

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MERCEDES-BENZ USA, LLC
Petitioner,

v.

YECHEZKAL EVAN SPERO
Patent Owner.

U.S. Patent No. 11,208,029

IPR Case No.: IPR2023-01034

SECOND DECLARATION OF MATTHEW A. TURK, Ph.D.

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List of Exhibits

Exhibit No.	Description
2001	Declaration of Matthew A. Turk, PhD
2002	Curriculum Vitae of Matthew A. Turk, PhD
2003	Intentionally left blank
2004	Intentionally left blank
2005	Intentionally left blank
2006	U.S. Published Patent Application US2003/0137849A1 to Alden, Prosecution History in the U.S. Patent and Trademark Office
2007-2039	Intentionally left blank
2040	Second Declaration of Matthew A. Turk, PhD
2042-2049	Intentionally left blank
2050	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)
2051	Michael Bass, <i>Handbook of Optics</i> 3 RD Edition Volume II, (McGraw-Hill, 2010) (Available at https://www.worldcat.org/title/555545456)
2052	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/)
2053	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/)

2054	Intentionally left blank.
2055	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)
2056	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.)
2057	Intentionally left blank
2058	Intentionally left blank
2059	Intentionally left blank
2060	Michael Bass, <i>Handbook of Optics</i> 3 RD Edition Volume V, (McGraw-Hill, 2010) (Available at https://www.worldcat.org/title/557121959 .)
2061	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.)
2062	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.)
2063	Surendra Gupte, Osama Masoud, Robert F. K. Martin, and Nikolaos P. Papanikolopoulos “Detection and Classification of Vehicles” IEEE Transactions on Intelligent Transportation Systems, Vol. 3, No. 1 (March 2002) (Available at

	https://ieeexplore.ieee.org/document/994794) (Accessed February 20, 2024)
2064	Intentionally left blank.
2065	Webster's New Universal Unabridged Dictionary Deluxe 2 nd Edition excerpts, Simon and Schuster (1983)
2066	Transcript of Deposition of Nikolaos Papanikolopoulos, Ph.D. <i>Mercedes Benz-USA, LLC v. Yechezkal Evan Spero</i> , taken on March 26, 2024, IPR2023-01026, IPR2023-01027
2067	Transcript of Deposition of Nikolaos Papanikolopoulos, Ph.D. <i>Mercedes Benz-USA, LLC v. Yechezkal Evan Spero</i> , taken on March 27, 2024, IPR2023-01034

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. 11,208,029 (“the ’029 Patent”) to Yechezkal Evan Spero.

3. I previously prepared a declaration in this proceeding dated October 4, 2023, submitted as an exhibit (Ex. 2001) with a Patent Owner Preliminary Response regarding the ’029 Patent to a Petition filed on June 7, 2023 by Petitioner Mercedes Benz USA, LLC. I understand that the Board instituted the Petition on January 19, 2024.

4. For this second declaration, I have been asked to again provide opinions on the claims of the ’029 Patent in light of the prior art, Petitioner’s arguments in the Petition, and the corresponding declaration and testimony of Dr. Papanikolopoulos. 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 my work in this matter for 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 in my report, Dr. Papanikolopoulos's declaration (Ex. 1003) and his deposition transcript (Ex. 2041, Ex. 2066, Ex. 2067).

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.

IX. 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 graduate Computer Imaging course covered the fundamentals of imaging systems, including the capture, storage, display, retrieval, and processing of images, as well as the nature of light, color, optics, human vision, non-visible (UV and IR) and multispectral imaging, sensors, cameras, and illumination.

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. I have also published research focused on “multi-flash imaging” – using optics, illumination, and computer vision techniques all together, including: “A projector-camera setup for geometry-invariant frequency demultiplexing,”

IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2009), Miami, FL, June 2009; “Characterizing the shadow space of camera-light pairs,” IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2008), Anchorage, Alaska, June 24-26, 2008; “Multi-flash stereopsis: depth edge preserving stereo with small baseline illumination,” IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 30, No. 1, pp. 147-159, January 2008; “Dealing with multi-scale depth changes and motion in depth edge detection,” Brazilian Symposium on Computer Graphics and Image Processing, October 2006. (Awarded “One of the Best Image Processing and Computer Vision Papers”); “Specular highlights detection and reduction with multi-flash photography,” Journal of the Brazilian Computer Society, Vol. 1, No. 12, pp. 35-42, 2006; “Efficient depth edge detection using structured light,” International Symposium on Visual Computing, Lake Tahoe, NV, December 5-7, 2005; “Discontinuity preserving stereo with small baseline multi-flash illumination,” International Conference on Computer Vision (ICCV'05), Beijing, China, 2005; “Harnessing real-world depth edges with multi-flash imaging,” IEEE Computer Graphics and Applications, Vol. 25, Issue 1, pp 32-38, January 2005; “Specular reflection reduction with multi-flash imaging,” Brazilian Symposium on Computer Graphics and Image Processing, pp. 316-323, Curitiba, PR, Brazil, October 2004; and “A non-photorealistic camera: depth edge detection and stylized rendering using

multi-flash imaging,” ACM SIGGRAPH, Los Angeles, August 2004 (also ACM Transactions on Graphics, Vol. 23, No. 3, pp. 676-685, August 2004.)

21. 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. In 2023, I was elected as a Fellow of the Artificial Intelligence Industry Alliance (AIIA). 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.

22. I have provided my full background in the curriculum vitae that is attached as Exhibit 2003.

X. Relevant Legal Standards

23. I have been asked to provide opinions on the claims of the '029 Patent in light of the prior art.

24. 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.

25. 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.

XI. State of the Art as of 2002

A. POSA Considerations for LED Forward Lighting

26. 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

27. 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. 2050¹ at 237.)

¹Jianzhong Jiao and Ben Wang, "Etendue Concern for Automotive Headlamp Using LEDs", SPIE Proceedings Vol. 5187, published by the international society

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

(Ex. 2050 at 234.)

28. 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

for optics and photonics (January 2004). Ex. 2050 is a true and accurate copy of a technical paper that I understand was published by SPIE in January 2004.

hotspot, the light that spreads to left and right or foreground has much less intensity and a large diverge or spread angle instead.

(Ex. 2050 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. 2051² 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

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

Ex. 2051 is a true and accurate copy of excerpts of a book that I understand was published by McGraw Hill in 2010.

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

(Ex. 2052³ 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. 2050 at 237-238.)

The light intensity distribution or beam pattern from a forward lighting device is regulated by federal, state and international laws for

³Ben 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. 2052 is a true and accurate copy of a technical paper that I understand was published by SAE in March 2004.

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. 2050 at 234.)

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

⁴Available 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)

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 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. 2051 at 18.5.)

C. Design Tradeoffs

30. 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. 2052 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. 2050 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. 2050 at 240.)

31. 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. 2052 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. 2050 at 238, emphasis added.)

32. 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. 2052 at 3.) Furthermore, “the luminance of LEDs must be comparable or higher than the existing tungsten halogen light sources.” (Ex. 2052 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. 2050 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. 2052 at 4, emphasis added.)

33. 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. 2052 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. 2052 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. 2050 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. 2052 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. 2052 at 8, emphasis added.)

D. Hardware

34. 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. 2052 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. 2052 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. 2050 at 237.)

E. Optical System

35. 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. 2050 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. 2052 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. 2050 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. 2053⁵ at 10.)

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. 2052 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

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

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. 2052 at 11.)

F. Spatial Light Modulator

36. A POSA would have understood a spatial light modulator (SLM), such as described by Beam (Ex. 1007), to be an array of 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. 2060⁶, 8.29-8.30, . 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.

⁶ Michael Bass, *Handbook of Optics* 3RD Edition Volume V, (McGraw-Hill, 2010.)

Ex. 2060 is a true and accurate copy of excerpts of a book that I understand was published by McGraw Hill in 2010.

(Ex. 2061⁷.) Light reflected at the first angle exits the device, while light reflected at the second angle is blocked by the device. (Ex. 2062⁸.)

37. An SLM is used by Beam 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) so that the smaller light beams can be individually blanked or blocked and do not exit the headlamp. (*See e.g.*, Ex. 1007 at 4:36-41.)

38. In addition to embodiments that use a single light source with an SLM to generate the multiple controllable microbeams or spotlight beams, Beam also describes alternative embodiments that replace the single light source and SLM

⁷Texas Instruments/Digikey “How DLP Technology Works.” Ex. 2061 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.

⁸Texas Instruments “Introduction to +/- 12 Degree Orthogonal Digital Micromirror Devices (DMDs). Ex. 2062 is a true and accurate copy of a Texas 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.)

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. 1007, Figs. 4, 6.)

39. As described by Beam, 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 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.

40. 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.

41. Intentionally left blank.

42. Intentionally left blank.

G. Heat management

43. 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. 2055⁹ at 7.)

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. 2055 is a true and accurate copy of a technical paper that I understand was published by SPIE in September 2007.

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 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. 2051 at 18.6.)

H. Packaging

44. Packaging considerations for automotive headlamps presented challenges even years after the earliest priority date of the '551 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. 2050 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. 2052 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. 2050 at 238.)

I. Cost

45. 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. 2051 at 18.5.)

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

(Ex. 2056¹⁰ at 66.)

J. Detection and Classification of Vehicles

46. Automotive adaptive forward lighting systems use various sensors and processing systems to detect and classify vehicles. In 2002, “magnetic loop

¹⁰Ex. 2056 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. 2056 is a true and accurate copy of a technical paper that I understand was published by the DOE in September 2008.

detectors” were often used to detect or count vehicles passing over them. However, “Vision-based video monitoring systems offer a number of advantages” over such detection systems for example, “[i]n addition to vehicle counts, a much larger set of traffic parameters such as vehicle classifications, lane changes, etc., can be measured.” (Ex. 2063¹¹, 37.) Dr. Papanikolopoulos explained that “there has been relatively little work done in the field of vehicle classification . . . because [it] is an inherently hard problem” due to, e.g., vehicles having different “shapes and sizes” and “occlusions, shadows, camera noise, changes in lighting and weather conditions” in “real-world traffic scenes.” *Id.*

47. Dr. Papanikolopoulos also explained that stereo cameras, e.g., cameras with two or more lenses with a separate image sensor or film frame for each lens, were unfeasible for real-time vehicle classification systems:

In addition, stereo cameras are rarely used for traffic monitoring. This makes the recovery of vehicle parameters—such as length, width,

¹¹Surendra Gupte, Osama Masoud, Robert F. K. Martin, and Nikolaos P. Papanikolopoulos, “Detection and Classification of Vehicles” IEEE Transactions on Intelligent Transportation Systems, Vol. 3, No. 1 (March 2002). Ex. 2063 is a true and accurate copy of a technical paper that I understand was published by IEEE in March 2002.

height etc., even more difficult given a single camera view. The inherent complexity of stereo algorithms and the need to solve the correspondence problem makes them unfeasible for real-time applications.

Id.

48. Accordingly, Dr. Papanikolopoulos proposed a system comprising six stages: 1) segmentation, 2) region tracking, 3) recovery of vehicle parameters, 4, vehicle identification, 5) vehicle tracking, and 6) vehicle classification. (*Id.* at 38.)

49. Intentionally left blank.

XII. Overview of the '029 Patent

50. The '029 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, 11:8-13.) The '029 Patent further explains that “[t]he terminology ‘digital’ as used herein refers to the discrete nature of the multiple 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.)

51. The '029 Patent also describes the deficiencies of prior art lighting systems that replace conventional lights with solid-state LED light sources “with

some minor adjustments” but do not utilize the full “digital” control of the LEDs.
 (Ex. 1001, 9:60-63.)

