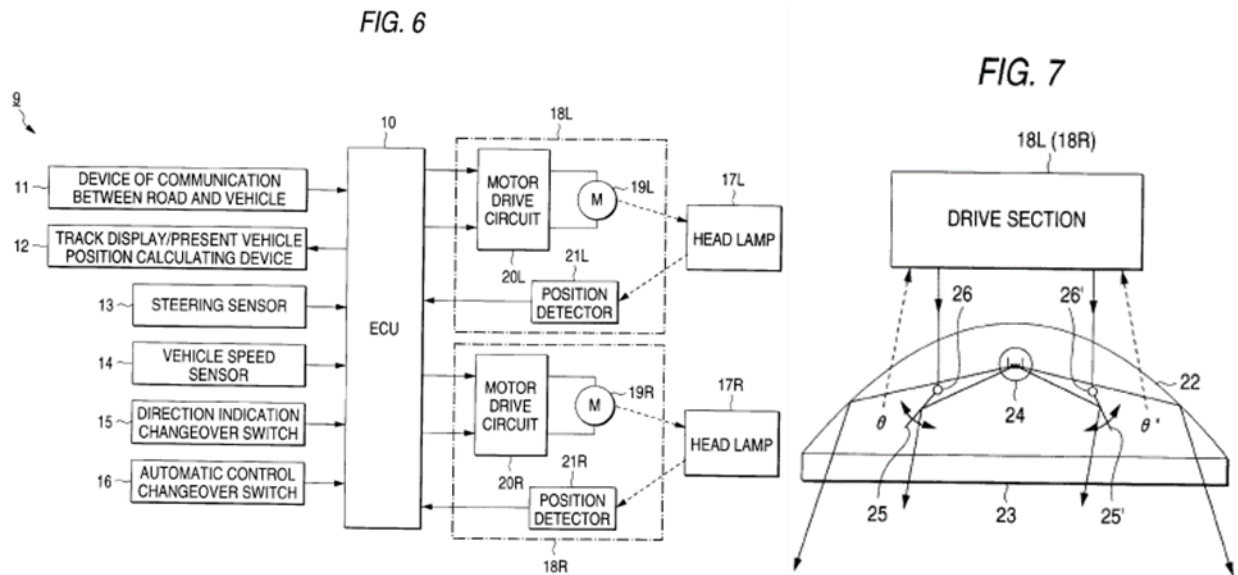
C. Kobayashi: U.S. Patent No. 6,049,749

77. Kobayashi discloses a “Lighting Device for a Vehicle.” (Ex. 1008.) Kobayashi is directed to a headlight control system that changes direction or range of a headlight beam using map information unless a predicted vehicle travel

direction as indicated by a turn indicator, steering angle, and vehicle speed/acceleration differs from the map data, i.e., “[w]hen the vehicle advancing direction at which the driver aims does not coincide with the profile of the road.” (Ex. 1008, 3:10-27.) More specifically, Kobayashi discloses a headlamp system with moveable components to control irradiation (illumination) direction and range in accordance with a road profile when the vehicle travels along a scheduled course, or in accordance with a steering angle and vehicle speed when the predicted advancing direction of the vehicle deviates from the scheduled course (Ex. 1008, 6:4-10; 17:59-67.) A “mechanical” and “moveable” system as used in this context refers to a system with moving parts and/or mechanisms to position the light beam.

78. Kobayashi changes irradiation direction using a motor to either rotate the entire lighting device about its axis, or to change relative position among internal lighting device components, such as a reflecting mirror, lens, light source, or shielding member. (Ex. 1008, 6:11-39.) Irradiation range is controlled by either combining different lighting devices with each other (such as a fog lamp, head lamp, and cornering lamp), or by controlling a motor to change position of the internal components (such as reflecting mirrors lenses, or shades) relative to one another. (Ex. 1008, 6:40-7:14.) Irradiation range may be changed responsive to a branch (intersection) ahead on a road by moving the internal lighting device

components to change a horizontal irradiating angle α . (Ex. 1008, 8:1-32.)



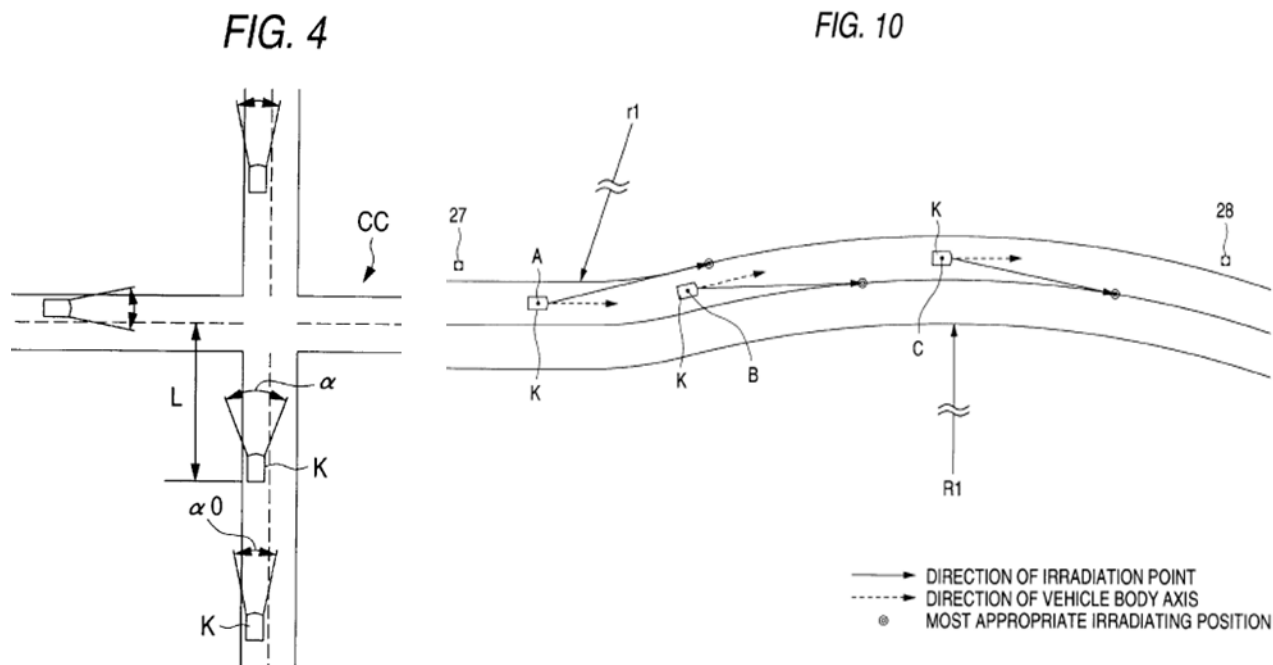
(Ex. 1008, FIGs. 6, 7)

79. Kobayashi's ECU 10 receives signals from: communication device 11 (conducting communication between a road and vehicle), track display/present vehicle position calculating device 12, steering sensor 13, vehicle speed sensor 14, direction indicating switch 15 and automatic control change-over switch 16. ECU 10 generates signals for drive sections 18L, 18R of head lamps 17L, 17R arranged on the left and right front portion of a vehicle. (Ex. 1008, 10:1-17.) Drive sections 18L, 18R include associated motor drive circuits 20L, 20R to drive associated motors 19L, 19R with position detectors 21L, 21R to detect the posture of the head lamps 17L, 17R or their composing members (internal components). (Ex. 1008, 10:66-11:4.)

80. Figure 7 illustrates a headlamp with moveable composing members to

control the direction and range of irradiation. Light source 24 and movable reflecting mirrors 25, 25' are positioned between stationary reflecting mirror 22 and front lens 23. Movable reflecting mirrors 25, 25' are rotated about respective rotating axes 26, 26' by a link mechanism to a rotation angle (θ , θ') to provide partial direction control of irradiating light. (Ex. 1008, 11:5-14.)

81. Figures 4 and 10 illustrate operation of the moveable composing members of the headlamps to control irradiation range and direction while approaching an intersection and running on a curved road, respectively. (Ex. 1008, 2:48-49, 65-67.)



(Ex. 1008, FIGs. 4, 10)

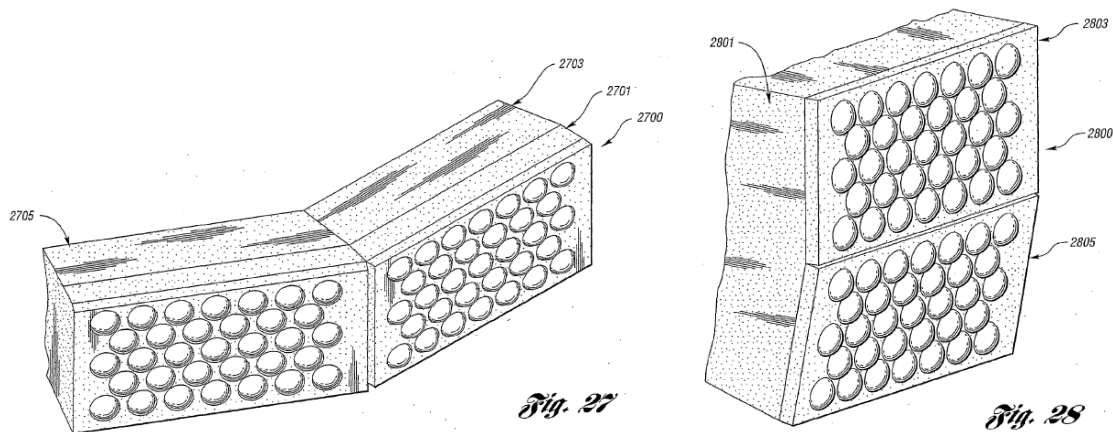
82. As shown in Figure 4, Kobayashi's headlamp motors are operated to increase horizontal irradiating angle α_0 to $\alpha > \alpha_0$ based on a distance L from

intersection CC and vehicle speed. (Ex. 1008, 8:14-25.) In Figure 10, the headlamp motors are operated according to road profile information and vehicle speed to change the irradiating direction toward a determined irradiating position for the driver's line of sight at each position of the vehicle. When the vehicle turns to the left at point A, the left shoulder is irradiated. When the vehicle turns to right, the right shoulder is irradiated, etc. If the driver operates the steering wheel by an angle larger than necessary for the curve, irradiation control is conducted in accordance with the vehicle advancing direction predicted by the steering angle. (Ex. 1008, 14:53-15:39.)

83. Intentionally left blank.

D. Stam: WIPO Publication No. 2001/1070538

84. Stam discloses a headlamp having single-function LED arrays with actuation of all LEDs within the array for a particular function, such as low beams or high beams. In the embodiment of Fig. 27, LED headlamp 2700 is controlled to actuate a first LED array in a first lamp section 2703 or a second LED array in a second lamp section 2705. Similarly, in the embodiment of Fig. 28, headlamp 2800 is controlled to actuate a first LED array in a first lamp section 2803 to provide a high beam function, or a second LED array in a second lamp section 2805 to provide a low beam function. (Ex.1007, 77:30-78:9, 84:21-85:2.)



(Ex.1007, Figs. 27, 28)

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86. Intentionally left blank.

E. Karlsson: PCT Application Pub. No. WO1998/054030

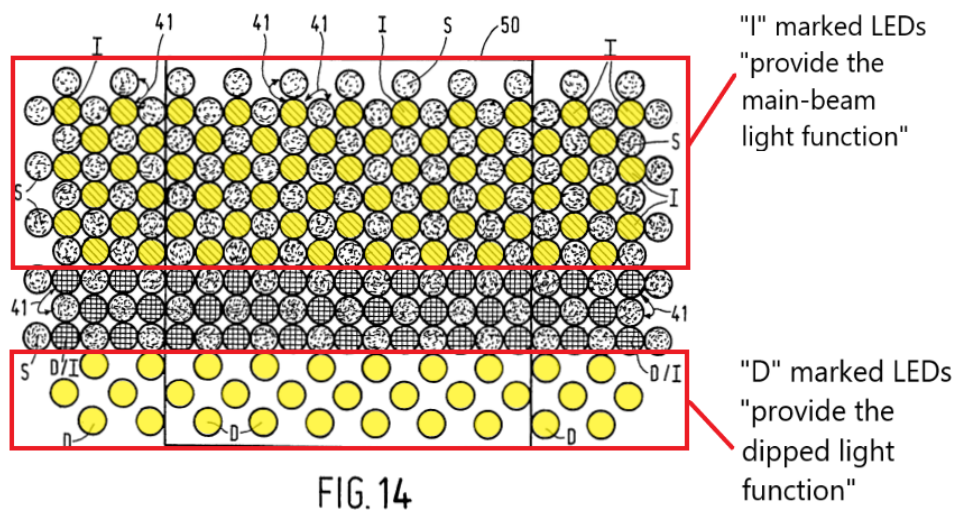
87. Karlsson discloses a “Lighting Device Having a Controllable Lighting Pattern,” wherein light sensors are interspersed with the LED “spotlight beams” to provide anti-blinding functionality, and the LEDs are dimmed during light sensor measurements so light from the LEDs doesn’t interfere with detecting light from oncoming traffic. (Ex. 1010, Abstract, 2:10-29.)