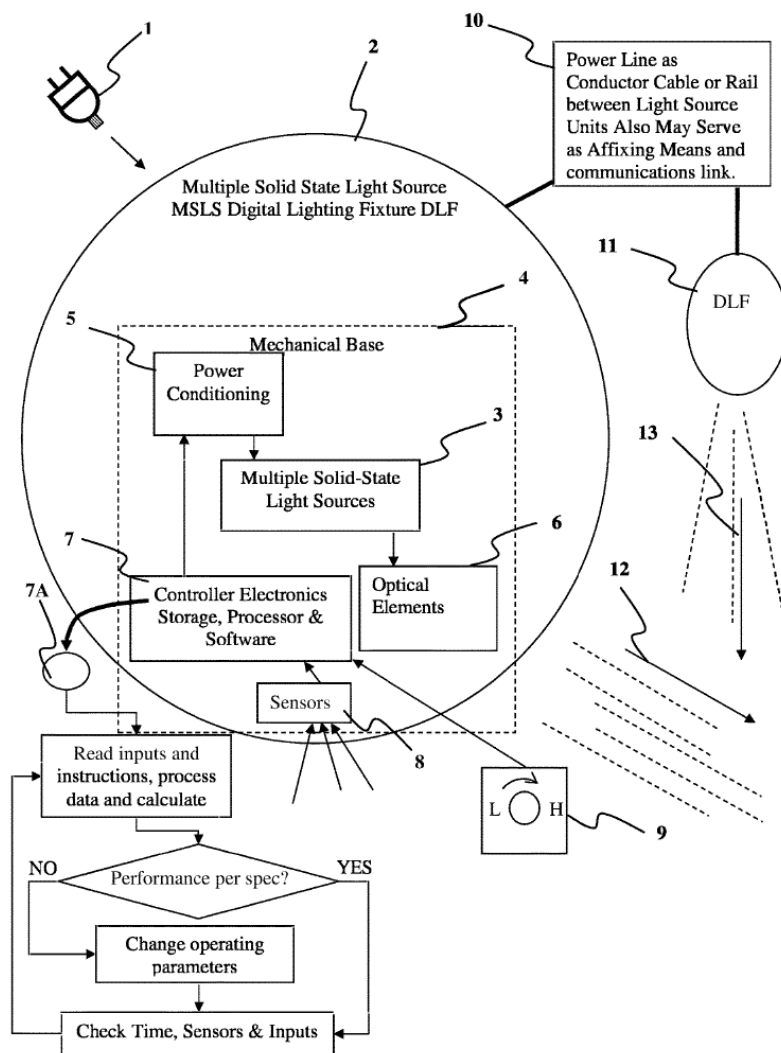


FIG. 1

(Ex. 1001, Fig. 1)

52. The digital lighting fixture (DLF) “includes more than one light source 3, which is preferably an electroluminescent solid-state light source” (SLS) and power conditioning circuitry 5 to condition the power supplied to the light sources 3. (Ex. 1001, 25:5-17.) For example, the LEDs may be operated on “pulse

power and current as well as timing in terms of duty cycle, pulse width and other signal modulations are useable by the controller to effect intensity changes.” (*Id.*, 23:22-25.) “The direction of light exiting from the DLF as a whole or from each SLS individually is controllable by optical elements 6, such as reflective surfaces and or refractors, and may be electronically variable optical elements.” (*Id.*, 25:17-21.)

53. The '029 Patent describes “a different approach which is to provide the end user with the most correct lighting solution not a new technology lamp to replace the old one.” (Ex. 1001, 11:5-8.) “In contrast to a prior art, single large, lamp replacement like light source, the present invention provides multiple, small sized sources of differing characteristics such that the effect of the whole is greater than the sum of the individual parts.” (*Id.*, 11:45-49.) “The added controllability offered by breaking the total light output up into **discrete (‘digital’) specifically aimable and dimmable elements**¹² 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.” (*Id.*, 11:56-62.) “The invention embraces LED-illuminating devices covering a wide scope of applications,” including transportation. (*Id.*, 11:14-21, 4:18-20, 50:49-50.)

¹² Emphasis added unless indicated otherwise.



SPERO EX. 2040

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.*, 22:26-28.) Similarly, an adaptive headlight system may utilize this dual functionality to aim a light beam at a curve ahead of the vehicle while maintaining forward lighting. (Ex. 1001, 50:61-67; 51:54-67.)

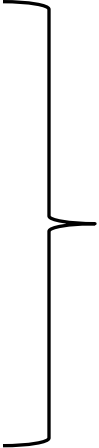
55. The Challenged Claims include independent claims 1, 12, and 23. Independent claim 1 is representative and reproduced below with emphasis added. The Predictive Curve Limitations call for the processor to determine changes involved with adapting a light pattern of the headlamps, in at least one of color, intensity or spatial distribution to increase light in the direction of the road curvature and control the LED light sources to provide light based at least in part on the determined light change and prior to the motor vehicle reaching the road curvature:

1. A system for a motor vehicle, comprising:
a plurality of headlamps, each comprising a plurality of
LED light sources;
one or more processors; and
a memory storing instructions that, when executed by one
or more of the one or more processors, enable the one or

more processors to:

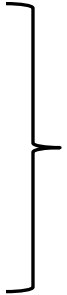
receive first data, including at least map data, indicating
a road curvature upcoming along a road on which the
motor vehicle is traveling;

determine a light change, the change adapting
a light pattern of the headlamps in at least one of color,
intensity or spatial distribution **to increase light in a**
direction of the road curvature ahead of the motor
vehicle and shaping light based at least in part on the
road curvature; and



Predictive
Illumination
Determination
Limitation

control at least a first plurality of the LED light
sources to provide light based at least in part on the
determined light change and prior to the motor vehicle
reaching the road curvature.



Control
Limitation

(Ex. 1001, claim 1.)

56. The '029 Patent describes various techniques for predicting and illuminating an upcoming curve in the road. For example, Adaptive Frontal-

lighting Systems are provided that “aid in seeing around curves and other features in the road.” (Ex. 1001, 51:54-56.) These systems predict upcoming curves in the road based on “instantaneous road conditions” and map data. (*Id.*, 51:56-67.) “A GPS system on the car may also let the headlamps system know of curves up ahead, one-way traffic and others factors such [that] the headlamp may be operated in the optimal mode at that instantaneous location.” (*Id.*) The ’029 Patent also describes adjusting “the intensity, spectrum and beam pattern of the headlamp” based on “instantaneous road conditions” and map data indicative of an upcoming curve. (*Id.*)

XIII. The Challenged Claims

57. The Challenged Claims are claims 1-33. Claims 1, 12, and 23 are the only independent claims among the Challenged Claims. All other Challenged Claims depend directly or indirectly from one of those independent claims.

XIV. Qualifications of One of Ordinary Skill in the Art

58. I understand that the Patent Owner does not dispute Petitioner’s proposed skill level for a person of ordinary skill in the art (“POSA”) because I satisfy it. (Petition at 8-9.)

XV. Proposed Claim Construction

59. To properly evaluate these claims, I understand that the terms of the claims must first be construed. In my opinion, the claims of the ’029 Patent include

terms that an ordinary artisan would understand according to their plain and ordinary meaning.

60. Here, properly construed according to their ordinary meanings and as supported by the specification of the '029 Patent, the limitations “*the control*” or “*the controlling*” recited in dependent claims 9/20/31 are not taught by the Alden, Kobayashi, or Beam reference. The ordinary meaning of each of these claim terms is provided below.

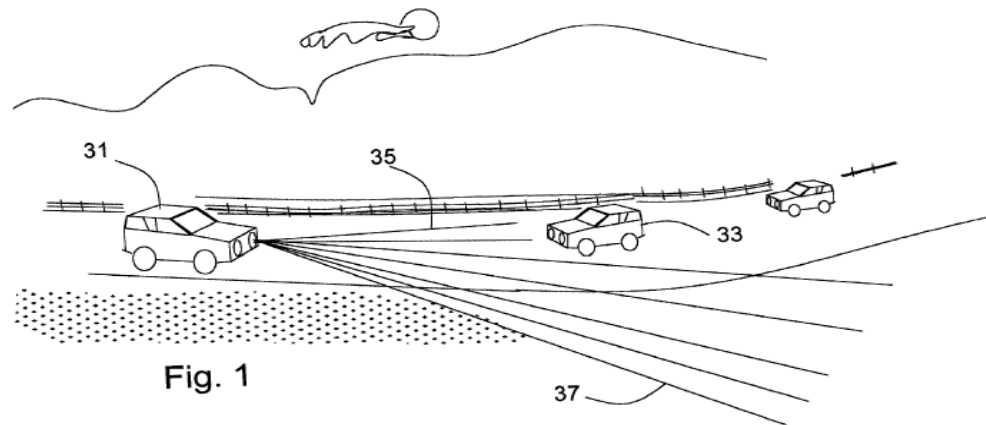
61. Intentionally left blank.

62. Intentionally left blank.

XVI. Overview of the Prior Art

A. Alden

63. Alden is directed to controlling the distribution of light by a vehicle headlight. Alden's systems include headlights that produce multiple individually controllable beam segments of light, each illuminating a sector of an area (“distribution area”) ahead of the vehicle equipped therewith (“equipped vehicle”). (Ex. 1005, ¶¶[0002], [0004-0006], [0008].)



(Ex. 1005, FIGURE 1)

64. The systems also include sensors 51a, 51b for detecting incoming light received from the distribution area, which sensors 51a, 51b are divided into multiple sectors associated with sectors of the distribution area illuminated by the beam segments of the headlight of the equipped vehicle. (Ex. 1005, ¶¶[0027-0028], Figs. 3-4.) The systems further include a central processing unit (CPU) 71 that determines whether incoming light detected in each sector of the sensors 51a, 51b has an intensity that exceeds a threshold value. (*Id.*)

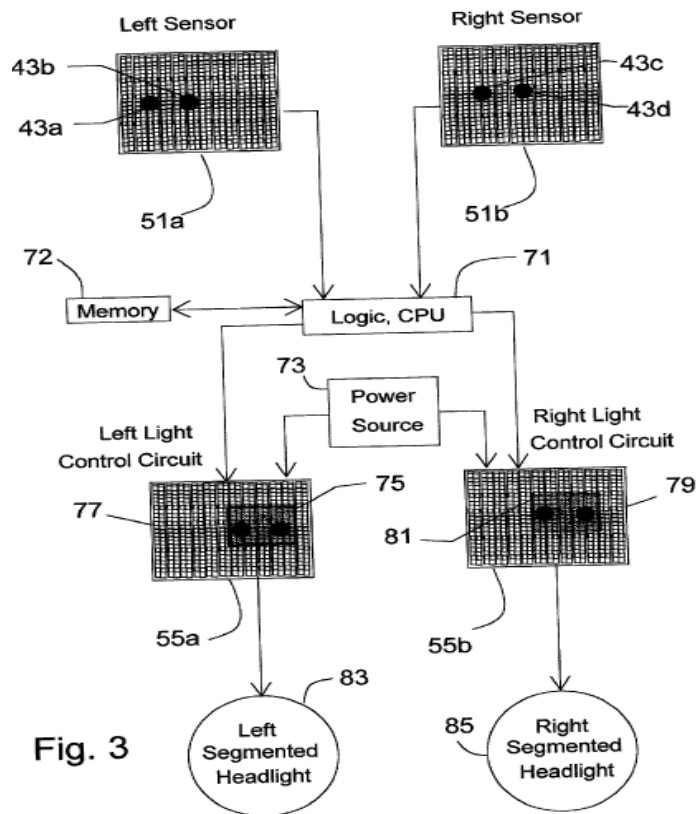
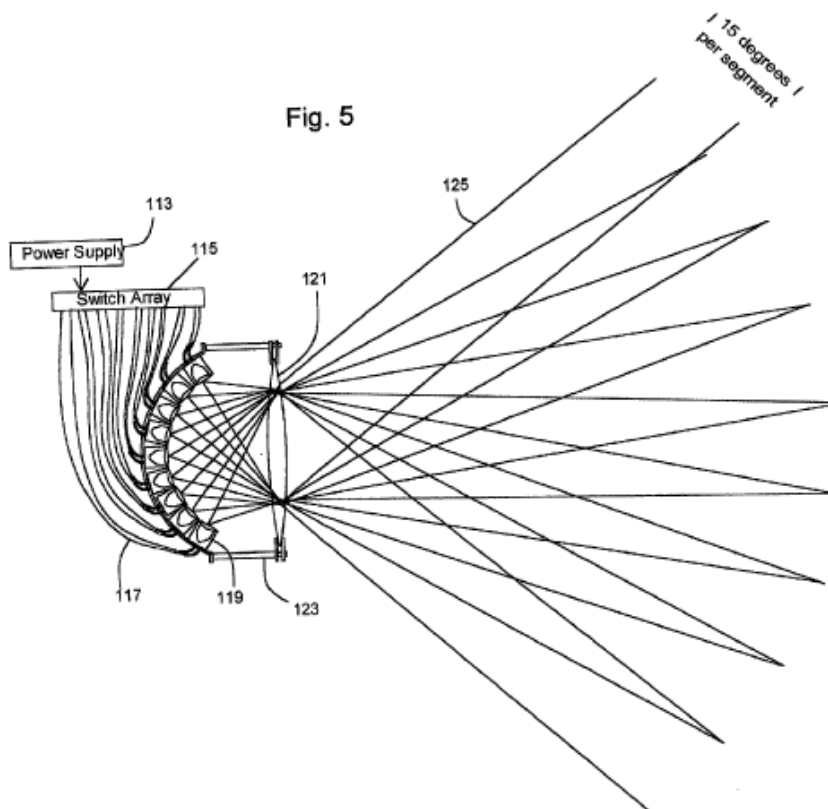


Fig. 3

(Ex. 1005, FIGURE 3)

65. In one of the three distinct embodiments, the headlight system dims the intensity of selected beam segments produced by the headlight of an equipped vehicle that seemingly correspond with a sector or sectors in the distribution area. (Ex. 1005, ¶¶[0025-0026], [0029], Figures 1, 2, 5.) A headlight 123 employs a single-row array of light emitting diode (LED) elements 119 and a double convex lens 121 for directing the beam segments produced by the LED elements 119 that illuminate different sectors of the distribution area. (Ex. 1005, ¶[0029], Figure 5.)