88. Despite the lack of details, one consistent and reasonable interpretation emerges from the Karlsson reference when viewed in totality along with the referential prior art, contemporaneous evidence, applicable regulations and Petitioner’s own admissions: Karlsson, like Beam, forms emitted beam 7 (Fig. 1) by using the entire beam array at full intensity, except when avoiding glare, at

which point, window 50, of reduced illumination (Fig. 14) is created to address glare situations. Per Karlsson, this configuration creates an “optimum” lighting effect — which, in Petitioner’s words, results from “maximiz[ing] the area that is fully illuminated.” (Ex. 1010, 2:7-9; Petition at 73.) Moreover, per Karlsson, main beams are optimized for long range illumination (Ex. 1010, 1:19-20) and “constant” main beam usage is “highly desirable” (*Id.*, 1:21-24). Karlsson’s removal of situational glare permits this.

1. Karlsson’s Window 50 Depicts Illumination Being Reduced for Situational Glare

89. Karlsson’s lighting device includes a headlamp embodiment that provides a light beam 7 usable for driving, which includes dipped-beam LEDs (low beam), main-beam LEDs (high beams), and combined dipped/main beam LEDs that span the full width of the LED array. (Ex. 1010, 19:24-28; 20:24-29.)



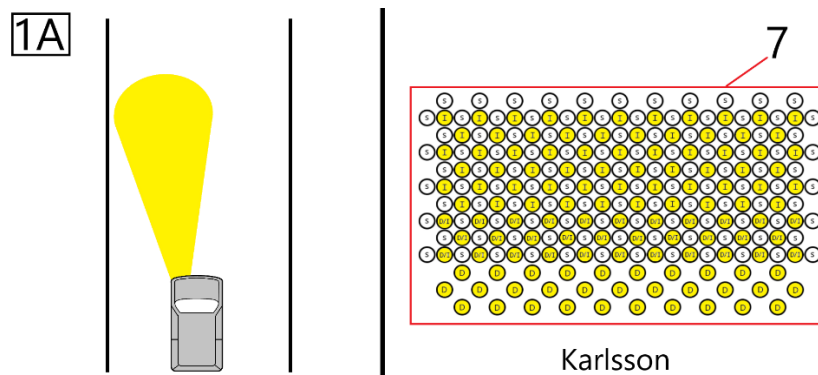
(Ex. 1010, Fig. 14, Annotated)

90. In Fig. 14, for example, Karlsson discloses that “spotlight sources indicated at D provide the dipped light [low-beam] function **in accordance with existing vehicle headlights**,” and “sources indicated at I provide the main-beam light function of **existing vehicle headlights**.” (Ex. 1010, 19:22-28, emphasis added). Karlsson also discloses that the “spotlight sources indicated at D/I are both operative as dipped and main beam lights.” (*Id.*)

91. In normal driving situations where glare adjustment is not needed, Karlsson’s array would operate “**to the greatest extent possible**” (as Petitioner admits), i.e., the entire main beam and dipped beam would be on full intensity—to “perform the function of existing headlights.” (Ex. 1010, 19:22-28; Petition at 74.)

92. For example, Figure 1A below illustrates Karlsson’s Fig. 14 LED array with all spotlight sources activated to collectively emit a beam of light 7; and

Figure 2A illustrates an “existing headlight” with incandescent dipped (Low) and main (High) beam light sources activated to provide a comparable beam of light. While Figure 1A illustrates exemplary operation with all LEDs for the dipped and main beams on, operation of a main beam mode with only the “I” LEDs or “I” and “D/I” LEDs, but without the dipped beam LEDs results in the same analysis and conclusions.



(Figure 1A, Ex. 1010, Fig. 14, Annotated)

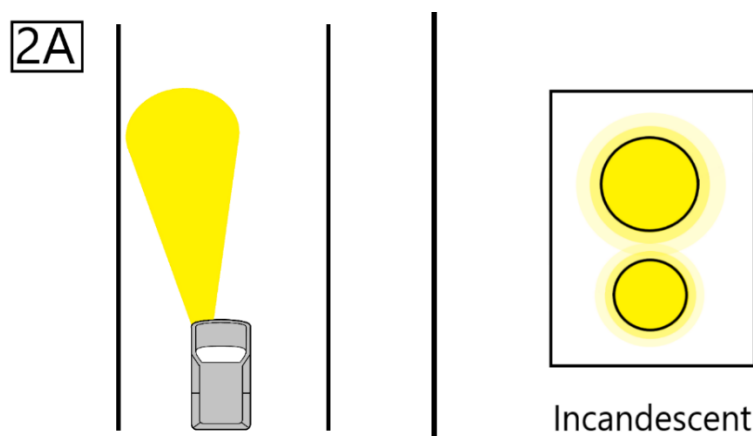


Figure 2A

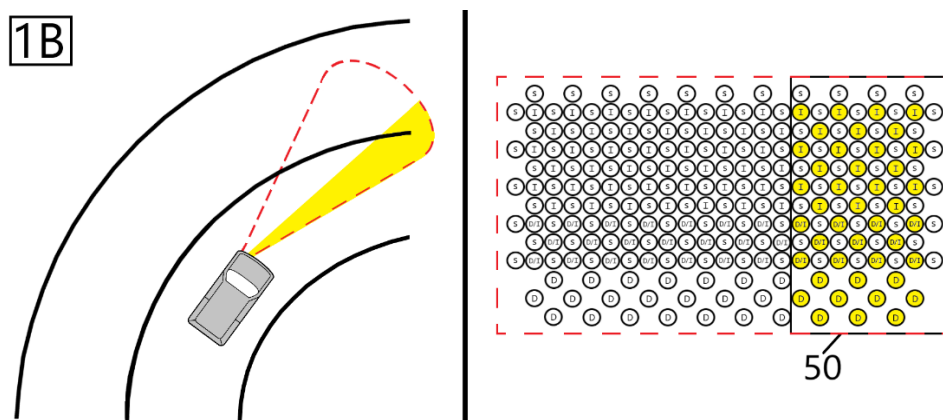
93. Karlsson then uses Fig. 14 to illustrate a “reduction” control strategy to reduce emitted beam 7 in a manner that provides anti-glare functionality for specific situations, and allows for expanded usage of the main/high beam light. (Ex. 1010, 20:6-11.) The situationally adjustable beam 50 illustrates how glare reduction can be achieved.

94. Karlsson teaches that glare occurs in multiple situations when using high beams (*Id.*, 1:19-26) when rapid velocity changes or overloading pitches the vehicle (*Id.*, 1:30-34), and when turning (*Id.*, 1:35-2:1.) Absent glare situations, Karlsson prefers providing “a light beam, the intensity of which is optimally adapted to the road and to the ambient light,” meaning all spotlight sources are on. (Ex. 1010, 2:7-9, 4:17-21, 9:23-26, Fig. 1.)

95. To address glare situations, Karlsson describes adaptation via: 1) use of light sensors to detect light and to control the LED array to prevent or diminish emission in the direction of detected light (*Id.*, 9:19-23); and adapting light to prevent glare. (Ex. 1010, 20:24-32.) Karlsson even explains, in the context of Fig. 14, that “an emitted light beam 50 is represented as a window which can shift” left-to-right and top-to-bottom “in dependence on the desired pattern and direction of the beam.” (Ex. 1010, 19:29-33.) The window 50 in Fig. 14 is an exemplar, to illustrate the concept of situational reduction of full beam 7. As shown below in Figures 1B – 1D, the shifting window can be used to temporarily reduce the full

beam 7 in order to adapt to possible glare in exactly the situations Karlsson describes. When there is no risk of glare, beam 50 would expand its dimension to the greatest extent possible – i.e., to fully utilize the array and create full beam 7.

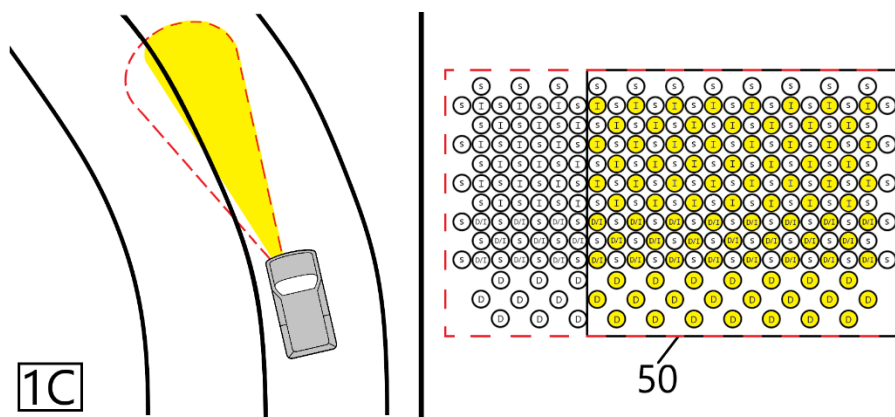
96. Karlsson addresses glare caused when a vehicle is taking a curve, the beam may be “adapted” (shifted) away from the other lane. (Ex. 1010, 1:34-2:1; 20:29-32.) This shift, however, is not a shift of the entire main driving beam 7, it is a temporary **reduction** of the beam aimed at the opposite lane, achieved by temporarily shutting off some portion of the array. Figures 1B and 1C below illustrate Karlsson’s Reduction Control Strategy during a turning maneuver, showing possible shifts in right and left turns, respectively.



(Figure 1B, Ex. 1010, Fig. 14, Annotated)

97. The above Figure 1B illustrates a full beam in dashed red-line as the vehicle takes a sharp right turn. Figure 1B also illustrates a reduced beam portion

in yellow line, according to Karlsson's Reduction Control Strategy to avoid glaring illumination spillover onto the opposing lane. This beam reduction may be achieved by deactivating the LEDs on the left side of the array, "shifting" the window 50 to the right, as illustrated above. (Ex. 1010, 20:23-32.)

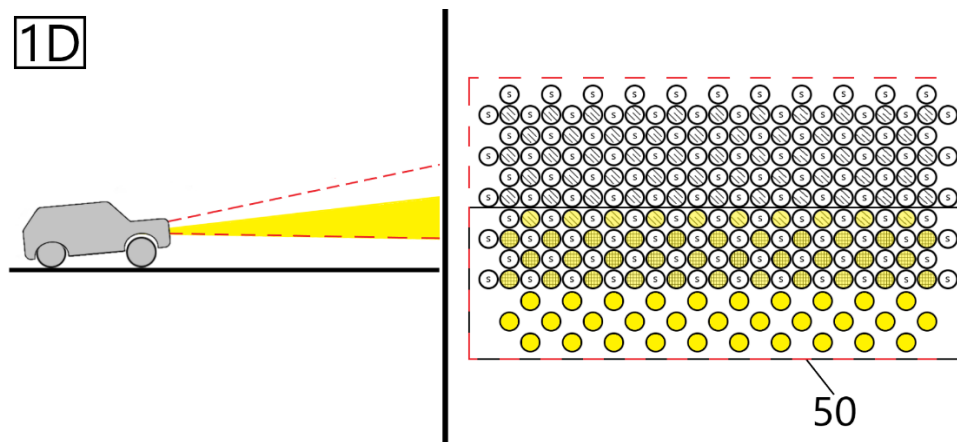


(Ex. 1010, Fig. 14, Annotated)

98. Figure 1C illustrated above depicts a vehicle taking a gradual left turn. The beam may be reduced using Karlsson's Reduction Control Strategy to deactivate LEDs on the left side of the array, shifting the window 50 to the right again based on direction sensor 54, but less so. The remaining yellow beam is wider than the one illustrated in Figure 1B due to the gradual nature of the turn, since there would be less potential glaring light than with a sharp turn. (Ex. 1010, 20:23-32.)

99. In reference to Figure 16, Karlsson also addresses glare caused when a vehicle pitches due to velocity changes or is overloaded-- the inclination sensors

detect “any deviation from the horizontal position,” allowing the pitched beam, possibly glaring other drivers, to be “shifted” down via deactivation of the upper rows of the array, as shown in Fig. 1D below. (Ex. 1010, 6:26-30.)



(Ex. 1010, Fig. 14, Annotated)

100. Thus, Karlsson deals with a variety of possible glare situations. If light-detection is the predicate for possible glare, light beam 7 is selectively reduced (*Id.*, 5:28-32) as needed. If the vehicle is pitched, the light beam 7 is adapted to account for pitch (*Id.*, 20:25-29) – per the vertical shift example described with reference to Fig. 14. If the vehicle is taking a curve, the light beam 7 is adapted to prevent glare in the opposite lane (*Id.*, 20:29-33) — per the horizontal shift described for Fig. 14.