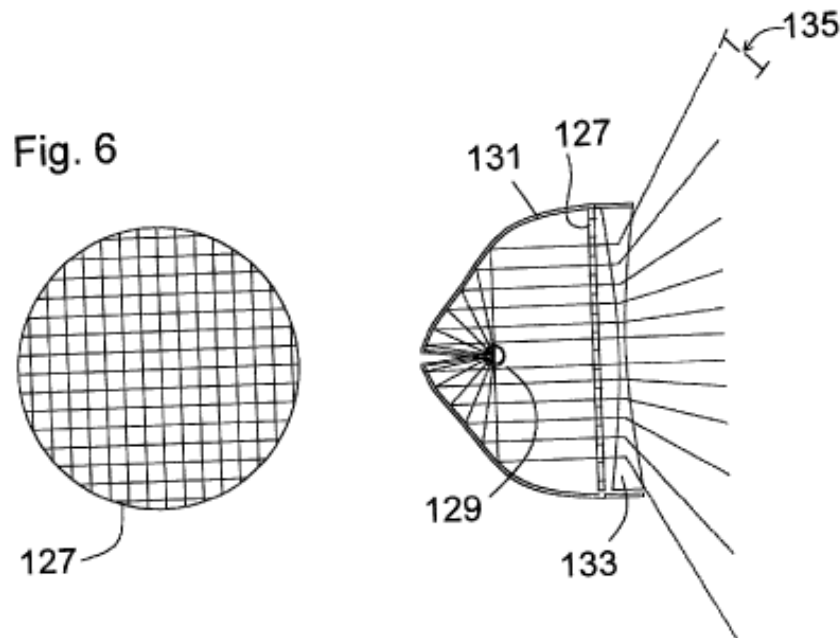


(Ex. 1005, FIGURE 5)

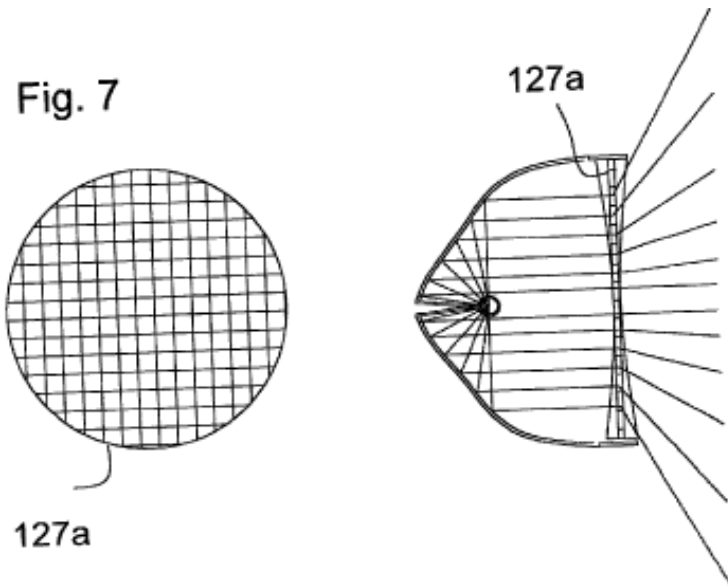
66. The CPU 71 may determine the sector or sectors of the sensors 51a, 51b receiving incoming light from the distribution area that have a detected threshold intensity, which are used to create a region within which light is to be dimmed. (*Id.*, ¶¶[0026-0029].) In response, the CPU 71 controls the headlight 123 to dim some number of beam segments produced by the individual LED elements 119. (*Id.*) Alden uses a convex lens with a curved LED array in this arrangement to create output where LED 119 is responsible for sector 125. (Ex. 1005, ¶[0029].)

67. Such operations may also be accomplished by another different headlight system embodiment of Alden shown in Figures 6 and 7. As seen therein,

that embodiment employs a single light source 129 and a collimating reflector 131 to produce collimated light which may be segmented using electro-chromatic dimming elements 127 that, in conjunction with a double concave lens 133, can dim a given segment. (*Id.*, ¶[0030-0031], Figures 6, 7.) In Figure 7, the electro-chromatic elements 127a are within the double concave lens. (Ex. 1005, ¶[0030-0031].)

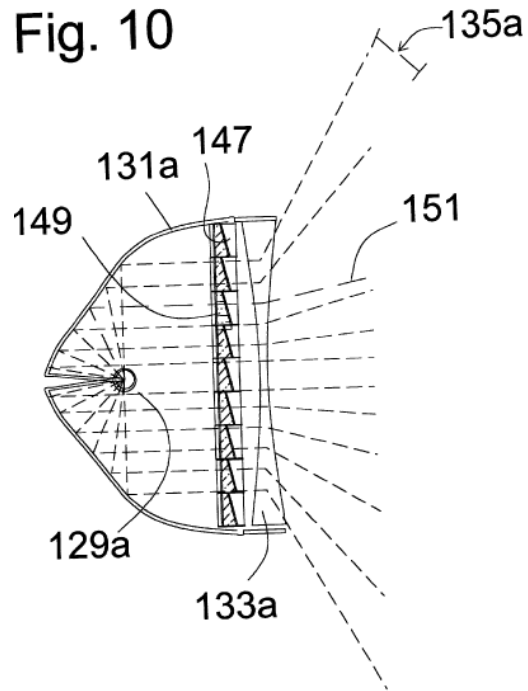


(Ex. 1005, FIGURE 6)



(Ex. 1005, FIGURE 7)

68. A third, further distinct embodiment is shown in Figure 10, in which the headlight system employs a single light source 129, a collimating reflector 131, and electro-optic refractive material 147, 149 to produce multiple light beam segments. (*Id.*, ¶¶[0032-0035], Figure 10.) The CPU 71 can control the electro-optic refractive material 147, 149 to change the direction of the beam segments passing through that element. (*Id.*)



(Ex. 1005, FIGURE 10)

69. In this embodiment, the electro-optic refractive material 147, 149 are bi-refrident liquid crystals, the principles of which Alden describes as well known in the prior art. (Ex. 1005, ¶[0033].)¹³ Therefore, as seen in Figures 8 and 9, they can direct light in only two directions – straight and “bent” in one direction. (*Id.*, ¶¶[0050-0052].)

¹³Birefringent: “having the quality of birefringence”; Birefringence: “the power of double refraction.” (Ex. 2065, 186.)

Fig. 8

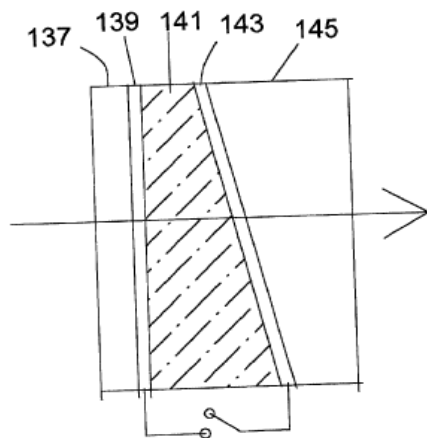
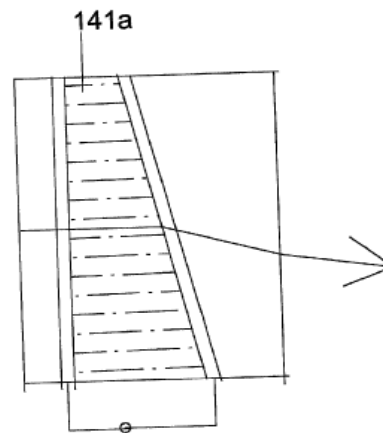


Fig. 9



(Ex. 1005, FIGURES 8, 9)

70. In addition, all beam segments of Alden's various segmented beam headlight embodiments are always at high beam intensity/direction unless specifically dimmed. (Ex. 1005, ¶¶[0006], [0026].) In that regard, Alden states in connection with Figure 3 that those portions of the segmented headlight not dimmed will be on high beam. (*Id.*, ¶[0027].) In connection with Figure 6, Alden states that distribution of light is dimmed for an oncoming vehicle but on high beam elsewhere. (Ex. 1005, ¶[0030].) In connection with Figure 10, Alden states that those beam segments not diverted for an oncoming vehicle are in high beam. (Ex. 1005, ¶[0035].) In general, Alden states in conjunction with Fig. 2 that "the driver of [vehicle] 47 can see everything illuminated to the maximum except the area where [vehicle] 41 is", providing a "highly functional and reliable means for providing maximum light for an equipped vehicle's driver." (Ex. 1005, ¶¶[0026],

[0060].)

71. Alden thus discloses headlight embodiments that provide segmented illumination to defined illumination sectors of the light distribution area. (Ex. 1005, ¶¶[0008], [0029-0038].) Alden illustrates three distinct embodiments thereof. (Ex. 1005, ¶¶[0029-0030], [0035].) For example, Alden states that “FIG. 5 illustrates the segmented headlight means and controlling switch array in a first embodiment.” (Ex. 1005, ¶[0029].) Alden also states that “FIG. 6 illustrates headlight distribution area segmenting means of a second embodiment. ... The collimated light passes through a segmented array 127 of electro-chromatic cells” (Ex. 1005, ¶[0030]), and that “FIG. 7 is identical to [the second embodiment of] FIG. 6 except that the alternate segmented electro-chromatic element 127a is incorporated into the optic (whereas they were separate components in FIG. 6)” (Ex. 1005, ¶[0031].) Alden further states that “FIG. 10 depicts a segmented headlight with individually controlled sectors of distribution of the third embodiment.” (Ex. 1005, ¶[0035].)

72. In these distinct embodiments, Alden’s headlight systems with segmented light distribution elements are designed to provide a high beam to all sectors except sectors where light exceeding a threshold has been detected, in which sectors the systems either selectively change the intensity or lower the direction of beam segments. (*Id.*, ¶¶[0029-0030], [0033-0035].) As demonstrated

above, Figure 5 illustrates a first headlight embodiment that is capable of selectively dimming beam segments produced by multiple LEDs 119. (Ex. 1005, ¶[0029], Fig. 5.) Figures 6 and 7 illustrate a second headlight embodiment that is capable of selectively dimming beam segments having a single light source 129 and a collimating reflector 131. In this second embodiment, an electro-chromatic material is used that changes transmissivity depending on its state. (Ex. 1005, ¶[0030-0031], Figs. 6-7.) In Alden's third embodiment described in connection with Figures 8-10, the electro-optic refractive material 147, 149 allows collimated light to be emitted either along a normal axis or an angled axis via refraction. (Ex. 1005, ¶[0033], Figs. 8-9.)

73. These embodiments disclosed by Alden are also discrete and include features that are incompatible with each other. For example, the third headlight system embodiment of Figures 8-10 having electro-optic refractive material 147, 149 for changing the direction of light passing therethrough is designed to work with collimated light produced by single point light source 129 and collimating reflector 131. (Ex. 1005, ¶[0033-0035], Figs. 8-10.) However, in the first headlight system embodiment of Figure 5, the LED elements 119 of headlight 123 produce non-collimated light. Non-collimated light could not be directed in any meaningful fashion by electro-optic refractive material 147, 149 as shown in Figure 10. (Ex. 1005, ¶[0033-0035].) Rather, non-collimated light would blend

and have different incident angles on the electro-optic refractive material 147, 149, thereby preventing the electro-optic refractive material 147, 149 from performing any meaningful control of beam segments, as well as redirecting much of the non-collimated input light away from the desired sectors of the distribution area. (*Id.*) Any headlight resulting from a combination of Alden's incompatible features would therefore be incapable of meeting the basic requirements of a headlight, *i.e.*, effectively illuminating the area ahead of the equipped vehicle, let alone directing its emitted light in any meaningful fashion. (*Id.*)

74. Additionally, Alden's disclosure is theoretical in nature. It is ambiguous and fails to enable its disclosure in critical respects. (Ex. 1005, ¶[0027-0035].) In that regard, the disclosure in Alden broadly describes certain features of headlight systems and the general functions such features and systems would desirably provide but lacks detailed explanations as to how those features and systems are practically implemented or how those functions are realized thereby. (*Id.*) For example, while Alden depicts control circuit switch array switches in Figure 3 for dimming certain headlight beam segments while leaving other beam segments on high intensity, it does not clearly describe or specifically demonstrate how such operations are accomplished using the single-row array of LED elements 119 of headlight 123 illustrated in Figure 5. (*Id.*) In connection with Figure 4, Alden describes progressing through the sectors of sensors 51a, 51b of Figure 3 to

detect incoming light, but it does not explain how those sensor sectors are mapped to either the single-row array of LED elements 119 shown in Figure 5, the single-row array of switches 115 for that array, or the particular distribution area sectors depicted therein. (*Id.*) In fact, Alden specifically states that the switch arrays of the light control circuits 55a, 55b shown in Figure 3 are merely for illustrative purposes. (*Id.*) Modifications would have to be made, if using Figures 3 and 5 together, to correlate switches from the switch array to the LEDs of Figure 9, since there are 576 switches in the array and 9 LEDs shown, and yet, each LED is operated by “a corresponding switch” that controls power to the LED.

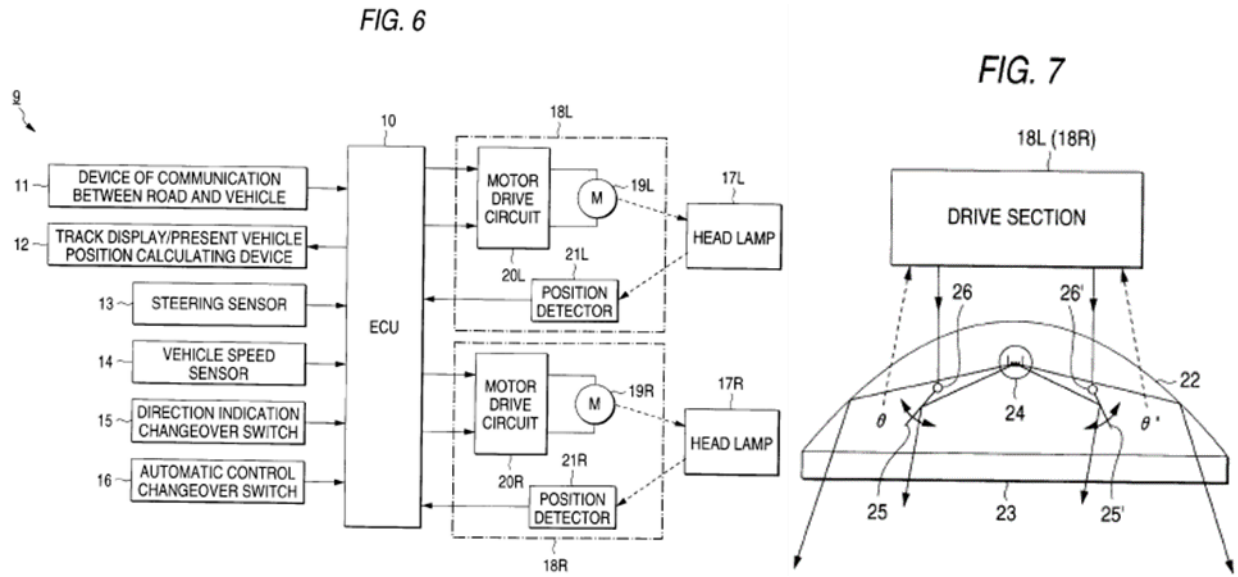
75. Notably, Alden contacted Gentex Corporation, an automotive industry supplier, regarding his segmented headlight system and was informed that Gentex’s technical staff had determined the system to be “futuristic” and likely “years away from any practical use.” (Ex. 2006, 39.)

B. Kobayashi

76. Kobayashi is directed to a mechanical headlight control system that changes direction or range of a non-LED headlight beam using map information unless a predicted vehicle travel direction as indicated by a turn indicator, steering angle, 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. 1006, 2:34-36.) 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. 1006, 6:4-10, 17:59-67.)

77. 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. 1006, 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. 1006, 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. 1006, 8:1-32.)



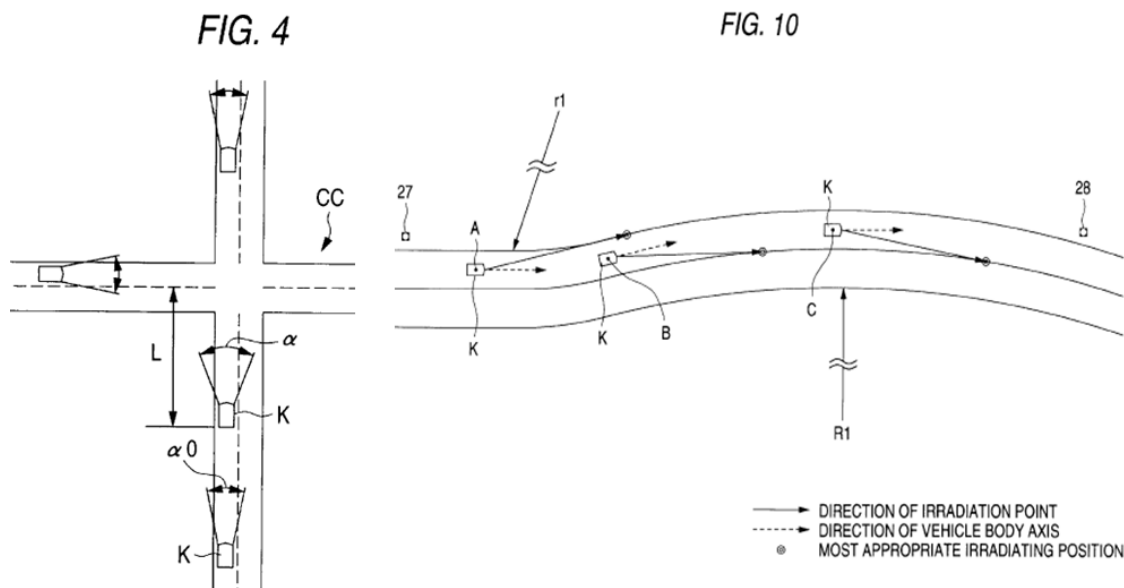
(Ex. 1006, FIGs. 6, 7)

78. 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. 1006, 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. 1006, 10:66-11:4.)

79. 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. 1006, 11:5-14.)

80. 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. 1006, 2:48-49, 2:65-67.)



(Ex. 1006, FIGs. 4, 10)

81. As shown in Figure 4, Kobayashi's headlamp motors are operated to increase horizontal irradiating angle α to $\alpha > \alpha_0$ based on a distance L from intersection CC and vehicle speed. (Ex. 1006, 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. (Ex. 1006, 14:53-15:28.) When the vehicle turns to the left at point A, the left shoulder is irradiated. When the vehicle turns to right at Point B, the right shoulder is irradiated, etc. (Ex. 1006, 8:14-25.) 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. 1006, 14:53-15:39.)

C. Beam

82. Beam discloses “Adaptive/Anti-Blinding Headlights” (AABH) and is directed to a system that provides a multiplicity of microbeams that “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. 1007, 3:8-15, 6:11-12, 6:40-44, 6:54-56.) Beam provides significantly reduced illumination only in those portions of the headlight beam that would otherwise dazzle or annoy other drivers. (Ex. 1007, 3:8-15, 6:40-44.) 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. 1007, 1:14-19, Claims 4, 5.)

XVII. Grounds for Challenge

83. For **Ground 1**, Petitioner combines Alden and Kobayashi to satisfy the elements of claims 1-8, 10-19, 21-30, 32, and 33. Of those, claims 1, 12, and 23 are independent claims, with the remainder depending directly or indirectly from one of those independent claims. For **Ground 2**, Petitioner combines Alden, Kobayashi, and Beam to satisfy the elements of dependent claims 9, 20, and 31, which depend indirectly from independent claims 1, 12, and 23, respectively. In my opinion, Petitioner has failed to show that Alden combined with Kobayashi or that Alden combined with Kobayashi and Beam teaches or discloses all the limitations of the Challenged Claims.

A. Ground 1: Alden-Kobayashi

84. It is my understanding that Petitioner must show where each claim limitation is found in the applied references and that failure to do so defeats a claim of obviousness. It is also my understanding that to establish an obviousness rejection, all of the claimed elements must be taught or suggested by the prior art.

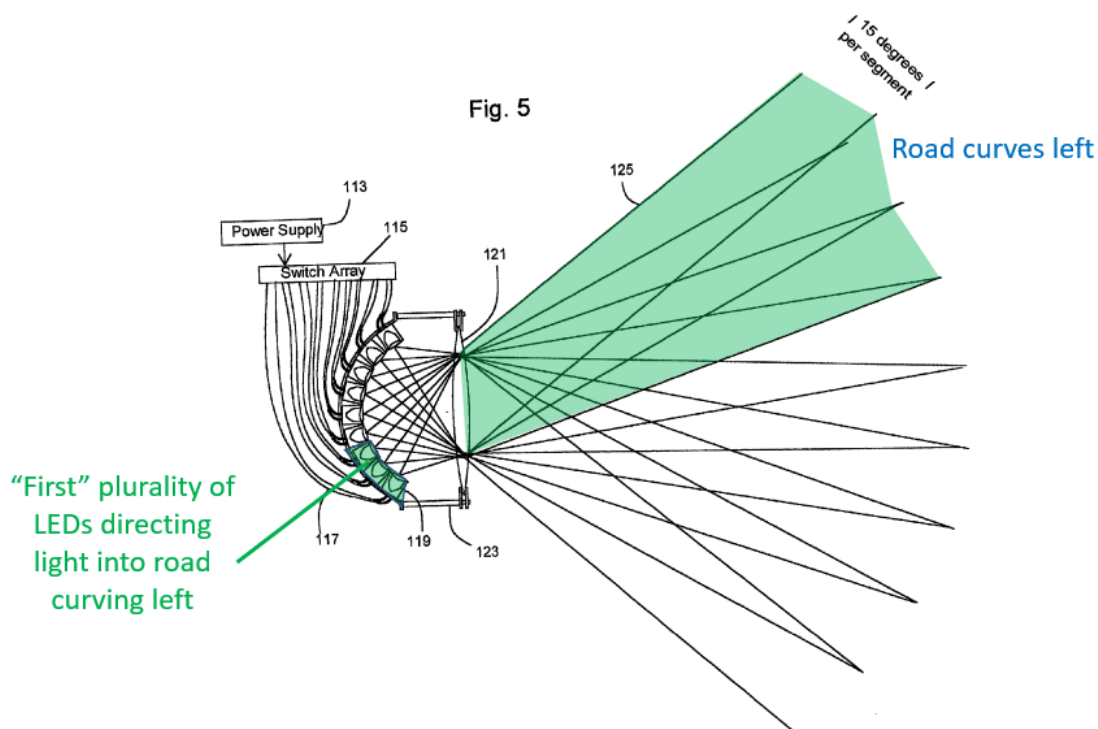
85. It is my understanding that Petitioner must explain how and why a POSA would have modified or combined the prior art and that there must be an articulated reasoning with a rational underpinning to support a legal conclusion of obviousness. It is also my understanding that, if a proposed modification would render the prior art invention being modified unsatisfactory for its intended

purpose, then there is no suggestion or motivation to make the proposed modification. It is still further my understanding that, if a proposed modification or combination of prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are insufficient to render a claim obvious. Petitioner fails to address these issues.