2. The Base Device That Karlsson Improves Takes A Similar Approach To Situationally Reducing Full Emission

101. Karlsson describes that it seeks to improve aspects of a prior art

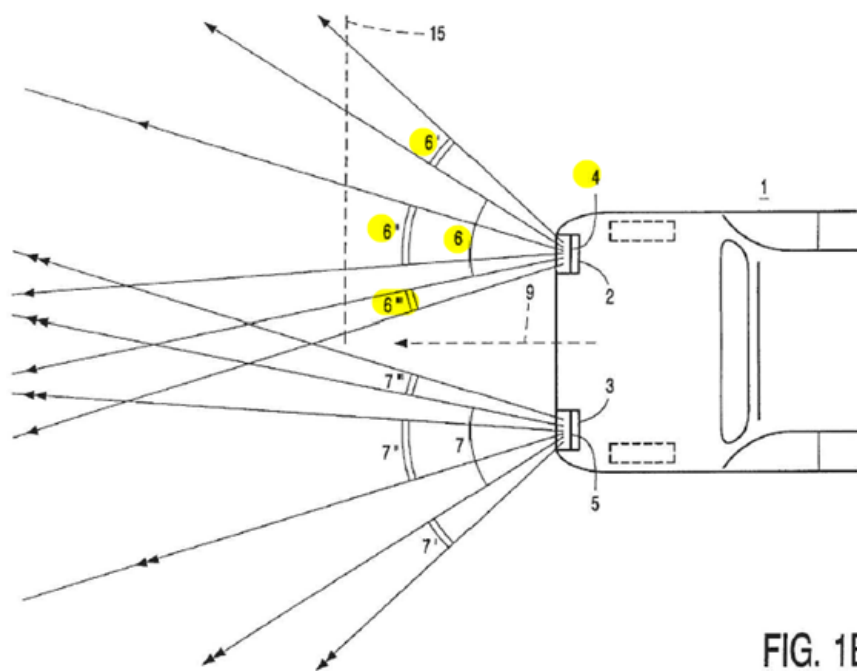
device of the “type known from” WIPO Patent Publication WO 86/05147 (“Flaaten,” Ex. 2017), which uses light sensitive detectors and a control unit to detect and control the light distribution pattern of a headlight “based on the distribution of detected light.” (Ex. 2017, Abstract; Ex. 1010, 1:1-7.) Flaaten states a clear objective: the light from a vehicle is dipped selectively so that **“only that portion of the light is removed that would otherwise inconvenience the driver of oncoming cars... at the same time as the roadway, the edges of the road, curves, etc. are satisfactorily illuminated.”** (Ex. 2017 at 1-2.) Karlsson even explains that the Flaaten “prior art lighting device” “retain[ing] an **optimum lighting** effect for the driver of the vehicle...” (Ex. 1010, 2:2-9.)

102. Flaaten, like Karlsson, recognizes the desire for full illumination to the “greatest extent possible” while also removing glare: “It is ... desirable to enable such control of the light that **only the portion of the light that would inconvenience the driver of meeting cars is removed, leaving as much as possible of the roadway and the surroundings illuminated.**” (Ex. 2017 at 1.) The reduced illumination provided by window 50 corresponds with Karlsson’s desire to retain “an optimum lighting effect,” even under glaring situations, per the base device in Flaaten.

F. Harbers: WIPO Publication No. 2001/001038

103. Harbers discloses a headlamp system having fixed, planar LED arrays

with groups of LEDs associated with different illumination functions. As depicted in Figure 1B of Harbers, a “headlamp (2;3) of a vehicle (1) has a light source (4;5) comprising a plurality of opto-electronic elements (11;12;13;14), preferably light-emitting diodes (LEDs). . . The light beam generated by the light source comprises at least two light beam segments (6, 6'; 7,7') which define the spatial distribution of the light beam.” (Ex.1011, Abstract.)



(Ex. 1011, FIG 1B, Annotated)

104. As depicted in the asymmetric light distribution patterns of FIGS 3A and 3B, Harbers discloses a headlamp that provides light along multiple optical axes. (Ex.1011, FIGS 3A and 3B.) Spatial distribution of the light beam is achieved by selectively switching on and off individual LEDs and the

corresponding light beam segments. (*Id.*, 7:15-19, 8:21-25.)

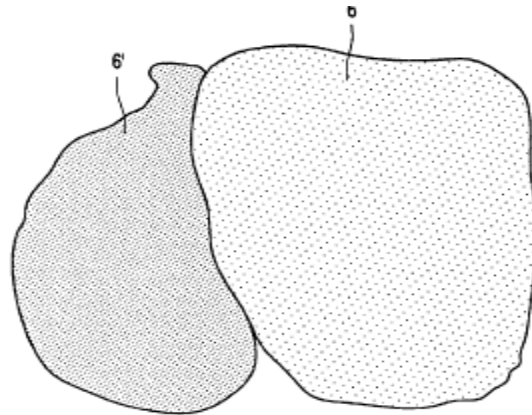


FIG. 3A

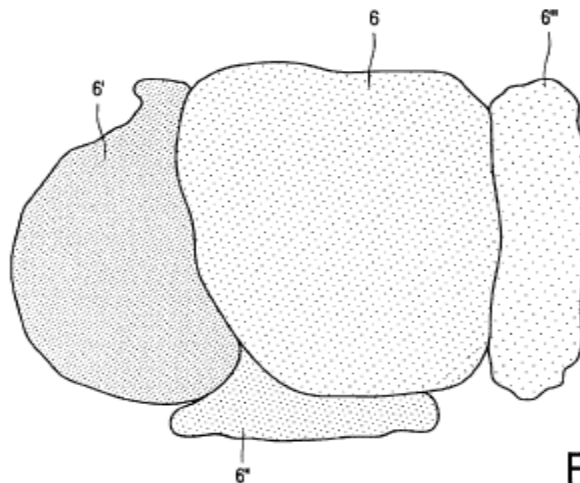


FIG. 3B

(Ex. 1011, FIGS 3A, 3B)

105. Harbers identifies specific parameters that can be used to define the desired spatial distribution of the light beam. Per Harbers, “the spatial distribution of the light beam can be influenced by the velocity of the vehicle...It may also be desirable for the width of the light beam to decrease and/or the intensity distribution between on-axis viewing and off-axis viewing to change.” (*Id.*, 3:28-

34.)

106. In another embodiment, Harbers discloses that:

the spatial distribution of the light beam can be influenced by the rotational position of the steering wheel of the vehicle. This enables the spatial distribution of the light beam of the vehicle headlamps to be adapted to the position of the steering wheel of the vehicle...By switching on or off one or more opto-electronic elements at specific-limiting values of the rotational position of the steering wheel of the vehicle, a continuously adjustable spatial distribution of the light emitted by the vehicle is obtained.

(*Id.*, 4:5-14.)

107. In yet another embodiment, “the spatial distribution of the light beam can be influenced by the weather conditions.” (*Id.*, 4:16-17.) In a final embodiment, “the spatial distribution, for example, the range and/or the width of the light beam, . . . [may] be adjusted by the driver” of the vehicle. (*Id.*, 4:24-25.) Apart from the above-identified inputs that could be used to define the spatial distribution of the light beam, Harbers provides no control teachings related to sensors or map data and thus no ability to control the LEDs to illuminate a desired region.

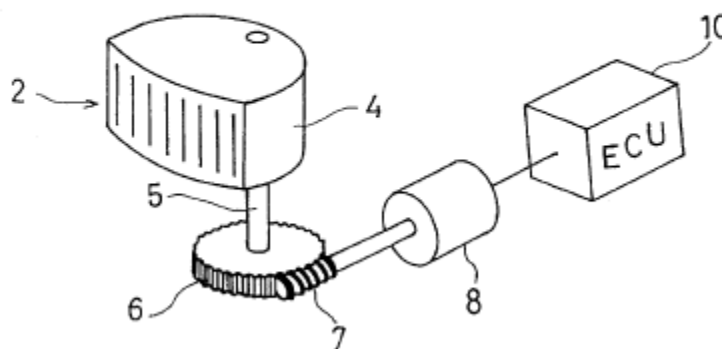
G. Gotou: U.S. Patent No. 5,588,733

108. Gotou discloses a “Head Lamp Device for Vehicle.” (Ex. 1012.) Gotou discloses headlamps that are rotated by a motor to change

leftward/rightward illumination direction using map information indicative of forward road shape, or in accordance with vehicle signals such as a direction indicating signal, a steering angle signal, and a vehicle speed signal “in the case that a vehicle runs on a place having no road information in a navigation system or the vehicle turns out of the planned course.” (Ex. 1012, Abstract, Fig. 1, Fig. 5, Fig. 6, 1:42-2:18, 3:31-41.)

109. Gotou discloses a “swinging mechanism,” shown in Figure 2, wherein “a lamp unit 4 of the head light 2 is fixed to a rotary shaft 5, and a worm gear 7 formed at a driving shaft of a motor 8 is engaged with a worm wheel 6 fitted to the rotary shaft 5.” (*Id.* at 3:36-41.)

FIG. 2

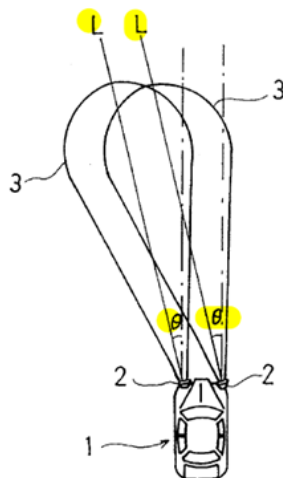


(Ex. 1012, FIG. 2)

110. As shown below in Figure 1 of Gotou, each headlight 2 provides light along a single optical axis L. “The right and left headlights 2 and 2 are swung

together in the same direction by the same angle and shown in FIG. 1, angles of their optical axes L and L, with respect to the advancing direction of the vehicle, i.e. optical axis angles are both set to be θ .” (Ex. 1012, 3:31-35.) Optical axes L and L are imaginary straight lines that pass through the center of the corresponding headlight projection, resulting in light output that is symmetric with respect to the optical axis at the chosen angle. Notably, while Gotou relies on adjustments to the optical axes to change the lighting region “in front of the vehicle in rightward and leftward directions,” it does not contemplate turning lamp unit 4 on/off or otherwise changing its intensity. (Ex. 1012, 1:60-64.)

FIG. 1



(Ex. 1012, FIG. 1, Annotated)

111. The driving of motor 8 is controlled by a light distributing control ECU 10, depicted in FIG. 3. Under the mechanical control system of Gotou, the ECU processes a series of inputs from the map information and vehicle signals

such as a “direction indicating signal,” “a steering angle signal” and a “vehicle speed signal” and “processes the information and signals to determine a requisite optical axis angle θ and an indicating signal is outputted to a motor driver 14 so as to achieve the optical axis angle θ , and thereby the right and left motors 8 and 8 are controlled in driving with the motor driver 14.” (Ex. 1012, 3:51-66.) When the “winker lever is operated, the optical axis angle is changed at once to a predetermined angle for lighting the turning direction of the vehicle early, and the determined optical axis angle is larger as the vehicle speed is faster.” (Ex. 1012, 4:58-64.)

112. Gotou further describes the state of the art at the time of the invention, pointing out the deficiencies in prior art systems predicated on steering wheel position:

[T]here are many proposals in the prior art in which the lamp optical axes are controlled for their movements in the horizontal rightward or leftward direction in response to a steering angle of the steering wheel. . . However, the lighting region in such prior art as above is not changed unless the steering wheel is operated, so that a turning direction can not be lighted at a stage before entering the curved part.

(Ex. 1012, 1:21-29, emphasis added.)

113. On review of the Gotou reference in its entirety, a POSA would also understand that Gotou does not disclose: 1) LEDs or any other “digital” lighting

source; 2) fixed or non-moveable light sources, 3) headlamps with multiple light sources with corresponding multiple optical axes; 4) any light sensor or other sensor to detect forward vehicles, or 5) any functions related to anti-blinding or preventing glare.

VIII. Petitioner Asserts Alternate Combinations

114. The Petition presents at least two discrete obviousness combinations to challenge each of the Challenged Claims. When unpacked, it becomes clear that Grounds 1 and 8 are each multiple distinct sub-grounds.

115. Intentionally left blank.

IX. Missing Elements

116. The Petition does not address the “as part of the instructed adjustment” limitation of claim 64.

Claim 25	Claim 64
The system of claim 20, wherein at least one of the one or more headlamps further includes at least one of reflectors, refractors, or lenses usable to alter emitted light from at least one of the light sources.	The system of claim 59, wherein at least one of the one or more headlamps further includes at least one of reflectors, refractors, or lenses usable to alter the light emitted from at least one of the light sources as part of the instructed adjustment.

117. This defect applies to claims 60-62 and 64 (in the rightmost two columns) which were rejected by analogy, with the **unaddressed, materially different** language noted in bold. (See Pet. at 64, 76, 123). The leftmost two

columns display the claim language that **was** addressed.