1. Independent Claim 1

a. The Alden-Kobayashi Combination Does Not Teach the Predictive Curve Illumination Limitation

86. Independent claim 1 includes predictive illumination determination elements recited as determine a light change, the change adapting a light pattern of the headlamps in at least one of color, intensity or spatial distribution to increase light in a direction of the road curvature ahead of the motor vehicle. (Ex. 1001, Claim 1.) In its obviousness contention, Petitioner argues that Alden allegedly teaches this limitation, and cites its annotated version of Figure 5 of Alden (Petition at 29), reproduced immediately below:



(Ex. 1005, FIGURE 5, Annotated by Petitioner)

87. Petitioner has annotated Figure 5 of Alden to show the purported operation of headlight 123 for a leftward road curve. According to Petitioner, in the event of a leftward road curve, only a selected first plurality of LED elements 119 configured to illuminate sectors on the left of the distribution area ahead of the equipped vehicle are activated. The remaining LED elements 119 configured to illuminate sectors in the center and on the right of that distribution area are deactivated. (Petition at 28-29.)

88. However, the operation of headlight 123 shown by Petitioner in its annotations is not disclosed in Alden. To the contrary, based on Alden's disclosure, the headlight 123 of Figure 5 would never be operated in such a

fashion. Alden states repeatedly that the primary object of its headlight systems is to maximize the amount of light that the driver of a vehicle equipped with such systems can use, selectively dimming only those sectors of the distribution area illuminated by such systems in which an oncoming vehicle is located to minimize glare for the driver of that oncoming vehicle. (Ex. 1005, ¶¶[0006, 0008, 0026-0027, 0036-0038].) In the headlight system of Figure 5 of Alden, the LED elements 119 of headlight 123 are individually controlled to provide such selective dimming. (Ex. 1005, ¶¶[0025-0026, 0029].)

89. That is, the default operating state of the LED elements 119 in headlight 123 is the emission of high intensity beam segments (*i.e.*, high beam) to provide maximum illumination of the distribution area ahead of the equipped vehicle. Petitioner's expert, Dr. Nikolas Papanikolopoulos, confirmed this fact. (Ex. 2067, 17:3-25.) Only in the event of an oncoming vehicle are the high intensity beam segments emitted by selected LED elements 119 reduced so that those selected LED elements 119 emit low intensity beam segments (*e.g.*, low beam). Thus, contrary to Petitioner's annotation of Figure 5, none of the LED elements 119 of headlight 123 is ever deactivated. (Ex. 1005, ¶¶[0025-0027, 0029].)

90. Thus, in the context of an equipped vehicle traversing a road curve, all the LED elements 119 of headlight 123 in Figure 5 of Alden would operate in their

default state, emitting high intensity beam segments (*i.e.*, high beam) to maximize the amount of light that the driver of the equipped vehicle can use. (Ex. 1005, ¶¶[0006, 0008, 0026, 0036-0038].) Petitioner's expert confirmed such operation. (Ex. 2067, 50:8-15; *see also*, 48:3-15.) Because all LED elements 119 would emit high intensity beam segments (*i.e.*, high beam), there would be no change in the intensity nor the spatial distribution (*e.g.*, depth, width, height) of light produced by the headlight 123. Petitioner's expert confirmed such operation. (Ex. 2067, 50:8-15; *see also*, 48:3-15.) As a result, there would be no adaptation of the light pattern produced by the headlight 123 in intensity or spatial distribution to increase light in a direction of the road curvature, as required by independent claim 1.

91. Even assuming that Petitioner's annotation of Figure 5 of Alden is accurate, which is not conceded, that annotation still fails to illustrate adapting intensity to increase light in the direction of the road curvature, as required by independent claim 1. As previously demonstrated, the default operating state of the LED elements 119 of headlight 123 is the emission of high intensity beam segments (*i.e.*, high beam) to maximize the amount of light that the driver of the equipped vehicle can use. (Ex. 1005, ¶¶[0006, 0008, 0026, 0036-0038].) In the leftward road curve scenario illustrated in Petitioner's annotated Figure 5, those LED elements 119 that were purportedly illuminating the distribution area in directions other than the direction of the curve are deactivated. Those LED

elements 119 purportedly illuminating the distribution area in the direction of the curve continue to emit the same high intensity beam segments (*i.e.*, high beam) as before, thus having the same spatial distribution as before. As a result, there is again no adaptation of the light pattern of the headlight 123 in intensity or spatial distribution to increase light in a direction of the road curvature, as required by independent claim 1.

92. This would be the case even if none of the LED elements 119 of headlight 123 were deactivated (*i.e.*, even if all the LED elements 119 remained activated), because the high intensity of the beam segments (*i.e.*, high beam) emitted by the subset of LED elements 119 illuminating the left distribution area sectors would still never increase nor would their spatial distribution ever change.

93. Moreover, because the primary object of Alden's headlight systems is to maximize the amount of light that the driver of a vehicle equipped with such systems can use, selectively dimming only those sectors of the distribution area illuminated by such systems in which an oncoming vehicle is located, Petitioner's proposed modification of the operation of headlight 123 including LED elements 119 would render the resulting headlight system inoperable or unsatisfactory for its intended purpose and change its principle of operation, making it an unsuitable option. As a result, a POSA would not be motivated to modify operation of the LED headlight 123 of Figure 5 of Alden as proposed by Petitioner. Alden is

therefore insufficient to render the claimed invention obvious, and Petitioner does not cite or rely on Kobayashi in connection with the independent claim 1 limitation relating to increasing light. (Petition 25-27.)

94. Furthermore, the operation of LED headlight 123 of Figure 5 that is illustrated in Figure 11 of Alden (as headlight 155) does not shift or otherwise change the direction of any beam segments emitted by any LED elements 119. Instead, the light produced by headlight 123 is permanently directed toward the distribution area ahead of the equipped vehicle, *i.e.*, in a fixed direction and never re-directed. (Ex. 1005, ¶¶[0025-0026, 0029].) The headlight system of Figure 5 of Alden merely reduces the intensity of beam segments emitted by selected LED elements 119 of headlight 123 from high intensity (*i.e.*, high beam) to low intensity (*e.g.*, low beam) in the event of an oncoming vehicle. (*Id.*)

95. While the headlight system of Figures 8-10 of Alden changes the direction of light emitted by a headlight having a single point light source 129 (Ex. 1005, ¶¶[0029-0040]), as previously demonstrated, each of the embodiments disclosed by Alden is distinct and includes features that are incompatible with the others. Alden discloses “a headlight system which produces high beams in areas where no vehicle is present and concurrently produces low beams in areas where vehicles are present.” (Ex. 1005, Abstract.) As stated in Alden, “All embodiments maximize the areas receiving high beams for the benefit of the equipped vehicle

driver while concurrently all areas with other drivers present receive low beams so as to minimize the glare for [the] betterment of other drivers.” (*Id.*)

96. Three embodiments are disclosed in Alden, each having a different principle of operation to control either (a) intensity or (b) direction of light exiting the headlights to maximize the areas receiving high beams while providing low beams to areas with other drivers present. These include: (i) a first embodiment (Figure 5) with an array of LEDs “individually controlled with regard to intensity to provide dim beam areas and high beam areas concurrently” (Ex. 1005, Abstract; ¶¶[0025-0026], [0029]); (ii) a second embodiment (Figures 6-7) having “electrochromatic elements in array [] individually controlled so as to provide a means to create dim beam areas and high beam areas concurrently” (Ex. 1005, Abstract; ¶[0030-0031]); and (iii) a third embodiment (Figures 8-10) with “variable refractive segments in array [] individually controlled to redirect beam portions such that high beam and dim beam areas are created concurrently” (Ex. 1005, Abstract; ¶¶[0032-0035].)

97. The first embodiment individually controls the intensity of multiple light sources (a row of LEDs shown in Figure 5) to control intensity of headlight beam segments. The intensity of one or more LEDs may be reduced to low beam intensity in response to light detected within a particular area of a corresponding sensor exceeding a threshold (Figures 3-4). The intensity is reduced by reducing

the power from power supply 113 supplied to a corresponding LED 119 via a switch array 115. The array of LEDs is curved along a focal point of a converging double convex lens 121 that distributes light from each LED to a 15-degree segment. (Ex. 1005, ¶¶[0025-0026], [0029].) The light generated by the LEDs is non-collimated light directed forward toward the lens without being reflected from any internal reflectors or passing through any other optical components. The direction and spread of light exiting the headlight is fixed based on the fixed position and distance of each LED 119 relative to the double convex lens 121. Direct illumination from the LEDs without the use of reflectors, filters, or other optical components minimizes losses to maximize optical efficiency, which is important due to the lower lumen output of LEDs compared to conventional incandescent light sources.

98. In contrast to the first embodiment, the second embodiment does not control intensity of the light source to control intensity of headlight beam segments. Rather, as illustrated in Figures 6-7, the second embodiment has a single light source 129 that directs light rearward to a reflector 131 that collimates the light before passing through a planar 2D array of individually controlled electro-optic (more specifically electro-chromatic) elements 127. Intensity is reduced by changing power supplied to each electro-optic element to selectively filter/block some of the light passing through it to produce a low-beam intensity for that

portion of light in response to light detected within a particular area of a corresponding sensor exceeding a threshold. (Ex. 1005, ¶¶[0030-0031].) Collimated light passing through the electro-chromatic elements 127 is distributed by a diverging double-concave lens to maximize the areas receiving high beam light while concurrently producing low beam light where drivers are detected. Blocking of light from source 129 that would directly illuminate element 127, use of reflector 131, passing light through electro-chromatic elements 127, and controlling electro-chromatic elements 127 to filter/block a portion of light all reduce the optical efficiency of light exiting the headlight and therefore require higher lumen output from the single light source 129.

99. Like the second embodiment, the third embodiment (Figures 8-10) does not control intensity of the light source and uses a single light source 129a that directs light rearward to a reflector that collimates the light before passing through a planar 2D array of electro-optic (more specifically liquid crystal) elements. (Ex. 1005, ¶¶[0032-0035].) Furthermore, in contrast to both the first and second embodiments, the third embodiment does not control intensity of light exiting the headlight. Rather, the third embodiment controls the individual electro-optic elements to redirect collimated input light passing through them to “become diverted light 151 (in low beam where a vehicle (not shown) has been sensed) while the light from other segments [is] not diverted (are in high beam) where no

vehicle is sensed.” (*Id.*, ¶[0035].) Like the second embodiment, light passing through the array of electro-optic elements (most of which is collimated) is distributed by a diverging double concave lens.

100. Because the first embodiment uses a significantly different principle of operation and control relative to the second and third embodiments, Alden does not disclose or suggest combining or otherwise modifying these embodiments. Similarly, even if a POSA could rearrange components disclosed by Alden, there is no reason that a POSA would be motivated to do so due to the different principles of operation and corresponding different optical components and control strategies that are not interchangeable or combinable. For example, use of multiple light sources vs. single light source; use of forward facing light sources vs. rearward facing light sources; use of extended, curved light source vs. point light source; use of collimated light and collimating reflector vs. non-collimated light; use of converging double convex lens vs. diverging double concave lens; controlling power supplied to light source(s) vs. controlling power supplied to electro-optic elements, controlling intensity by controlling power to the light source(s) vs. controlling intensity by filtering or redirecting light from the light sources, *etc.*, would limit the modifications or substitutions of components, particularly those of the first embodiment with either the second or third embodiments disclosed by Alden. As a result, a POSA would not be motivated to combine the distinct

embodiments of Alden.

101. The significantly different principle of operation and control among the embodiments disclosed by Alden would constrain available options for reconfiguring, combining, or otherwise modifying any particular embodiment(s), even if a POSA had a motivation to do so. Selection of a particular principle of operation, light source(s), lens, *etc.*, may dictate selection of other components, controls, *etc.*, and functionally or practically foreclose selection of otherwise available options disclosed in another embodiment. For example, selection of an LED light source from the first embodiment (Figure 5) requires multiple LEDs to provide acceptable intensity to maximize the areas receiving high beams while concurrently providing low beams to all areas with other drivers present. The non-collimated, diverging light produced by LEDs requires a converging lens to produce the desired headlight beam. The non-collimated light is not suitable for use with electro-optic elements of the second or third embodiments. Collimating the light from LEDs, or controlling intensity using electro-optic elements, would result in additional losses and require additional LEDs to maximize the areas of high beam light, *etc.* Similarly, other substitutions or reconfigurations -- *e.g.*, of a single light source, or to selection of electro-optic elements to control intensity, or selection of various other aspects -- would impact the functionality of the system and could necessitate a myriad of other modifications to produce an operative

system.

102. As previously noted, the electro-optical refractive elements 147, 149 and double concave lens 133 of the headlight of Figures 8-10 are designed to work with the collimated light produced by single light source 129a and collimating reflector 131 and would be inoperable with the non-collimated light produced by the LED elements 119 of the headlight of Figure 5. Non-collimated light cannot be directed in any meaningful fashion by the electro-optical refractive elements 147, 149 of the headlight of Figures 8-10 of Alden. Rather, non-collimated light would blend and have different incident angles on those electro-optical refractive elements 147, 149 thereby preventing any meaningful control of individual sectors as well as redirecting much of the non-collimated light they receive away from the desired sectors of the distribution area. The result of any combination thereof would therefore be incapable of meeting the basic requirements of a headlight, *i.e.*, effectively illuminating the area ahead of the equipped vehicle, let alone directing its emitted light in any meaningful fashion. (*See, §X.A., supra.*) Any combination of Alden's incompatible embodiments would thus render the resulting headlight system inoperable or unsatisfactory for its intended purpose and changes its principle of operation, making it an unsuitable option. The incompatibility of Alden's different embodiments is applicable to all Challenged Claims, *e.g.*, independent claims 1/12/23 and dependent claims 10/11/21/22/32/33, where

Petitioner's obviousness contentions rely on any combination or combinations thereof, such as a combination of the headlight system of Figure 5 with that of Figures 8-10.

103. It is my understanding that Petitioner cannot treat the various features of Alden's embodiments as interchangeable. Instead, it is my understanding that Alden's disclosure must support any contention of interchangeability. It is also my understanding that extrinsic evidence, such as an expert declaration, on what Alden's different embodiments could include or would accommodate is not the same as what Alden specifically discloses, and that a sufficient rationale to combine Alden's different embodiments must be provided.

104. As a result, it is only by mischaracterizing the operation of the headlight system of Figure 5 of Alden that Petitioner can contend that it allegedly teaches the independent claim 1 limitation *adapting a light pattern of the headlamps in . . . intensity or spatial distribution to increase light in a direction of the road curvature*. The headlight system of Figure 5 of Alden does not teach this limitation.

b. The Alden-Kobayashi Combination Does Not Teach the Control Limitation

105. Independent claim 1 also includes the Control Limitation recited as control at least a first plurality of the LED light sources to provide light based at

least in part on the determined light change and prior to the motor vehicle reaching the road curvature. Petitioner first contends that Alden teaches the Control Limitation of independent claim 1 because it allegedly discusses the detection of an upcoming road curve in connection with the headlight system of Figure 11 thereof. (Petition at 29-30.)

106. In connection with Figure 11, Alden states that “an equipped vehicle 153 senses that the road turns by receiving light from reflectors, such as a reflector 157” and does not teach that such sensing occurs prior to the equipped vehicle entering the turn. (Ex. 1005, ¶[0036].) Similarly, Alden’s statement that “[t]he responding headlights 155 direct light into the corner to maximize the driver’s ability to see there” is also not a teaching that such re-direction of light occurs prior to the equipped vehicle entering the turn. (*Id.*)

107. Even assuming that Alden discusses detection of an upcoming curve, which is not conceded, detection of an upcoming curve is neither the same as nor a teaching of re-directing the light produced by the headlight of that embodiment, nor re-directing that light prior to the equipped vehicle entering that curve.

108. Alden does not discuss the timing of the re-direction of the light emitted by headlights 155 in connection with Figure 11. (Ex. 1005, ¶[0036].) The only discussion of the timing of the re-direction of light occurs in connection with Figures 14 and 15, where Alden states “[a]s the steering wheel 191 rotates ‘x’

degrees, rotation sensor 193 detects the rotation” and “[t]he system calculates the new direction of the vehicle and changes the direction of the headlight output 197 a corresponding “f(x)” degrees.” (Ex. 1005, ¶[0040].) Thus, in the headlight system of Figure 11 of Alden, any re-direction of the light emitted by headlights 155 does not occur until the steering wheel is turned when the equipped vehicle enters the curve. Alden therefore fails to teach the independent claim 1 Control Limitation of *control at least a first plurality of the LED light sources to provide light based at least in part on the determined light change and prior to the motor vehicle reaching the road curvature.*

109. Kobayashi also fails to teach the Control Limitation of independent claim 1. In connection with the discussion of Figure 10 depicting a vehicle K traversing a curved road, Kobayashi expressly states: “As shown at point A in FIG. 10, when the vehicle turns to the left, the left shoulder is illuminated.” (Ex. 1006, 15:21-22, (emphasis added), Figure 10.) Thus, for the road curve in Figure 10 having a radius of curvature r_1 , re-direction of the light emitted by the headlights of Kobayashi’s vehicle K does not occur until the vehicle enters that curve at point A. In that same discussion of Figure 10, Kobayashi subsequently expressly states: “When the vehicle turns to right, the right shoulder is irradiated.” (Ex. 1006, 15:22-23, Figure 10.) Thus, for the road curve in Figure 10 having a radius of curvature R_1 , re-direction of the light emitted by the headlights of Kobayashi’s vehicle K

does not occur until the vehicle enters that curve at point B. Therefore, Petitioner's assertion that this language from Kobayashi supports a conclusion that Kobayashi teaches re-directing light emitted by the headlights of the vehicle K in advance of a road curve is incorrect.

110. Kobayashi's discussion of controlling the (lateral) range of light emitted by vehicle headlights relates only to road intersections (also referred to as branches), which Kobayashi expressly distinguishes from road curves. (Ex. 1006, 14:53-16:56, Figure 11.)

111. Like Alden, Kobayashi fails to teach the independent claim 1 Control Limitation of control at least a first plurality of the LED light sources to provide light based at least in part on the determined light change and prior to the motor vehicle reaching the road curvature. Because neither Alden nor Kobayashi teaches the Control Limitation of independent claim 1, any combination of those references would fail to result in the claimed invention recited therein.

2. Independent Claim 12

a. The Alden-Kobayashi Combination Does Not Teach the Predictive Curve Illumination Limitation

112. Like independent claim 1, independent claim 12 includes a Predictive Curve Illumination Limitation, recited as determine a light change, the change adapting a light pattern of the headlamps in at least one of color, intensity or spatial

distribution to increase light in a direction of the road curvature ahead of the motor vehicle. Petitioner's obviousness contentions relating to independent claim 12 are the same as those relating to independent claim 1, i.e., that independent claim 12 is an obvious combination of Alden and Kobayashi.

113. For the same reasons set forth above in connection with independent claim 1, neither Alden nor Kobayashi teaches the Predictive Curve Illumination Limitation of independent claim 12 as it relates to adapting a light pattern to increase light in a direction of the road curvature. Because neither Alden nor Kobayashi teaches these independent claim 12 limitations, any combination of those references would fail to result in the claimed invention recited therein. (*See*, §IX.A.1.a., *supra*.)

b. The Alden-Kobayashi Combination Does Not Teach the Control Limitation

114. Like independent claim 1, independent claim 12 also includes a Control Limitation, recited as control at least a first plurality of the LED light sources to provide light based at least in part on the determined light change and prior to the motor vehicle reaching the road curvature. Petitioner's obviousness contentions relating to independent claim 12 are the same as those relating to independent claim 1, i.e., that independent claim 12 is an obvious combination of Alden and Kobayashi.

115. For the same reasons set forth above in connection with independent claim 1, neither Alden nor Kobayashi teaches the Control Limitation of independent claim 12 as it relates to control of LED light sources based on the determined light change prior to the motor vehicle reaching the road curvature. Because neither Alden nor Kobayashi teaches these independent claim 12 limitations, any combination of those references would fail to result in the claimed invention recited therein. (*See*, §IX.A.1.b., *supra*.)

3. Independent Claim 23

a. The Alden-Kobayashi Combination Does Not Teach the Predictive Curve Illumination Limitation

116. Like independent claim 1, independent claim 23 includes a Predictive Curve Illumination Limitation, namely, determining a light output, the output adapting a light pattern of the headlamps in at least one of color, intensity or spatial distribution to increase light in a direction associated with the [road] shape change ahead of the motor vehicle. (Ex. 1001, Claim 23.) Petitioner's obviousness contentions relating to independent claim 23 are the same as those relating to independent claim 1, i.e., that independent claim 23 is an obvious combination of Alden and Kobayashi.

117. For the same reasons set forth above in connection with independent claim 1, neither Alden nor Kobayashi teaches the Predictive Curve Illumination

Limitation of independent claim 12 as it relates to adapting a light pattern to increase light in a direction of the road shape change. Because neither Alden nor Kobayashi teaches these independent claim 12 limitations, any combination of those references would fail to result in the claimed invention recited therein. (*See*, §IX.A.1.a., *supra*.)

b. The Alden-Kobayashi Combination Does Not Teach the Control Limitation

118. Like independent claim 1, independent claim 23 also includes a Control Limitation, recited as prior to reaching the road shape change, causing at least a first plurality of the LED light sources to provide light based at least in part on the determined light output. Petitioner's obviousness contentions relating to independent claim 23 are the same as those relating to independent claim 1, i.e., that independent claim 23 is an obvious combination of Alden and Kobayashi.

119. For the same reasons set forth above in connection with independent claim 1, neither Alden nor Kobayashi teaches the Control Limitation of independent claim 23 as it relates to causing LED light sources to provide light based on the determined light change prior to reaching the road shape change. Because neither Alden nor Kobayashi teaches these independent claim 23 limitations, any combination of those references would fail to result in the claimed invention recited therein. (*See*, §IX.A.1.b., *supra*.)

4. Dependent Claims 5/16/27: The Alden-Kobayashi Combination Does Not Teach the Claim Limitation *the increase of light in the direction of the road curvature includes at least an increase of light emitted at a level below high-beam light and directed in the direction of the road curvature*

120. Dependent claims 5/16/27 depend directly from independent claims 1/12/23, respectively, and require that the increase of light in the direction of the road curvature or road shape change required by those independent claims includes an increase of light emitted at an intensity below high-beam. Such limitations as set forth in dependent claim 5 are representative of similar limitations recited in dependent claims 16/27. In that regard, dependent claim 5 recites *wherein the increase of light in the direction of the road curvature includes at least an increase of light emitted at a level below high-beam light and directed in the direction of the road curvature*. (Ex. 1001, Claims 5/16/27.)

121. In its contention that Alden allegedly teaches this limitation, Petitioner cites the statement in Alden that its segmented light distribution system may provide illumination to independently controlled segments each operable within a range of intensities between high-beam and low-beam. (Petition 42; Ex. 1005, ¶[0061].) According to Petitioner, a POSA would therefore be motivated to modify the headlight system of Figure 5 of Alden on an equipped vehicle traversing a road curve to control the LED elements 119 of headlight 123 to emit increased light

below high-beam in the direction of the curve that would allow the driver of the equipped vehicle to sufficiently see the curve while not blinding a potential oncoming vehicle that is not yet visible to that driver. (Petition, 42-43.)

122. Petitioner's proposed operation of the headlight 123 of Figure 5 is contrary to Alden's disclosure. The headlight 123 of Figure 5 would never be operated as proposed by Petitioner because such operation would be contrary to its primary object, and thus is not disclosed in Alden. Alden states repeatedly that the primary object of its headlight systems is to maximize the amount of light that the driver of a vehicle equipped with such systems can use, selectively dimming only those sectors of the distribution area illuminated by such systems in which an oncoming vehicle is located to minimize glare for the driver of that oncoming vehicle. (Ex. 1005, ¶¶[0006, 0008, 0026-0027, 0036-0038].) In the headlight system of Figure 5 of Alden, the LED elements 119 of headlight 123 are individually controlled to provide such selective dimming. (Ex. 1005, ¶¶[0025-0026, 0029].)

123. The default operating state of the LED elements 119 in headlight 123 is the emission of high intensity beam segments (*i.e.*, high beam) to provide maximum illumination of the distribution area ahead of the equipped vehicle. It is only in the event of an oncoming vehicle that the high intensity beam segments emitted by selected LED elements 119 are reduced so that those selected LED

elements 119 emit low intensity beam segments (*e.g.*, low beam). (Ex. 1005, ¶¶[0025-0027, 0029].)