Claim	Language	Claim	Language
25	... headlamps further includes at least one of reflectors, refractors, or lenses usable to alter emitted light from at least one of the light sources.	64	... headlamps further includes at least one of reflectors, refractors, or lenses usable to alter the light emitted from at least one of the light sources as part of the instructed adjustment.
21	... processor is further configured to ... direct the control circuitry to adjust the directional light sources to increase illumination in a direction of the road curvature.	60	... processors is further configured to ... determine light output that aims illumination in a direction of the road curvature.
22	... processor is further configured to ... to direct the control circuitry to increase illumination illuminating the turn.	61	... processors is further configured to ... determine light output that illuminates the turn.
23	Same as 22	62	Same as 61

118. Intentionally left blank.

I. The Challenged Claims are Patentable

A. Grounds 1A-1E: The Proffered Combination Fails to Teach the Aiming Limitations in [20.2]

119. Independent Claim 20 of the Challenged Claims requires the Aiming Limitation: each headlamp including at least three directional light sources aimed at different angles [or in 59.2 having different aimings] relative to the vehicle. Notwithstanding Petitioner's contradictory positions, noted below, regarding the

teachings in the applied references, the Aiming Limitation in all Challenged Claims is not met.

B. Grounds 1A-1B: Beam Does Not Teach Directional Light Sources Having Different Aimings

120. In Grounds 1A-1B, to satisfy limitations [20.2]/[59.2], Petitioner improperly asserts “each light source of the array has its own independent angular position (angle/aiming), that combines to form the headlamp beam; so, Beam’s array of light sources 401 form at least three directional light sources having different angles/aimings.” (Pet. at 24.) The array, however, is planar with commonly aimed sources and the light source they show for Fig. 2 is singular (and omni-directional) and so neither meets the claim limitations.

121. Petitioner takes two distinctly contradictory positions to satisfy the Aiming Limitations — arguing on the one hand for purposes of claim construction that the position that the light source “includes any headlamp light source” (citing various emitters, as well as discussing “microbeam sources” and “spotlight sources” in the same breath, implying at least that even Petitioner understood its correlation between emitter and “source and then its Expert undermines its own previously-stated understanding to now assert that “each microbeam is a directional ‘source’”. (Ex.1003, ¶147.) This flawed logic is also advanced with respect to limitations [20.3] and [20.4] — where Petitioner conflates the

microbeam with the *light source*. (Pet. at 36-37.) Moreover, as no other explanation is provided beyond a citation to Section VI (an invitation to search 27 pages for additional argument), the Expert Declaration provides the only actual explanation.

122. Notwithstanding Petitioner's machinations, and as reflected in the Institution Decision, concluding that a beam of light cannot constitute *a light source*: "We do not agree with Petitioners' analysis because we find that the 'microbeams' are the light itself, not the light source, as we have construed that term." (DI at 11.)

123. Absent Petitioner's contrived construction of *light source*, the fundamental flaw in Grounds 1A-1B is fully exposed, neither embodiment has the claimed *at least three directional light sources*, since the source in Fig. 2 is just a single directional lamp and the sources in Fig.4 are in a planar array. (Pet. at 14, 24.)

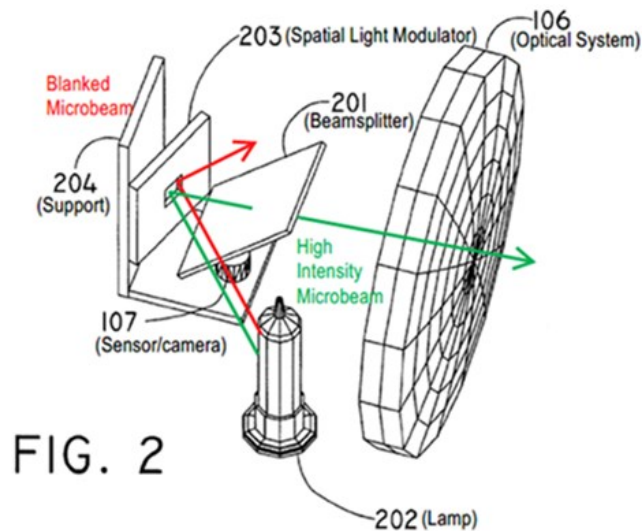


FIG. 2

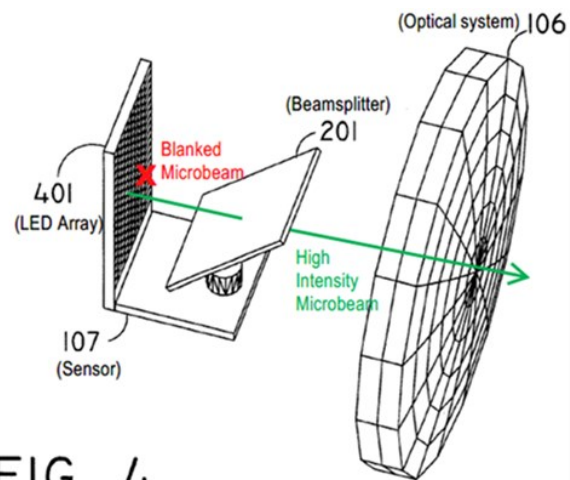


FIG. 4

(Ex.1005, FIGs. 2, 4, Annotated)

124. As the Board correctly concluded, and as Beam literally states, the lamp 202 and SLM 203 in the Figure 2 embodiment is **replaced** in the Figure 4 embodiment with an LED array 401 having LEDs fixed in place — with no ability to provide independent angular positioning. (DI at 11-12.) Beam’s AABH system is thus incapable of operating as Petitioner contends; the Board agreed as much, in the Institution Decision:

We, however, find nothing in the cited portions of Beam, or in the Jiao Declaration (which simply parrots the Petition), to suggest that the individual light sources in array 401 of Figure 4 are aimed at different angles. Most of the material cited by Petitioner, including the “angular position” language, is describing the Beam’s Figure 2 embodiment, not the Figure 4 embodiment.

(DI at 12-13.)

125. Thus, the proof for 1B is based on largely inapplicable evidence that

fails to demonstrate the elements of claims 20 and 59 to which it was applied in at least 20.2/59.2. While Petitioner may attempt to circle back to the 27 pages it cited— **no** other argument was sufficiently developed beyond the Figs. actually presented for 20.2/59.2 and four paragraphs of the Declaration. (Pet. at 34-36, 56; Ex.1003, ¶¶146-149.)

126. Because the Figure 2 SLM embodiment [Ground 1A], includes a single light source 202, it fails to satisfy the *three directional light source* limitation in both claims 20 and 59.

127. The Figure 4 LED array embodiment in Beam [Ground 1B] also fails to satisfy the Aiming Limitation and is fundamentally flawed as being founded in an unsupported construction of “source.” Significantly, Beam neither teaches any mechanism to adjust the physical aiming of the LED nor any mechanism for the LEDs to *have different aimings* under [59.2]. Indeed, per claim 20, Beam is incapable of controlling the angular position of each LED— the LEDs are fixed in place within the X-Y matrix. (Ex.1005, 5:3-16.)

128. During his deposition, Petitioner’s expert argued that Beam’s light source requires an SLM:

by looking at his [Beam] specification as well as Figure 4 and 6 and his claim 4, that the light source must include both emitter and spatial light modulator, especially if you look at Figure 6. And Figure 6 is

alternative Figure 5. You have to have a modulator in order to work as microbeam.

(Ex.2025 at 21.)

129. Neither the Petition nor paragraphs 146-149 of the Declaration advance this argument, which in addition to being incorrect is contrary to at least prior portions of the declaration below.

130. In the Petition and Expert Declaration, Petitioner correlates “microbeam source” with LEDs, with no requirement of an interposed modulator or SLM (presented as merely an option):

Beam uses the term ‘microbeam,’ as light emitted from a ‘microbeam source,’ which includes ‘*individual, controllable, light-emitting diodes*’ (LEDs). So, for clarity, when I refer to Beam’s system and its LEDs, a POSA would have understood that **all instances of “microbeam” in Beam’s disclosure correlate with ‘*individual, controllable, light-emitting diodes (LEDs)*’**. Relatedly, as Beam uses the term ‘source,’ a POSA would have understood that the term ‘source’ **may** include not only the emitter but also **may** include lenses/optics, packaging, etc.

(Ex.1003, ¶76; Pet. at13.)

C. Grounds 1C-1E: Even Combined, Beam and Thominet Fail to Teach the Aiming Limitation

131. In Grounds 1C- 1E Petitioner hedges its arguments to add the teachings of Thominet, in case “Patent Owner argues, incorrectly, that Beam does

not disclose [20.2]/[59.2].” (Pet. at 25.) Ultimately, the addition of Thominet in Grounds 1C-1E is of little use; the combinations are riddled with issues.

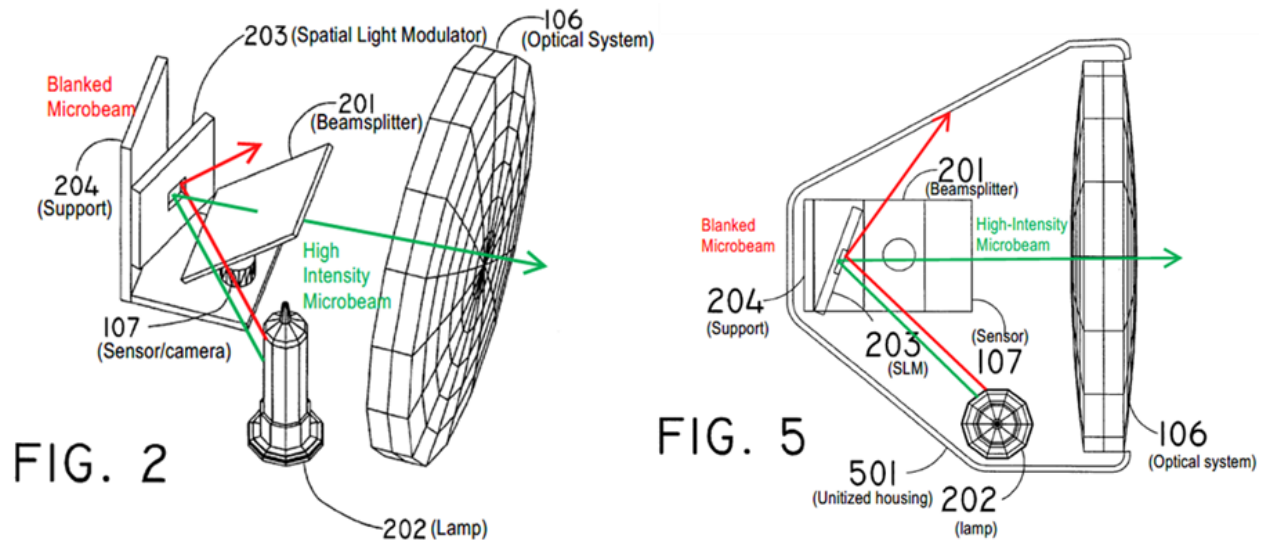
1. Sub-ground 1C does not meet the limitations of the claims

132. For Ground 1C Petitioner combines Beam’s SLM embodiment — Beam’s controller 108/illuminator 109 (including SLM 203) — with the “control technique (software implementation)” in Thominet: “using multiple directional beam regions for different functions.” (Pet. at 26, 29.) This ground only includes Beam’s hardware, and, moreover, only the combination) (*Id.*, 26-27.) Thus, in Ground 1C as in Ground 1A, because the Figure 2 SLM embodiment includes a single light source 202, it fails to satisfy the *three directional light source* limitation in all claims.

2. Petitioner’s Motivation to Combine is Flawed for 1C

133. Petitioner’s Ground 1C motivation to combine arguments are equally flawed. Thominet’s semiconductor system with multi-function controls and Beam’s SLM embodiment do not constitute “similar systems” that a POSA would have “readily applied. . .in the same way.” (Pet. at 29.) In Beam’s SLM embodiment, illustrated in Fig. 2 (perspective view) and Fig. 5 (top view), light from lamp 202 falls on spatial light modulator (SLM) 203, is controlled so that the associated individual microbeams are either 1) reflected by SLM 203 at full

intensity through beam splitter 201 and out through headlamp optical system 106, or 2) “blanked (attenuated by being either absorbed or deflected [by SLM 203] to an absorbing surface” so that they do not exit the headlamp optical system 106. (Ex.1005, 4:36-40, 5:65-66.)



(Ex.1005, FIGs. 2, 5, Annotated)

134. By contrast, Thominet’s software assigns different LEDs within the LED array to provide “different illumination functions (low beam, high beam, low sight, large width).” (Pet. at 15.) More specifically, the different illumination functions in Thominet are provided by LEDs “arranged in partial quantities in different defined partial regions of [the] matrix” and these partial regions are “operatable independently from one another.” (Ex.1006, claim 1; Abstract, ¶20.) Thus, in terms of the system hardware, control functions and defined output—the Beam SLM embodiment and Thominet’s software implementation are wholly

dissimilar systems.