124. In the context of an equipped vehicle traversing a road curve, all the LED elements 119 of headlight 123 in Figure 5 of Alden would operate in their default state, emitting high intensity beam segments (*i.e.*, high beam) to maximize the amount of light that the driver of the equipped vehicle can use. (Ex. 1005, ¶¶[0006, 0008, 0026, 0036-0038].) Because all LED elements 119 would emit high intensity beam segments (*i.e.*, high beam), there would never be an increase of light emitted at an intensity below high beam in the direction of the road curvature. As a result, there would never be *an increase of light emitted at a level below high-beam light and directed in the direction of the road curvature*, as required by dependent claim 5.

125. Because the primary object of Alden's headlight systems is to maximize the amount of light that the driver of a vehicle equipped with such systems can use, selectively dimming only those sectors of the distribution area illuminated by such systems in which an oncoming vehicle is located, Petitioner's proposed modification of the operation of headlight 123 including LED elements 119 would render the resulting headlight system inoperable or unsatisfactory for its intended purpose and change its principle of operation, making it an unsuitable option. Petitioner also relies solely on Alden and does not cite Kobayashi in

connection with the dependent claim 5 limitation relating to increasing light. As a result, a POSA would not be motivated to modify Alden as proposed by Petitioner.

126. Because neither Alden nor Kobayashi teaches the limitations of dependent claims 5/16/27 noted, any combination of those references would fail to result in the claimed invention as recited therein.

5. Dependent Claims 6/17/28: The Alden-Kobayashi Combination Does Not Teach the Claim Limitations
(i) the second change adapting the light pattern of the headlamps in at least one of color, intensity or spatial distribution to increase light in a direction of the second road curvature ahead of the motor vehicle, and (ii) control at least a second plurality of the LED light sources . . . to provide light based at least in part on the determined second light change and prior to the motor vehicle reaching the second road curvature

127. Dependent claims 6/17/28 depend directly from independent claims 1/12/23, respectively, and include further limitations related to the Predictive Curve Illumination Limitation and the Control Limitation of their respective independent claims and which are directed to features such as a second change, a second road curvature, or a second plurality of LED light sources. Such further limitations as set forth in dependent claim 6 are representative of similar limitations recited in dependent claims 17/28. In that regard, dependent claim 6 recites (i) *the second change adapting the light pattern of the headlamps in at least one of color, intensity or spatial distribution to increase light in a direction of the*

second road curvature ahead of the motor vehicle and (ii) control at least a second plurality of the LED light sources . . . , to provide light based at least in part on the determined second light change and prior to the motor vehicle reaching the second road curvature.

128. Petitioner's obviousness contentions relating to dependent claims 6/17/28 are similar to those relating to independent claims 1/12/23, *i.e.*, that those dependent claims are obvious combinations of Alden and Kobayashi. (Petition, 43-50.) As previously demonstrated, neither Alden nor Kobayashi teaches the Predictive Curve Illumination Limitation and the Control Limitation of independent claims 1/12/23 as they relate to a light change adapting a light pattern to increase light in a direction of the road curvature and control of a plurality of LED light sources based on the determined light change prior to the motor vehicle reaching the road curvature. (See, §IX.A.1., A.2., and A.3., *supra*.) As a result, for the same reasons set forth above in connection with independent claims 1/12/23, Alden and Kobayashi each also fails to teach the further limitations of dependent claims 6/17/28 as they relate to a second light change adapting a light pattern to increase light in a direction of a second road curvature and control a second plurality of LED light sources based on the second light change prior to the motor vehicle reaching the second road curvature. (*Id.*)

129. Because neither Alden nor Kobayashi teaches the further limitations

of dependent claims 6/17/28 noted, any combination of those references would fail to result in the claimed invention as recited therein.

6. Dependent Claims 7/18/29: The Alden-Kobayashi Combination Does Not Teach the Claim Limitations
(i) the increase of light in the direction of the road curvature includes at least one of expansion of the light pattern in the direction of the road curvature or an increase to intensity of light directed in the direction of the road curvature, (ii) a variation to at least one of intensity or color of individual LEDs of the first plurality of LED light sources, and (iii) providing light directed in the direction of the road curvature from an LED not providing light directed in the direction of the road curvature prior to the change

130. Dependent claims 7/18/29 depend directly from independent claims 1/12/23, respectively, and include further limitations similar to the Predictive Curve Illumination Limitation of their respective independent claims and which are directed to features such as providing light in the direction of the road curve from an LED that was not providing such light prior to a determined light change. Such further limitations as set forth in dependent claim 7 are representative of similar limitations recited in dependent claims 18/29. In that regard, dependent claim 7 recites (i) *the increase of light in the direction of the road curvature includes at least one of expansion of the light pattern in the direction of the road curvature or an increase to intensity of light directed in the direction of the road curvature, (ii) a variation to at least one of intensity or color of individual LEDs of*

the first plurality of LED light sources, and (iii) providing light directed in the direction of the road curvature from an LED not providing light directed in the direction of the road curvature prior to the change.

131. Petitioner's obviousness contentions relating to dependent claims 7/18/29 are similar to those relating to independent claims 1/12/23, *i.e.*, that those dependent claims are obvious combinations of Alden and Kobayashi. As previously demonstrated, neither Alden nor Kobayashi teaches the Predictive Curve Illumination Limitation and the Control Limitation of independent claims 1/12/23 as they relate to a light change adapting a light pattern to increase light in a direction of the road curvature and control of a plurality of LED light sources based on the determined light change prior to the motor vehicle reaching the road curvature. (*See*, §IX.A.1., A.2., and A.3., *supra*.) As a result, for the same reasons set forth above in connection with independent claims 1/12/23, Alden and Kobayashi each also fails to teach the further limitations of dependent claims 7/18/29. (*Id.*)

132. Operation of the LED headlight 123 of Figure 5 that is illustrated in Figure 11 of Alden does not slant or otherwise change the direction of any beam segments emitted by any LED elements 119 of headlight 123. As previously demonstrated, the headlight system of Figure 5 of Alden reduces the intensity of beam segments emitted by selected LED elements 119 of headlight 123 from high

intensity (*i.e.*, high beam) to low intensity (*e.g.*, low beam) in the event of an oncoming vehicle. While the headlight system of Figures 8-10 of Alden changes the direction of light emitted by a headlight having a single point light source 129 (Ex. 1005, ¶¶0029-0040)], as previously demonstrated, each of the embodiments disclosed by Alden is distinct and includes features that are incompatible with the others. Any combination of Alden's incompatible embodiments would thus render the resulting headlight system inoperable or unsatisfactory for its intended purpose and changes its principle of operation, making it an unsuitable option.

133. Because neither Alden nor Kobayashi teaches the further limitations of dependent claims 7/18/29 noted, any combination of those references would fail to result in the claimed invention as recited therein. Petitioner's obviousness contentions relating to dependent claims 7/18/29 therefore also fail. *See, e.g., Kinetic Concepts*, 688 F.3d at 1361; *In re Royka*, 490 F.2d 981.

7. Dependent Claims 8/19/30

- a. The Alden-Kobayashi Combination Does Not Teach the Claim Limitations *control . . . a second plurality of LED light sources providing light directed toward an area including at least a portion of the other vehicle to diminish glare to a driver of the other vehicle by a decrease to intensity of light directed towards and illuminating the area, that light having lower intensity compared to light directed towards points laterally adjacent the area to either side***

134. Dependent claims 8/19/30 depend directly from independent claims 1/12/23 and require diminishing glare to a driver of another vehicle by a decrease to the intensity of light directed toward the area including the other vehicle compared to light directed laterally adjacent the area. Dependent claims 8/19/30 recite the limitation *control [or controlling] . . . a second plurality of LED light sources providing light directed toward an area including at least a portion of the other vehicle to diminish glare to a driver of the other vehicle by a decrease to intensity of light directed towards and illuminating the area, that light having lower intensity compared to light directed towards points laterally adjacent the area to either side.*

135. Petitioner's obviousness contentions relating to dependent claims 8/19/30 are similar to those relating to independent claims 1/12/23, *i.e.*, that those dependent claims are obvious combinations of Alden and Kobayashi. In its obviousness contentions, Petitioner does not cite Kobayashi but relies only on Alden in connection with the limitations of claims 8/19/30. (Petition, 52-63.)

136. Petitioner's contentions regarding the general and broad functionality of the systems described by Alden assume the specific details needed to implement such functionality and to meet the above-noted limitations of claims 8/19/30. (Petition, 12-33, 52-63.) It is the absence of specific details from Alden's disclosure which demonstrates that Alden fails to teach such claim limitations. The

ambiguity of Alden's disclosure also establishes that it fails to provide an enabling disclosure of such claim limitations.

137. Regarding the Figure 5 LED first embodiment, Alden describes a row of LEDs positioned along the focal point of a lens. (Ex. 1005, ¶[0029]) Alden never mentions any additional rows/columns of LEDs above or below the single row of LEDs shown in Figure 5, let alone any positioning of such rows. (Ex. 1005, ¶[0029].) Alden's depiction of the row of LEDs being positioned along the focal point of the lens undermines a conclusion that the Figure 5 LED embodiment expressly discloses a two-dimensional array; at a minimum, a POSA would conclude that any additional rows, above or below, would still be "positioned along the focal point." (Ex. 1005 ¶[0029], Fig. 5.) When asked, Dr. Papanikolopoulos, explained a variety of configurations and placements of LEDs, none of which are expressly taught in Alden. (Ex. 2066, 35:10-13, 47:7-11.) In addition, in prior testimony, Dr. Papanikolopoulos stated that there were "many variations" of possible placement of rows. (Ex. 2041, 119:9-22.)

138. In his first deposition in a related proceeding, Dr. Papanikolopoulos stated that: 1) Alden's Figure 5 embodiment is a "high-end schematic"; 2) Alden lacks specific details on how the sensing and control elements of Figure 3 inform the operation of the Figure 5 embodiment; 3) Figure 5 requires speculation because "there are a lot of [missing] parameters which come into play: How many LEDs?

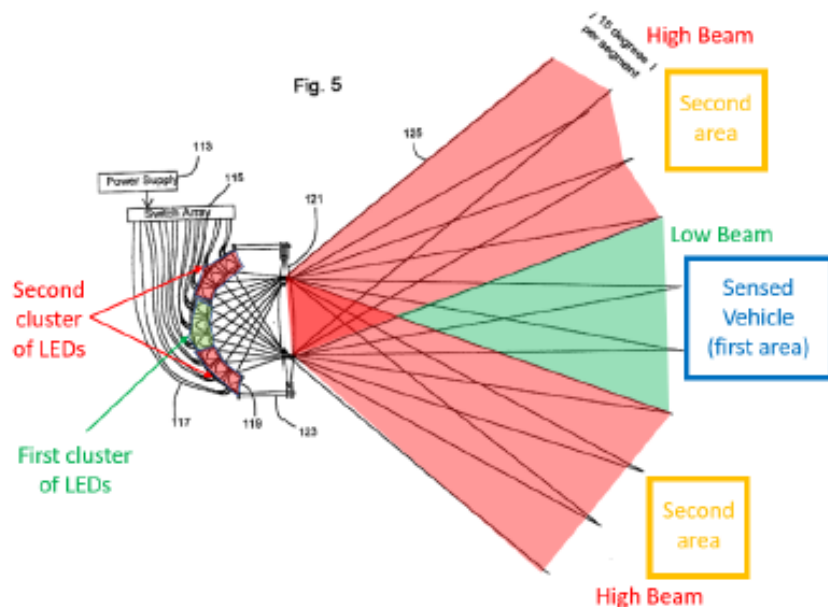
What is the angle, the curvature”; and 4) these missing parameters constrain the expert’s ability to determine the Figure 5 beam shape, number of LED rows, placement of LED rows, *etc.* (Ex. 2041, 56:25-57:3, 108:11-109:5, 112:19-113:3.) Petitioner’s expert indicated that it is “not clear” and could not explain how the switch array shown in Figure 3 controls the LED array shown in Figure 5 to create the beam spread illustrated therein. (Ex. 2041, 108:11-18; 108:23-109:1-5.)

139. In deposition testimony from a related proceeding, Petitioner’s expert identified at least three modifications that would be required of the Figure 5 express teachings. (Ex. 2066,.) A first modification involves increasing the number of LEDs to “reach the lumen output required.” (Ex. 2066, 99:11-100:5.) Second, Petitioner’s expert modified the arrangement of LEDs, by stating that the Figure 5 embodiment “will be multiple -- so think of stacks of this section that are going to form the -- basically, the array of LED elements that corresponds to this control switch which is shown in Figure 3, the element 77 and 79.” (Ex. 2041, 115:25-116:6.) Finally, Petitioner’s expert testified that, “slice to slice,” the LED placement would be adjusted “closer to or further from the lens” to “capitalize on the focal point”. (Ex. 2066, 47:1-19.)