3. The Ground 1C Combination Is Unsuitable As It Reduces Forward Illumination

135. Moreover, if Thominet's preassigned software were combined with Beam's utilization of selective blanking, the combination would result in significantly diminished forward illumination; entire beam segments would be preassigned for different functions and thus unavailable for forward illumination. Accordingly, the combination presents an **unsuitable** option.

136. As such, contrary to Petitioner's assertions for Ground 1C, a POSA would **not** have "readily applied" Thominet's LED software implementation to Beam's SLM embodiment because the combined systems are fundamentally incompatible, without a complex revamp of the software controls, that would not be routine or within the skill of a POSA.

4. Ground 1D- Absent Thominet's Software, the Combination Is Incapable of Achieving Segmentation

137. Finally, in Grounds 1D-1E Petitioner attempts to "additionally or alternatively" argue that "a POSA would have sought to incorporate known components (hardware implementation)"—"Beam's array of light sources 401 and Thominet's differently angled/aimed semiconductor sources 10 on curved surface 12." (Pet. at 30, 32.) Because the "additionally" version is a combination that would require both embodiments of the system (Fig. 2 from software combination,

fig 4 from hardware combination) it is never explained with particularity. This leaves the “alternatively” combined options that use Thominet’s hardware and Beam’s control software.

138. In both “hardware” alternatives, the absence of Thominet’s software controls means that there is no proven automatic control and no proven segmentation and thus the stated motivation to combine is missing from the combination. (Turk.) Essentially what is being added is a new curved version of an LED array that cannot achieve any of the obviousness rationale. Without Thominet software, Beam has no need for this array.

139. Intentionally left blank.

**5. Grounds 1D-1E- The Petition Offers No Rationale
For the Addition of Thominet’s Optional Curved
Array**

a. The Petition Omits the Needed Proofs

140. For Grounds 1D-1E, the of Thominet’s hardware with Thominet’s array substituting for Beam’s LED array, the Petition completely fails to explain why a POSA would select the “concavely_curved surface or stepped surface” option in Thominet over the “one plane” arrangement — when Thominet is silent as to any link between the choice of surface arrangement and functionality. As noted above, the lack of software otherwise strips out the motivation to combine, even if it were valid – there is no proven segmentation and no proven automatic

control. Accordingly, in 1D and 1E, all that is left is a curved array from Thominet (1D) or simply using the curve concept to modify Beam (1E.)

141. As the Board posits, it “appears that differently angled light sources may not be necessary to achieve the benefits of the secondary references’ lighting schemes.” (DI at 19-20.) On this point, the Board specifically invited the parties to address 1) whether Petitioner’s rationale for combining the primary references to use the secondary reference lighting schemes is sufficient to support modifying the primary reference to use the secondary references’ curved substrate; and 2) whether the law requires a specific or separate motivation to include what may be an optional aspect of the secondary references. (*Id.*)

b. The Optional Curved Array Is Lacking Both a General and Specific Motivation to Combine

142. Here, neither the Petition nor the accompanying Jiao Declaration offer any evidence as to why in the “hardware combination” of Grounds 1D-1E, a POSA would have even a general motivation to combine Thominet’s curved hardware with the Beam system. Indeed, rather than providing a motivation, Petitioner makes it clear that the “hardware combination” shares the same generic motivation as the “software implementation”: “Like the software implementation, this hardware combination—Beam’s array of light sources 401 and Thominet’s differently angled/aimed semiconductor sources 10 on curved surface 12 — would

have provided Beam's system with different spatial distributions for different driving situations... thereby **improving driver safety**.” (Pet. at 32.)

143. This assertion fails to explain why the addition of Thominet's differently angled LEDs on curved surface 12 improves driver safety.

144. The Petition offers no explanation for why a POSA would select an optional curved substrate over the similarly functioning flat substrate in Thominet, especially when the primary reference also includes a flat substrate. Moreover, given the absence of Thominet's software, there would be no segmentation or automatic control.

145. Accordingly, by recycling broad-based, generic motivation to combine statements for each of Grounds 1D-1E, Petitioner failed to provide either a general or specific motivation to combine that supports modifying the primary reference to use the secondary references' optional curved substrate. Petitioner has simply fallen short of meeting its burden of proof.

146. Here, because the applied prior art is directed to different types of headlight systems that function in different ways to address different problems — in Beam, providing a simple but comprehensive anti-glare solution versus Thominet's effort to provide multiple, different functions for LEDs within an array.

147. Petitioner provides no plausible explanation for why a POSA would

have added an optional curved substrate to Beam.

c. Ground 1C Lacks Explanation of “How” the Combination Results in a Functional System

148. Compounding the problems, in the Ground 1C “software” combination, the Petition also fails to explain how the addition of Thominet’s software, attempting to automatically segment a beam that Beam is trying to fully operate, would result in a functional system.

149. Even if Ground 1C was otherwise unflawed, the combination would result in a non-functional system. As Petitioner correctly points out in Thominet, “semiconductor light sources 10 arranged on curved surface 12 provide beam regions 22, 24, 26, 28 for different driving situations.” (Pet. at 31.) What Petitioner fails to mention however, is that each of the beam regions are predefined for specific functions and controlled as a unit — rendering Thominet fundamentally incompatible with Beam. When combined, the two systems are going to attempt conflicting usages of the SLM, when one wants to segment light and the other wants to use the full array.

150. The use of Thominet’s clustered regions for predefined functions, when coupled with Beam’s LED array, would compromise the ability of the combined system to deliver forward illumination. Because groupings of LEDs would be assigned to predefined functions, e.g., to produce light of different colors

(for a signal function and a headlight), a concentric high beam, a horizontally dispersed light beam with wider front illumination or to provide “one-side oriented light”, in operation, entire LED clusters would be unavailable to provide forward illumination.

151. Considering the relevant state of the art, and limitations surrounding white LED lumen output, which Petitioner’s expert Dr Jiao repeatedly discussed in articles from the early 2000s (Ex. 2015), a combined system that relies on only certain segments of LEDs for forward illumination would fail to provide sufficient forward illumination and most likely result in a non-functional system. Given the state of the art at the time, without creating issues with packaging, heat degradation and cost, additional LEDs could not simply be added to preserve forward illumination and multi-functional LED clusters.

152. In the early 2000s, LED headlamp design posed a complex set of challenges and tradeoffs involving optics, heat management, white LED lumen output and packaging issues, all of which affected cost. Per Petitioner’s expert, in 2004, the efficiency of available white LEDs was a fraction of a conventional bulb, creating significant technical challenges for their use in headlight applications. For example, as Petitioner’s expert points out in 2004, multiple LEDs (e.g., more than 30) were required to generate lumen output similar to a typical tungsten filament halogen bulb because “currently available white LED’s lumen output [was] around

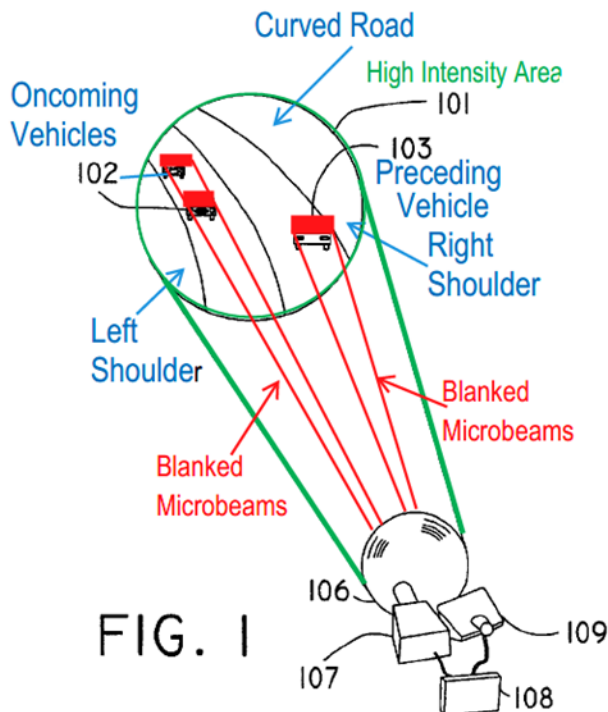
30 lm (maximum), which [was] about 3% of the typical tungsten halogen bulb's light flux output (1000 lm for 9006 bulb)." (Ex.2012 at 3.)

153. Finally, the Petition fails to identify the issue and/or explain if/how a POSA would reconcile Beam's binary blanking/maximum intensity system with Thominet's control strategy which, by design, provides partial predefined regions that are controllable as a unit to deliver multi-functional capability with an LED array.

154. The specification details the central tenet of the Beam reference — to darken the area of the beam that would dazzle the driver, **"while maintaining [full] intensity elsewhere."** Beam specifically recognizes and disparages prior art attempts to control the direction of the headlight beams. (Ex.1005, 1:60-2:6.) According to Beam, prior art systems that had to choose where to put light and that changed the direction of the headlamp beam, were prone to errors and/or subject to misalignment. (Ex.1005, 2:15-26.)

155. In response to these prior art problems, Beam's solution is to provide "the equivalent of high beam headlights or brighter on at all times, greatly enhancing the ability to see at night" (Id., 6:53-56) except for areas where incoming light is detected. Since Beam is already putting maximum intensity light everywhere it can, there is no light left to place or move or add; thus there would be no reason to provide the ability to change the direction of microbeams in the

AABH system or point or direct light in any particular direction.



(Ex. 1005, FIG 1, Annotated)

156. Indeed, in the annotated Figure above, everything, the curve, shoulders, etc. are already illuminated, except where Beam is blanking for glare. If Thominet segmented the beam above, then the full illumination would be lost. If the blanking strategy above were applied to such a segmented beam, the problem would be exacerbated, as now the already-diminished subset of light is being further blanked. Further, because the vehicles in the scene move, the blanking would be unpredictable.

157. All of these control incompatibilities need to be resolved, if they even can be, before a functioning system can be derived; giving a POSA pause as to

whether the combination would be functional as proposed.

158. Petitioner’s “jigsaw puzzle” approach does not “explain what reason or motivation one of ordinary skill in the art at the time of the invention would have had to place these pieces together.” *Id.*

D. Grounds 1A-1E: Neither Beam Nor Beam-Thominet Teach the Detected Vehicle Limitations of Claims 20/59

1. Grounds 1A-1E Lack the Ability to Detect or Identify a Vehicle

159. In Grounds 1A-1E, Petitioner relies exclusively on Beam to meet the [20.9] limitation—which requires the processor, in communication with at least the sensors and the control circuitry, configured to process the sensor data to determine, within a field-of-view, at least a first sub-section including a detected vehicle and the [59.7] limitation which requires that the processor is configured to: process the sensor data to identify a first subsection, of a field of view, that includes at least a portion of the second vehicle. (Pet. at 43.)

160. Specifically, to satisfy [20.9], Petitioner points to Beam’s ability to provide a “shaded area based on blanking signals” and Beam’s statement that the “blanked area tracks the location of the oncoming vehicle.” (*Id.*) Beam however lacks the ability to **detect or identify a vehicle** and then segment the field of view based on the location of the detected/identified vehicle.

161. The plain meaning of “detect” is to “determine the existence, presence

or fact of.” (<https://www.merriam-webster.com/dictionary/detect.>) As such, for the processor to “determine a subsection including a detected vehicle”, it must be able to determine the existence/presence/fact that a vehicle exists. To satisfy [20.10], the processor must similarly be able to determine the absence of/fact that a detected vehicle does not exist, to demarcate a second subsection. For both limitations, a mere association will not suffice.

162. In Beam, incoming light — which may be associated with any light source, e.g., house lights, streetlights, motorcycles, interior vehicle lights, headlights of an oncoming vehicle and/or taillights of a preceding vehicle-- is transmitted through optical system 106 and detected by a sensor (camera) 107. (*Id.*) Data from sensor 107 is used by controller 108 to map the angular position of incoming light to a corresponding position/size of microbeams that must be significantly reduced in intensity. (Ex.1005, 4:9-24, 53-59, 62-64.)

163. Beam’s AABH system is agnostic to whether the incoming light is from a vehicle, a streetlight or another light source; it simply blanks all LEDs correlated with the position of incoming light, regardless of the classification of the light source. Thus, Beam lacks any specific way to differentiate between different sources of incoming light. (*Id.*) Beam’s generalized, more simplistic solution is devoid of a machine vision system or pattern recognition system for detecting or identifying a vehicle. (*Id.*, ¶91.) As such, it is incapable of detecting or identifying

a vehicle and segmenting the field of view based on the location of the detected vehicle, as required by the [20.9]/[59.7] limitations.

164. Intentionally left blank.

**a. Because a Vehicle is Not a Species of the Light Genus,
Genus/Species Law Does Not Apply**

165. In the Institution Decision, the Board disagreed with Patent Owner's position:

We find these arguments unpersuasive because the claims do not require that the system detect **only vehicles**. We find it sufficient to meet the claim language that Beam and Karlsson would identify oncoming **headlights** and dim the light being projected in that area, even if they would also reduce **light being projected towards other types of light sources**.

(DI at 20.)

166. The prior art genus disclosure of light anticipates the narrower species of **headlights**. However, the claims are directed to detecting a **vehicle**, not a headlight. Because a vehicle is not a species of the light genus, genus/species law does not apply. It is also worth noting that the systems do not technically “identify” headlights, they detect lights that **may** include headlights or any other kind of light – so light detection does not equate to headlight detection, let alone headlight “identification.” Beam and Karlsson’s systems do not actually “know” that these are specifically headlights, and so “identifying headlights” cannot serve as a proxy

for detecting a vehicle either because the true function is “detecting light.”

167. Moreover, per the claim language, the detection of light is *per se* insufficient, the processor must be able to **detect a vehicle**, which inherently requires the processor to use the sensor data to determine whether the sensor inputs confirm **vehicle detection**. On this point, the '503 Patent describes the use of image sensing data and machine vision/pattern recognition technology to detect a vehicle by filtering out nuisance light sources such as road signs and reflectors.

168. Though the claims do not require the use of machine vision or pattern recognition technology, they do require the processor to process the sensor data to determine, within a field-of-view, at least a first subsection including a detected vehicle and at least a second subsection not including the detected vehicle, and require the processor to confirm from the sensed data the existence or absence of a detected vehicle in a specific subsection, so the processor can maximize vehicle operator visibility in at least the second subsection while a disturbing effect resulting from the illumination output on the vision of other traffic in at least the first subsection.

169. The ability to distinguish a vehicle based on detected light, that may include light from nuisance sources, is thus part of the Detected Vehicle Limitation. As such, the mere detection of light in Beam and Karlsson is insufficient to satisfy the Detected Vehicle Limitation.

170. Even if genus/species law is applied, the “Federal Circuit and its predecessor court [the CCPA] have found anticipation of a species by a genus in this context only when the genus itself is narrowly defined,” i.e. the genus is “so small that a person of skill would immediately recognize the ‘defined and limited class’” of species as falling within the genus.

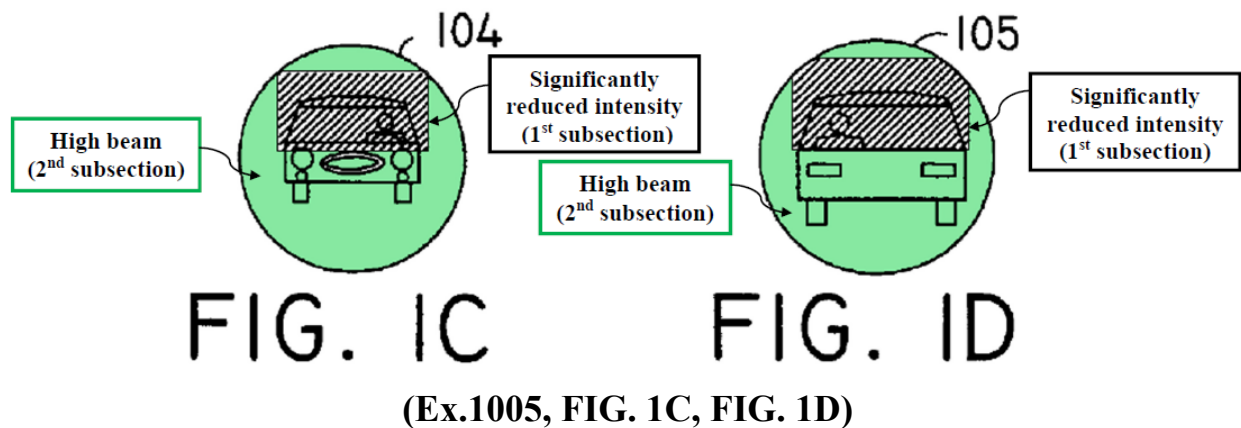
171. Here, as the genus is light, which includes for example, landscape lights, residential lights, house lights, interior lights, motorcycle lights, streetlights, bicycle lights and vehicle lights, a POSA would not immediately recognize vehicle headlights as falling within the light genus. Accordingly, even if genus/species law applied, the disclosure of light detection in the primary Beam and Karlsson references fails to anticipate the species claim to vehicle detection.

b. Grounds 1A-1E: Beam Does Not Determine Illumination of the First and Second Subsections

172. Finally, Petitioner’s argument that each pixel is determined to be blanked or not blanked during pixel evaluation does not satisfy the Detecting Vehicle Limitation, which also requires “**determining illumination**” for a first and second subsection. Pet at 43.) Beam’s pixel evaluation **determines whether to blank** the light source (off), which is distinct from **determining illumination**. By definition, the absence of light, is not illumination. The plain meaning of illumination is “the action of illuminating or state of being illuminated.”

(<https://www.merriam-webster.com/dictionary/illumination>.) Because at least the first subsection includes the detected light, Beam would blank the first subsection and thus never *determine illumination for the first subsection*, as required by [20.9] and [59.7].

173. Petitioner's proofs for the second subsection also fail for claim [20.9]. With Annotated Figures 1C and 1D from Beam, Petitioner identifies what it considers to be the claimed second subsection. (Pet. at26.)



174. Significantly, the “2nd subsection” identified in **both** annotated pictures, **plainly includes the second vehicle**, thus failing to meet the *at least a second subsection of the field-of-view not including the other vehicle* limitation in [20.9].

E. Grounds 1A-1E: The Proffered Combinations Fail to Teach the Detected Vehicle Limitations in [20.9-20.10] and the Output Limitations in [20.11-20.13]

175. Limitation [20.9] requires the processor to process the sensor data to determine, within a field-of-view, at least a first subsection including a **detected**

vehicle. Limitation [20.10] similarly requires the processor to determine a second subsection not including the **detected** vehicle. Per the Merriam Webster Dictionary, the plain meaning of “detect” is to “determine the existence, presence or fact of.” (<https://www.merriam-webster.com/dictionary/detect>.) As such, for the processor to “determine a subsection **including a vehicle**”, it must be able to determine the existence/presence/fact that a vehicle exists. To satisfy [20.10], the processor must similarly be able to determine the absence of/fact that a detected vehicle does not exist, to demarcate a second subsection. For both limitations, a mere association will not suffice.

176. Left intentionally blank

177. Because Beam is incapable of **detecting** a vehicle, it is also incapable of differently illuminating at least two distinct subsections to minimize light output at **a subsection including the detected vehicle** in [20.11-20.13].

F. Ground 1- Dependent claim 25

178. Claim 25, which depends from independent claim 20, includes *at least one of reflectors, refractors or lenses usable to alter emitted light from at least one of the light sources*. The Petition addresses claim 25 with one sentence: “Beam discloses ‘a spatial light modulator. . . digital mirror devices’ and ‘an optical system 106 (e.g., a bi-convex lens)’. [citations omitted] (‘a reflector or lens’), 4:10-59 (‘reflected by a beamsplitter 201’), 5:17-21; EX 1003, ¶¶199-201.” (Pet. at 50-

51.)

179. Petitioner's arguments regarding claim 25 fails for at least two reasons: 1) none of the LED combinations include an SLM; and 2) the beamsplitter 201 does not output reflected light, but rather prevents certain microbeams from exiting the headlamp to facilitate blanking.

G. Ground 2: Even combined, Beam, Thominet, and Stam Fail to Teach the "Predefined Illuminance" Limitation in Claims 59 and 63-64, And Beam's Failings Further Render the Proofs Deficient

1. Sub-grounds 2A and 2D Inherit Deficiencies of Sub-ground 1C

180. Sub-grounds 2A and 2D include the logic of sub-ground 1C and thus inherit its deficiencies.

2. Sub-grounds 2B and 2E Inherit Deficiencies of Sub-ground 1D

181. Sub-grounds 2B and 2E include the logic of sub-ground 1D and thus inherit its deficiencies. No POSA would have made either combination.

3. Sub-grounds 2C and 2F Inherit Deficiencies of Sub-ground 1E

182. Sub-grounds 2C and 2F include the logic of sub-ground 1E and thus inherit its deficiencies. No POSA would have made either combination.

4. Sub-grounds 2A-2F All Inherit Beam's Failures

183. All sub-grounds include Beam and Petitioner relies on proofs related

to Beam as evidence of features of claim 59 it equates to being comparable to features of claim 20. For example, Petitioner argues that 59.7 is patentably indistinct from 20.9. (Petition, 58.) Accordingly, Petitioner's proof for 59.7 fails on all grounds for reasons comparable to its failure with respect to claim 20.9.

184. Claim 59.8 recites “determine output that aims illumination at the first subsection.” Petitioner's proof is that figures show illumination in the shaded areas that is less than low beam. (*Id.*) This is not evidence of aimed illumination, this is evidence of spillover illumination. (Ex. 1005, 6:45-50.) Moreover, the mere presence of illumination certainly fails to **prove** that Beam “aims” illumination at this section.

5. Grounds 2D-2F: There Is No Motivation to Combine Blanked Subsections With A Predefined Illuminance Level

185. The Petition fails to specify **which** Beam-Thominet ground is being combined with Stam, giving rise to Grounds 2D-2F. (Pet. at 53-64.) In Grounds 2D-2F, Petitioner attempts to prove that the inclusion of Stam somehow “substantially illuminates the first subsection below a predefined illuminance.” By Petitioner's own admission, Beam alters the illumination pattern to blank or **prevent** illumination — eliminating the purported need for Stam, as blanking is necessarily below a predefined illuminance.

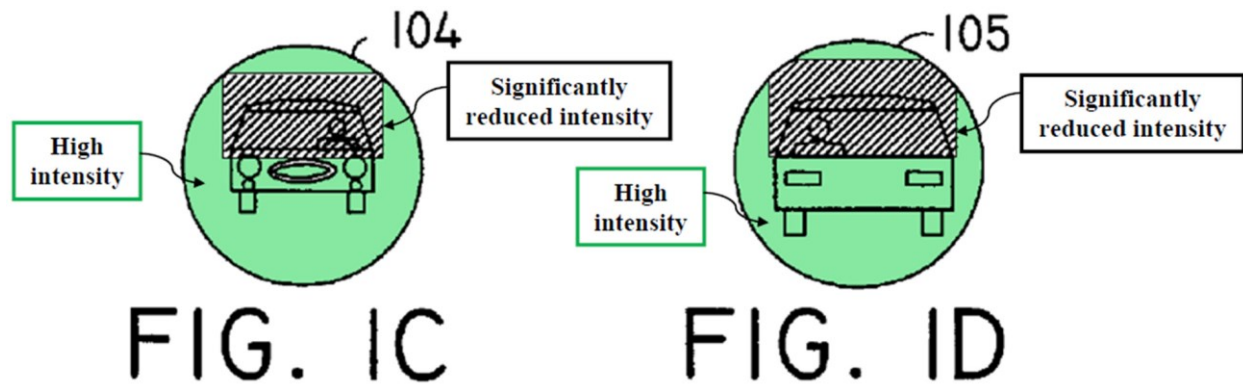
186. Additionally, because the first subsection is blanked, there is no

output that aims illumination at the first subsection, contrary to Petitioner's argument that the combination in Grounds 2D-2F results in significantly less illumination in shaded areas. Moreover, the Stam teaching is merely about when one should modify lamp emission, so in conjunction, the two teachings, at best, merely teach when to institute Beam's expressly determined emission-prevention.

6. Petitioner Fails to Prove at Least Limitations 58.8-58.9

187. Further, Claim 59 requires *determine light output ...that illuminates the first subsection below a predefined illuminance*. [59.8-59.9] This requires positive illumination, as “no” illumination does not “illuminate” anything (nor is it “aimed” anywhere as required in 59.8).

188. Moreover, there is a **determination** of this illumination, it is not the result of spillover illumination from a high-beam region, because the illumination that “illuminates the first subsection” is actually determined. Beam, which utilizes a blanking strategy, provides no illumination directed at the “blanked area” because it either blocks lamp 202 emission towards that area via the SLM or changes LEDs responsible for that area to a non-emitting state. (Ex. 1005, 4:36-40, 5:65-66.)



(Ex. 1005, Figs. 1C-1D, Annotated by Petitioner)

189. The fact that spillover illumination results in non-zero illumination of the shaded areas in Petitioner's annotated figures 1C and 1D above is not dispositive, because it is not actually proof that Beam determines any illumination that illuminates those areas at all, and is merely proof of off-axis (i.e., other-area) emission bleeding over. (Ex.1005, 6:44-48.)

190. Significantly, in IPR2023-00328, Petitioner undercuts its own position, quoting Beam, "Beam discloses 'reformatting the pattern... to prevent it from illuminating certain areas.'" (Pet. at 44.) The fact that Beam prevents illumination in the areas where a light source is detected, proves that the limitation *determine light output ...that illuminates the first subsection below a predefined illuminance*" does not occur in Grounds 2D-2F.

191. Intentionally left blank.

H. Ground 3: Dependent Claims 21-23 The Beam-Thominet-Kobayashi Combination Does Not Teach All Claim Limitations

1. Grounds 3A-3I Inherit Deficiencies of Sub-grounds 1C-1E

192. Grounds 3A-3I include Grounds 1C-1E and inherit the deficiencies of those sub-grounds.

2. Sub-grounds 3A-3I All Inherit Beam's Failures

193. All sub-grounds include Beam and elements of claim 20 by dependency. Thus the failures of proof using Beam for elements of claim 20 extend to all claims 21-23.

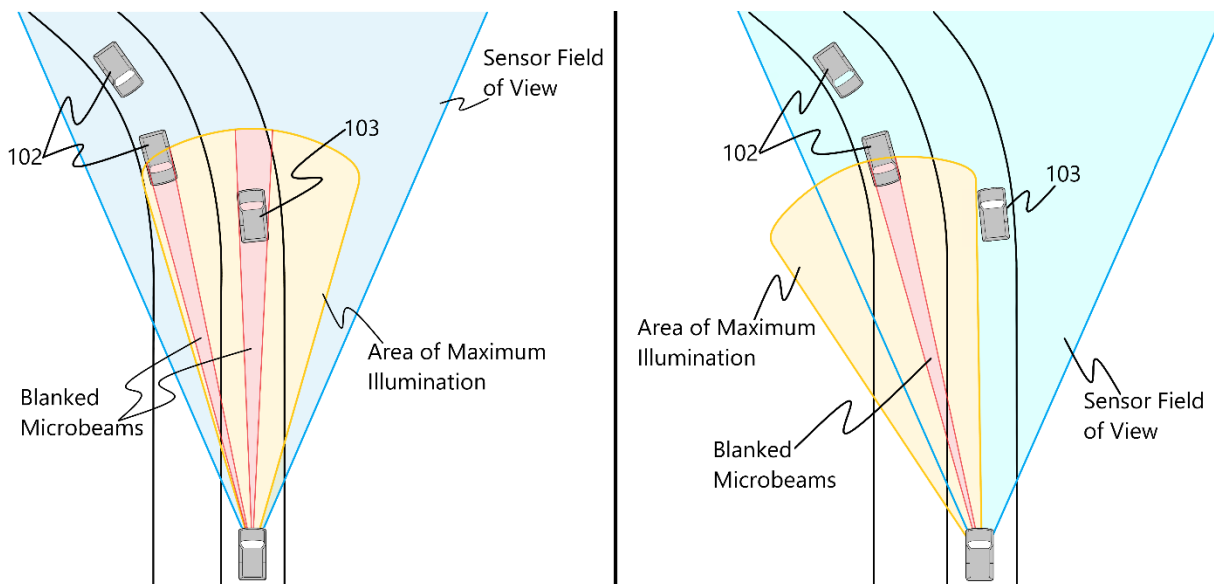
3. Beam-Thominet-Kobayashi Is Never Shown to "Increase" Illumination as Required in Claims 21-23

194. Claims 21-23, which depend from claim 20, require that the processor *is configured to determine at least a planned upcoming turn* or road curvature and *direct the control circuitry to increase illumination* illuminating the **turn or road curvature**. For claims 21-23, Petitioner argues that a POSA would have been motivated to modify Beam-Thominet "to adjust light based on map data including road curvature, as in Kobayashi, to further control Beam's directional microbeams to illuminate roadway curves." (Pet. at 64.)

195. The combination of Beam-Thominet and Kobayashi however fails to teach the limitations in claims 21-23 for at least two reasons: 1) because, as both parties agree, Beam provides maximum intensity light to the greatest extent possible in all areas outside of the anti-glare region, there would be no remaining

unlit LEDs with which to achieve the increase and further no reason *to increase illumination illuminating the turn or road curvature*; and 2) a POSA would have had no motivation to combine Beam-Thominet with Kobayashi.

196. For example, as illustrated below, changing direction of microbeams in the direction of an upcoming left-hand curve in response to map data would reduce illumination below the maximum possible in regions to the right of oncoming vehicles 102 and would defeat anti-blinding operability for any vehicles outside of the intersection of the illumination and sensor fields of view.



197. Beam, as Petitioner admits, “illuminat[es] non-shaded areas ‘at maximum intensity [at all times].’” (Pet., 46, quoting Ex. 1005, 6:30-33.) Accordingly, regardless of whether there is Kobayashi data indicating a curve or knowledge of a road profile or advancing direction, Beam is already maximally

illuminating everything it can illuminate. (Ex.1005, 4:57-59.) If there is “maximum intensity” at all times, as Petitioner contends, then any curve that Beam **could** illuminate is already **maximally** illuminated. This leaves the combined system with no use for Kobayashi’s map data.

198. In light of the fact that the presented combination can do nothing with Kobayashi’s map data, there is no reason to make such a combination that merely adds unusable, extraneous information.

199. For at least this reason, Petitioner’s combination is not a combination any POSA would be motivated to make.

200. Intentionally left blank.

I. Ground 4: Even Combined, Beam, Thominet, Stam and Kobayashi Fail to Teach Claims 60-62

1. Sub-grounds 4A-4I Inherit Deficiencies of Sub-grounds 1C-1E

201. Sub-grounds 4A-4I include sub-grounds 1C-1E through inclusion of “Beam-Thominet” and are deficient for the reasons noted with respect to the sub-ground 1C-1E combinations for Ground 1.

2. 4A-4I Are Duplicative of Ground 2, Sections 1-3

202. Further, all sub-grounds also include Beam-Thominet-Stam, and the claims depend from claim 59, so the failings of Beam-Thominet-Stam grounds 3A-3I are inherited through inclusion and dependency of claims.

3. The Ground 4 Argument Omits Material Limitations in Claims 60-62

203. As detailed in Section VII, the Petition omits material elements of claims 60-62, resulting in incomplete proofs.

J. Ground 5- Karlsson or Karlsson-Harbers Applied to Claims 20-25 and 59-64

204. Ground 5 includes the following Sub-grounds:

- 5A - Karlsson_LEDs
- 5B - Karlsson_LEDs+Modulator
- 5C - Karlsson_LEDs+Modulator + Harbers Control
- 5D - Karlsson_Control + Harbers Control + Harbers_Array
- 5E - Karlsson_Control+Harbers_Array
- 5F - Karlsson_LEDs+Modulator + Harbers Control + Harbers_Curve
- 5G - Karlsson_LEDs+Modulator + Harbers_Curve

1. Grounds 5F-5G There is no Motivation to Merely Use the Curve of Harbers

205. As detailed with respect to sub-ground 1E, *supra*, for Beam-Thominet, a POSA would understand that the addition of Harbers' curved substrate alone, is of no more use than Thominet's substrate.

2. Absent Harbers' Software, Ground 5E Lacks the Ability to Segment and Presents Color-Shifting Issues

206. Because Petitioner’s Ground 5E combination lacks Harbers’ software, per Dr. Jiao’s testimony, the control features of Harbers’ would be missing. (Ex. 2025, 65:13-19.) Without light segmentation the motivation to use Harbers’ hardware alone--curved substrate and LEDs-- is lacking. Further, the use of Harbers’ colored array combined with Karlsson’s controls creates a color-shifting problem because Karlsson will not know how or when to use colored LEDs, and will instead use them unpredictably in its own strategies, which are not designed to even generally accommodate color — all of which Petitioner fails to address.

**3. Grounds 5C-5D/5F Are Unmotivated Combinations
Due to the Unaddressed Issues Arising From
Conflicting Control Strategies**

207. Petitioner never explains how Karlsson’s selective dimming and Harbers particular automatic controls would contemporaneously function in situations where the two strategies required conflicting control. For example, Harbers control under “different driving situations” may try to widen a beam (due to a slowing vehicle) that Karlsson is controlling as in Petitioner’s annotated Fig. 14. (Pet., 81, 101.) At that moment, Harbers would be trying to place light where Karlsson is intentionally removing it, as well as possibly trying to dim forward illumination in the central segment of Fig. 14 that Karlsson is attempting to utilize at full output. (*Id.*, 101.) Petitioner never recognizes these conflicts nor resolves them, and these indicate the unsuitability of combining Harbers and Karlsson’s

conflicting control strategies into a single combination as in 5C-5D or 5F.

4. Ground 5F Lacks Necessary Particularity

208. In Ground 5F, there are two controllable systems, an LED array 2 and a modulator 3 from Karlsson. There are also two control strategies, Karlsson's selective control and Harbers' alleged automatic beam segmentation.

209. Petitioner never explains which controllable structure would be controlled by which control function, rendering the argument flawed for a lack of particularity. For example, it is unclear which of Karlsson or Harbers would control source 2 or modulator 3. As such, the combination lacks requisite particularity of explanation.

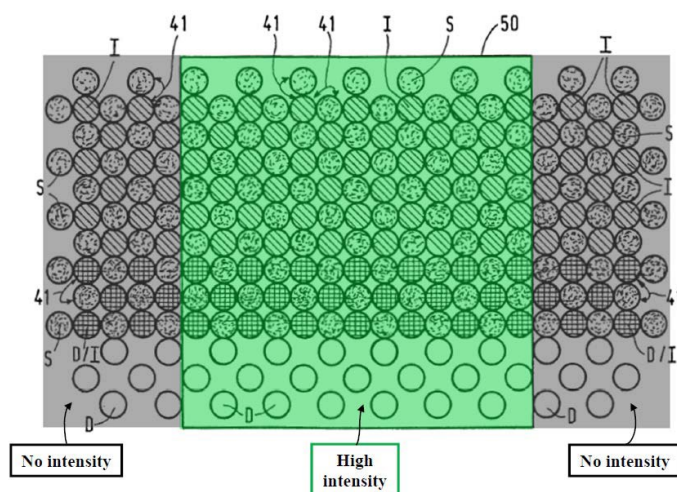
5. Karlsson's Failings Alone Are Sufficient To Defeat All Proposed Grounds Utilized Against Claims 20-25 and 59-64

210. Karlsson's teachings, as applied, include substantive failings that extend across all sub-grounds.

211. Petitioner contends that Fig. 14 is a functional representation of the actual operation of Karlsson in the presence of detected light, stating that "the shaded subsections below are "no intensity" sections **that correspond to detected light**. (Pet., 101) That is, these are not merely electively unused areas, they are, by Petitioner's contention, areas that are intentionally shaded responsive to detection, i.e., they were under use prior to shading (*Id.*) Karlsson, however, lacks these

teachings with respect to Fig. 14.

212. Petitioner’s statement, that those “shaded areas” are sections that correspond to “directions from which light is detected,” is useful to understand Petitioner’s position on how Karlsson generally functions— namely, these annotations present an array that would be fully utilized were light not being detected.



(Ex.1010, FIG.14, Annotated by Petitioner)

213. Petitioner’s “full usage of the array except when accommodating glare” interpretation generally supports Patent Owner’s similar understanding of how Karlsson functions.

6. Grounds 5A-5B, 5F-5G: Karlsson Does Not Teach Directional Light Sources Having Different Aimings

214. To satisfy the Aiming Limitation [20.2]/[59.2], Petitioner asserts that Karlsson “explicitly or implicitly” discloses every feature of claims 20 and 59, but if not, then Harbers discloses [20.2]/[59.2] and a POSITA would have been

motivated to extract them from Harbers and insert them into Karlsson. (Pet. at 76-77.)

215. As with Ground 1A, in Ground 5A Petitioner undermines its construction of *light source* to improperly conflate the emitted beam and the light source — arguing that each of Karlsson’s spotlight beams is a directional light source. (Pet. at 81-82.) Here, however, the failing is worse because now Petitioner uses ellipses to twist the meanings of teachings to maintain its argument.

216. First, Petitioner deletes words to equate “beams 34” to “being” light sources: “Karlsson discloses ‘spotlight beams 34 can be...a *grid of separate light sources*, such as *LEDs*...controlled either *individually* or in *groups*.’” What the section actually says is “beams 34 **can be obtained**, for example, **by using a light source 2, which is a grid of separate light sources**.” (Pet. at 77.) Karlsson clearly contemplates the plain meaning of the word “source”— i.e., the emitter that produces the light.

217. Petitioner immediately omits essential context again, now to create new capabilities for the modulator: “*light modulator means 3* advantageously can be switched to . . . *given directions*.” (Pet. at 77.) As the Board concluded, “Petitioner’s argument mischaracterizes the quoted language, using ellipses to flip the meaning.” (DI at 14.) Read in context, the quoted language is referring to the light modulator means ***detecting*** light ***from*** different directions to control

intensity, not projecting light in different directions. Absent these disingenuous quotations, Petitioner fails to establish that Karlsson discloses [at least three] *different light sources aimed at different angles*” or *having different aimings* per claim 59. (*Id.*)

218. Petitioner’s proof is ultimately “each spotlight beam is a directional ‘source’ having its own independent direction (angle/aiming).” (Petition, 77.) Since spotlight beams are not LEDs, this proof fails (sub-ground 5A). And, absent the directionality language improperly ascribed to the modulator through ellipses, Petitioner lacks proofs for their premise that the modulator (in 5B-5C/5F-5G) projects light in different directions. Petitioner is limited to the flawed evidence upon which it relied, and for these reasons grounds 5A and 5B relying exclusively on Karlsson fail, as well as grounds 5C and 5F-5G.

7. Grounds 5C-5G: Even Combined, Karlsson and Harbers Fail to Teach the Aiming Limitation in All Claims

219. Petitioner doesn’t explain whether or how various limitations of the Challenged Claims are found in Karlsson or Harbers or some combination thereof left to the imagination of the reader. Petitioner asserts that Karlsson explicitly or implicitly discloses every feature of claims 20 and 59, but if not, then Harbers discloses [20.2]/[59.2] and a POSITA would have been motivated to extract them from Harbers and insert them into Karlsson. (Pet. at 76.)

220. However, neither Petitioner nor Dr. Jiao describe how Harbers' "array of opto-electronic elements" a.k.a. "directional light sources" of Fig. 2 that may alternatively be provided on a curved substrate are combined or substituted into the planar LED array of Karlsson's Fig. 14 that includes interspersed light-sensitive sensors.

221. Intentionally left blank.

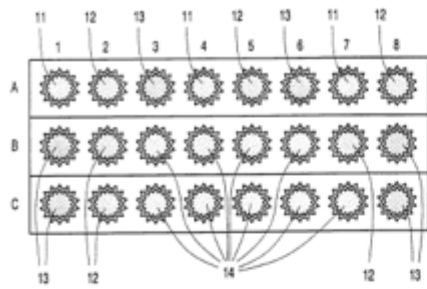


FIG. 2

Harbers Array/Light Pattern

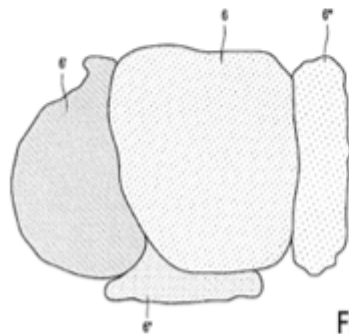


FIG. 3B

(Ex. 1011, Figs 2, 3B, Annotated)

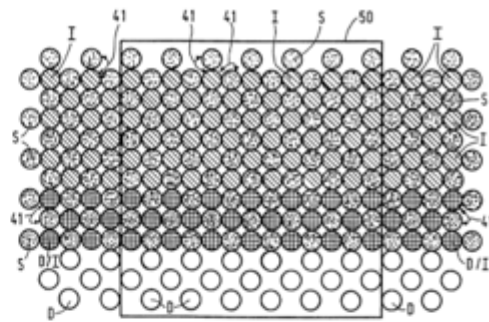


FIG. 14

Karlsson Array/Light Pattern

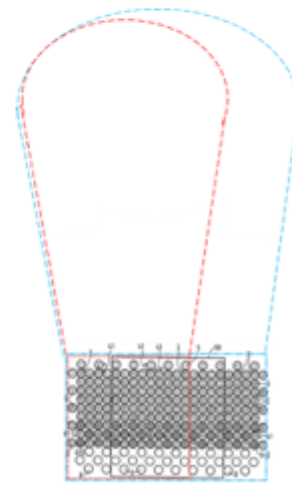


FIG. 14A

(Ex. 1010, Fig. 14, Annotated)

222. Furthermore, Petitioner does not explain how the combined Karlsson/Harbers system having a curved substrate to satisfy [20.2]/[59.2] controls intensity of the individual spotlight beams in response to light detected by the interspersed light-sensitive sensors of Karlsson, or how parameters such as vehicle velocity, steering wheel position, or weather as disclosed by Harbers are provided by the dipped/main beam groupings of LEDs disclosed by Karlsson.

223. Significantly, the Petition fails to explain how a POSA would reconcile the incompatible control systems of Karlsson—which strives for optimum illumination—with Harbers’ preassigned, selective controls. The combination leads to conflicts with forward illumination instructions. The problem is compounded by Harbers’ use of colored LEDs in the array, which would need to be addressed to avoid color-shifting issues.

Petitioner further fails to describe how the four beam segments and resulting light pattern of Harbers is provided by the groupings of D, I, and D/I LEDs in Karlsson that correspond to the dipped beam and main beam functions.

8. Ground 5A-5G: Karlsson Fails to Teach the Detected Vehicle Limitation

224. Similar to Grounds 1A-1E that rely on Beam to meet the [20.9] limitations, Petitioner relies on Karlsson in all sub-grounds 5A-5G in Ground 5.

225. Unlike Beam’s sensor (camera) 107 used to detect incoming light within the entire field-of-view, Karlsson relies on multiple spatially distributed “spotlight sensors” interspersed with the LEDs that generate “spotlight beams” to detect incoming light “whereby the field of view of the light-sensitive sensors and the illumination field of the light beam to be emitted, will coincide.” (Ex.1010, 3:29-31, 19:6-20:5, Figs. 13, 14.) One or more spotlight sensors are associated with each LED “for adjusting the light intensity of the spotlight beams . . . so as to

provide a compound light beam having a desired pattern.” (Ex1010, 4:25-31.)

226. But, more importantly, Karlsson, like Beam, detects light as a general predicate for control. So even if a camera were presented for Karlsson, it would, at best, use the camera as Beam does – merely to detect light.

227. As such, Karlsson, like Beam, is agnostic to the source of the incoming light and does not disclose any processing of the spotlight sensor signals to determine whether the source is a vehicle, house light, interior light, streetlight, or another light source. Rather, Karlsson simply adjusts intensity of one or more spotlight beams associated with the spotlight sensors that detect incoming light. Accordingly, for the same reasons detailed in Ground 1B, Ground 5B fails to satisfy the [20.9] Detected Vehicle limitations in the Challenged Claims and by extension, the Output Limitations in [20.10].

228. Intentionally left blank.

K. Ground 6 – Even Combined, Karlsson, Harbers, and Gotou Fail to Teach Claims 21-23 and 60-62

229. Petitioner relies on Gotou’s disclosure of adjusting light based on GPS data including road curvature for satisfying the sensor data limitations, and relies on Karlsson-Harbers for satisfying the hardware and software limitations. (Petition, 116.) This introduces a third control function, the alleged attempts to modify light into a curve as Gotou does it.

1. Grounds 6A-6E inherit issues from 5C-5G

230. All combinations involving Karlsson-Harbers have the deficiencies of sub-grounds 5C-5G, included respectively in grounds 6A-6E through combination.

2. Grounds 6A-6E inherit issues from Proofs of Claims 20 and 59 Reliant On Karlsson

231. Claims 21-23 depend from claim 20 and claims 60-62 depend from claim 59, and all the noted deficiencies of proof with respect to Ground 5 arguments against claims 20 and 59 thus extend to claims 21-23 and 60-62.

3. Combining Gotou with 6A, 6B, 6D Results in Multiple, Incompatible Control Functions

232. Grounds 6A, 6B, 6D include all controls of Karlsson, Harbers software and Gotou. This now presents three control functions that can desire conflicting results - e.g., the combination may instruct full illumination of the scene (Ex. 1010, 1:21-23), while conflictingly trying narrow the main beam based on speed (Ex. 1011, 3:18-22). Those functions already conflict. Then if the system further tried to steer the beam per Gotou, this would either confound the goals of the narrowed beam or be obviated by the already existent full illumination (depending on which system “won” the additional prior conflict). All of this is never noted or addressed in the proposed combination.

233. Further, in 6A and 6D, there are two controllable systems, the array 2 and modulator 3, and Petitioner fails to explain, let alone with particularity, which

controls would be achieved with which systems or how any sort of curving of a beam could be even achieved with a modulator (for example) that merely controls intensity. (Ex. 1010, 14:12-15.)

234. Given the multitude of possible situations arising from systems that purportedly individually accommodate varied instances of weather, curves, turns and traffic, all features that are highly prevalent on roads and which occur in almost limitless combinations, any POSA seeking to make a combination of Karlsson-Harbers, let alone Karlsson-Harbers-Gotou, would have needed to understand and adapt the system to deal with all likely scenarios — a complex undertaking when working with three systems not designed to work together.

235. Further, when Petitioner argues that Karlsson would “direct light of the spotlight beams appropriately,” that is an explanation devoid of substantive evidence or reasoning. (Petition, 119.) Petitioner never explains how Karlsson-Harbers is doing this or which combination of which sub-ground is doing this, or, for that matter, which controllable system is doing this, in combinations 6A, 6B and 6D, which have multiple controllable systems – LED array 2 and modulator 3. This is a fatal failing in particularity for all sub-grounds 6A-6E.

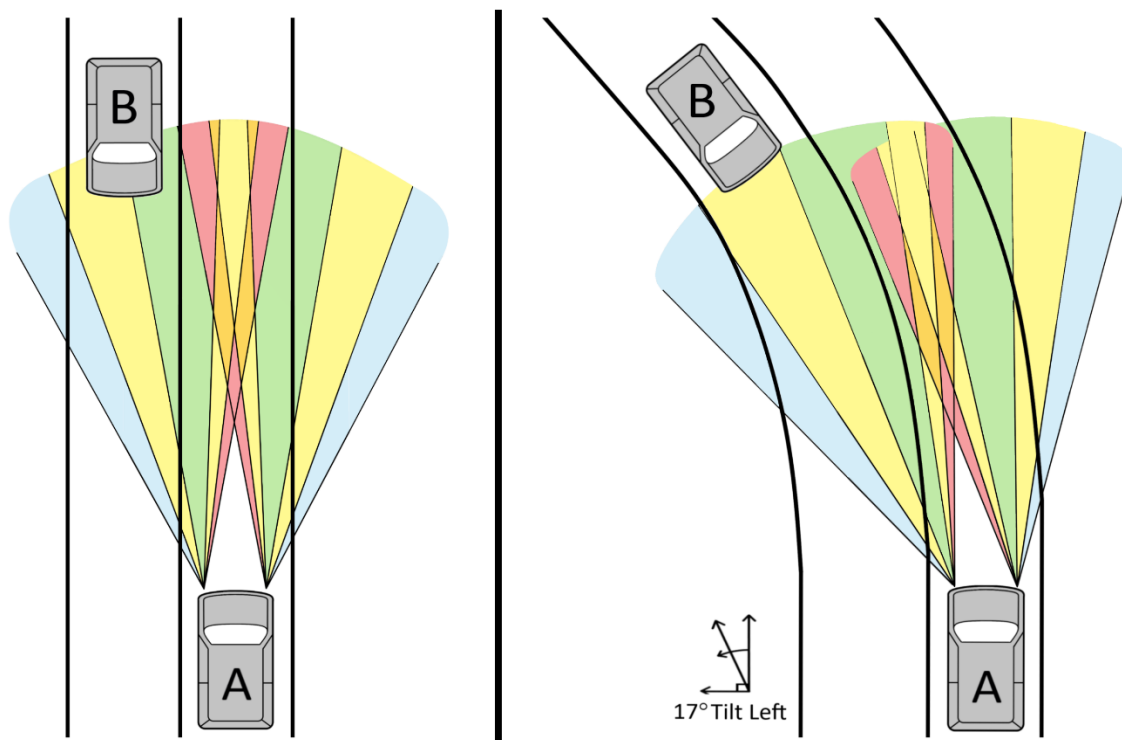
236. Accordingly, the highly unpredictable combination is not a combination a POSA would have made, regardless of which embodiment of Karlsson-Harbers were combined with Gotou.

4. Ground 6E Has No Directional Control

237. It is unclear that Karlsson's hardware could achieve Gotou's desired change, lacking directional control because the modulator merely controls intensity. (Ex. 1010, 14:12-15.) Moreover, the control is explained as nothing more than "adjust and direct light of the spotlight beams appropriately in view of Gotou's map..." but what control system is doing this is never stated, and different combinations of Karlsson-Harbers have different control systems. (Pet., 119.) This generic function and lack of detail lacks the requisite particularity to demonstrate a functional solution that a POSA would have been motivated to make, a failing extending to all sub-grounds 6A-6E.

5. Grounds 6B-6C Suffer From Color Shifting Issues

238. Steering a beam including color as in 6B or 6C would create color overlaps that create undesirable color shifts, as indicated below in the Annotated Fig.



239. Petitioner does not explain how systems resulting from sub-grounds 6B or 6C would actually achieve Gotou's output, but both sub-grounds do have colored LEDs from Harbers' array. Accordingly, if the overlap changed due to whatever alleged beam steering was utilized, color changes would result. These grounds thus suffer from a fatal lack of particularity on this point and raises issues that would render the lamps unsuitable for predictable road illumination.

II. Conclusion

240. In my opinion, the prior art references discussed above taken alone or in any permissible combination do not disclose or suggest each and every element of the challenged claims.

241. I reserve the right to supplement my opinions to address any information obtained, or positions taken, based on any new information that comes to light throughout this proceeding.

I declare under penalty of perjury that the foregoing is true and accurate to the best of my ability.

Executed on: October 12, 2023

A handwritten signature in blue ink, appearing to read "Matthew A. Turk", is written over a solid black horizontal line.

Matthew A. Turk PhD