140. The operation of Alden’s LED headlight embodiment shown in Figure 5 is unclear. The Petition takes definitive positions on how the Figure 5 embodiment operates -- including color coding beam segments to explain their

functionality and specifying the location of a vehicle in the beam pattern – but the deposition of Dr. Papanikolopoulos establishes that Petitioner’s contentions are predicated on speculation and/or the need to modify Alden.

141. Petitioner has also mischaracterized Alden’s disclosure. Petitioner contends that the LED headlight of Alden teaches the claimed limitations based on its annotated versions of Figure 5 and the accompanying description in the specification. (Petition, 63.) It is only by rendering the annotated sensed vehicle with a completely inaccurate scale relative to headlight 123 that Petitioner can contend that Alden teaches these claim 8/19/30 elements. Petitioner’s annotated Figure 5 is shown below.



(Petition, 63)

142. As seen in the annotated figure, at the distance shown from the headlight, the annotated oncoming vehicle is too small relative to the size of the

headlight. Indeed, the annotated vehicle has a width less than that of the headlight structure. Petitioner's annotations are therefore clearly inaccurate and, consequently, a mischaracterization of Alden's disclosure. Properly sized at the distance shown relative to the size of the headlight, Petitioner's annotated vehicle would be so large that it would be illuminated by all the beam segments of the headlight. Hence, according to the disclosure of Alden, all the beam segments shown would be dimmed. The annotated scenario illustrated thus fails to satisfy the independent claim 8/19/30 limitations *control [or controlling] . . . a second plurality of LED light sources providing light directed toward an area including at least a portion of the other vehicle to diminish glare to a driver of the other vehicle by a decrease to intensity of light directed towards and illuminating the area, that light having lower intensity compared to light directed towards points laterally adjacent the area to either side.*

b. The Alden-Kobayashi Combination Does Not Teach the Claim Limitations *one or more cameras positioned to capture data indicating at least one other vehicle ahead of the motor vehicle and determine a position associated with the at least one other vehicle based at least in part on second data captured by at least one of the one or more cameras*

143. Dependent claims 8/19/30 also require data from one or more cameras to determine a position of another vehicle. Such limitations as set forth in

dependent claim 8 are representative of similar limitations recited in dependent claims 19/30. In that regard, dependent claim 8 recites *one or more cameras positioned to capture data indicating at least one other vehicle ahead of the motor vehicle and determine a position associated with the at least one other vehicle based at least in part on second data captured by at least one of the one or more cameras.*

144. Petitioner's obviousness contentions relating to dependent claims 8/19/30 are similar to those relating to independent claims 1/12/23, *i.e.*, that those dependent claims are obvious combinations of Alden and Kobayashi. (Petition, 52-63.) Petitioner again does not cite Kobayashi but relies only on Alden in connection with the limitations of claims 8/19/30. (*Id.*, 52-63.)

145. Alden uses a photodiode array (or CCD) to detect photon intensity of headlights ("spots of nearly identical intensity and size representative of the [] headlights"). (Ex. 1005, ¶¶[0026- [0027].) As Figure 4 of Alden shows, this data is simply used for light thresholding purposes, once a light threshold is reached that data is discarded: "Thus (assuming the sensed light is above a threshold intensity or distance) the light sent to the sensed vehicle location is dimmer than the light sent to all other areas of the headlight distribution area. The process then begins again so as to be responsive to changing environmental conditions in real time." (*Id.*, ¶[0027].) As described with respect to Figure 4, the only processing is

of the “amount of light received” above a threshold where “The CPU compares the right map [of amount of light received by each sector] to the left map to determine the distance and intensity of each object sensed in a calculating process 101.” (*Id.*, ¶[0028].)

146. At no point does Alden use or suggest that data from the photodiode array (or CCD) should be used to generate a bounding box around the contours of the vehicle. Moreover, Alden fails to include any teachings associated with detecting the location of the vehicle in the distribution area or providing segmented light distribution based on the location of the vehicle or other objects in the distribution area.

147. Alden lacks a camera that can capture data that can be used by the processor to *determine a position associated with the at least one other vehicle* and then satisfy the claimed lighting controls.

B. Ground 2: Alden-Kobayashi-Beam

1. Dependent Claims 9/20/31: The Alden-Kobayashi-Beam Combination Does Not Teach the Claim Limitations *the control of the second plurality of LED light sources is based at least in part on third data received from a non-camera sensor of the motor vehicle*

148. Dependent claims 9/20/31 require the control or controlling of LED light sources based on data from a non-camera sensor. Dependent claims 9 and 20 each recites that *the control of the second plurality of LED light sources is based at*

least in part on third data received from a non-camera sensor of the motor vehicle.

Dependent claim 31 similarly recites that *the controlling of the second plurality of LED light sources is based at least in part on third data received from a non-camera sensor of the motor vehicle.*

149. Petitioner contends that dependent claims 9/20/31 are an obvious combination of Alden, Kobayashi, and Beam. However, in its obviousness contentions, Petitioner does not cite Beam but relies instead only on Alden and Kobayashi in connection with the limitations of claims 9/20/31 relating to the control or the controlling of LED light sources based on data from a non-camera sensor. More specifically, Petitioner cites Alden's equipped vehicle steering wheel rotation sensor or alternatively Kobayashi's GPS sensor as the *non-camera sensor* providing the data required by dependent claims 9/20/31. (Petition, 70-71.)

150. Dependent claims 9/20/31 depend directly from dependent claims 8/19/30. Dependent claims 8/19 each recites the limitation control . . . a second plurality of LED light sources providing light directed toward an area including at least a portion of the other vehicle to diminish glare to a driver of the other vehicle by a decrease to intensity of light directed towards and illuminating the area. Dependent claim 30 similarly recites the limitation controlling . . . a second plurality of LED light sources providing light directed toward an area including at least a portion of the other vehicle to diminish glare to a driver of the other vehicle

by decreasing intensity of light directed towards and illuminating the area.

151. The limitations *the control* and *the controlling* relating to *the second plurality of LED light sources* recited in dependent claims 9/20/31 refer to the limitations of *control* and *controlling* of *a second plurality of LED light sources* recited in dependent claims 8/19/29. As further recited in dependent claims 8/19/29, such control and controlling must *diminish glare* to the driver of another vehicle *by decreasing intensity of light*.

152. As a result, *the control* and *the controlling* recited in dependent claims 9/20/31 that must be based on data from *a non-camera sensor* is control and controlling of the second plurality of LED light sources to *diminish glare* to the driver of another vehicle *by decreasing intensity of light*. However, neither the vehicle steering wheel rotation sensor of Alden, nor the GPS sensor of Kobayashi provides data that is used to diminish glare to the driver of another vehicle by decreasing intensity of light. Instead, the data provided by Alden's equipped vehicle steering wheel rotation sensor and Kobayashi's GPS sensor is used to re-direct light beams produced by vehicle headlights. (See, e.g., Ex. 1005, ¶[0040]; Ex. 1006, 17:3-50.) Petitioner admits that the control performed on light sources by Alden's equipped vehicle steering wheel rotation sensor and Kobayashi's GPS sensor is changing or adjusting their direction. (Petition, 70-71.)

153. Neither Alden nor Kobayashi teaches the dependent claim 9 and 20

limitation the control of the second plurality of LED light sources is based at least in part on third data received from a non-camera sensor of the motor vehicle. Similarly, neither Alden nor Kobayashi teaches the claim 31 limitation the controlling of the second plurality of LED light sources is based at least in part on third data received from a non-camera sensor of the motor vehicle. Petitioner does not cite Beam but relies instead only on Alden and Kobayashi in connection with the limitations of claims 9/20/31 relating to the control or the controlling of LED light sources based on data from a non-camera sensor. Because neither Alden nor Kobayashi teaches such limitations, and because Petitioner does not explain any reliance on Beam, any combination of Alden, Kobayashi, and Beam would fail to result in the claimed invention recited in dependent claims 9/20/31.

2. Dependent Claims 9/20/31: The Alden-Kobayashi-Beam Combination Does Not Teach the Claim Limitations *the control of the second plurality of LED light sources additionally includes termination of light from at least one LED providing light directed to the area prior to the termination*

154. Dependent claims 9/20/31 also require the control or controlling of LED light sources includes termination of light from at least one LED. Dependent claims 9 and 20 each recites that *the control of the second plurality of LED light sources additionally includes termination of light from at least one LED providing light directed to the area prior to the termination*. Dependent claim 31 similarly

recites that *the controlling of the second plurality of LED light sources additionally includes termination of light from at least one LED providing light directed to the area prior to the termination.* (Ex. 1001, Claims 9/20/31.)

155. Petitioner contends that dependent claims 9/20/31 are an obvious combination of Alden, Kobayashi, and Beam. (Petition, 68-79.) However, in its obviousness contentions, Petitioner does not cite Kobayashi but relies instead only on Alden and Beam in connection with the limitations of claims 9/20/31 relating to the termination of light from an LED. (*Id.*, 75-78.)

156. Petitioner first argues that because the LEDs 119 of Figure 5 can be operated in a range of intensities between high beam and low beam states, a POSA would have understood such a range to include operating at an intensity of zero. (Petition 75.) Contrary to Petitioner's contention, a range of intensities between high beam and low beam does not include zero.

157. The default operating state of the LED elements 119 in headlight 123 of Alden is the emission of high intensity beam segments (*i.e.*, high beam) to provide maximum illumination of the distribution area ahead of the equipped vehicle. (Ex. 1005, ¶¶[0025-0027, 0029].) Petitioner's expert confirmed this fact. (Ex. 2067, 17:3-25.) Only in the event of an oncoming vehicle are the high intensity beam segments emitted by selected LED elements 119 reduced so that those selected LED elements 119 emit low intensity beam segments (*e.g.*, low

beam). Contrary to Petitioner's annotation of Figure 5, none of the LED elements 119 of headlight 123 is ever deactivated. (Ex. 1005, ¶¶[0025-0027, 0029].)

158. Petitioner next argues that Beam discloses terminating selected individually controlled light sources of a headlight. (Petition, 76-77.) Once again, the primary object of Alden's headlight systems is to maximize the amount of light that the driver of a vehicle equipped with such systems can use, only dimming selected light segments illuminating those sectors of the distribution area in which an oncoming vehicle is located. As a result, Petitioner's proposed modification to the headlight 123 of Alden according to the teaching of Beam to operate certain LED elements 119 at zero intensity (i.e., deactivate) rather than selectively dimming those LED elements 119 as explicitly disclosed by Alden would render the resulting headlight system inoperable or unsatisfactory for its intended purpose and change its principle of operation, making it an unsuitable option. As a result, Petitioner's proposed modification to deactivate LED elements 119 of headlight 123 of Alden according to the teaching of Beam would render the resulting headlight system inoperable or unsatisfactory for its intended purpose and change its principle of operation, making it an unsuitable option. As a result, a POSA would not be motivated to combine Alden and Beam as proposed by Petitioner.

159. Petitioner does not cite Kobayashi but relies instead only on Alden and Beam in connection with the limitations of claims 9/20/31 relating to the

termination of light. (Petition, 75-78.)

C. Ground 1: Alden -Kobayashi (Independent claim 1)

1. Only the “map data” of Kobayashi is included in the combination

160. Kobayashi uses map data to determine the shape of roads via its “profile calculating means”. Kobayashi also includes a separate and distinct “irradiation control means” to determine the direction light should be controlled. While Kobayashi teaches road calculating profile means that provides direction data (e.g. calculated from map data), Petitioner’s combination includes only the map data of Kobayashi. Petitioner explains that Kobayashi “uses [] inputs to automatically adjust the illumination of headlamp 5,” but it never motivates or explains a combination for claim 1 using Kobayashi’s control strategy. Petitioner explains that it “would have been obvious to apply these teachings to Alden **to additionally use map data to identify road curvature** when adapting the LEDs of Alden...” and “Kobayashi **simply discloses an additional known means to detect road curvature: road map data.**” (Petition, 23-24.) Petitioner continues: “A POSITA would have understood the systems to be complimentary, **as both disclose sensor data fed to a controller**, which then controls lighting.” (*Id.*) Petitioner’s proffered expectation of success states “Alden’s controller can already synthesize multiple sources of data ... and **the map data of Kobayashi could be**

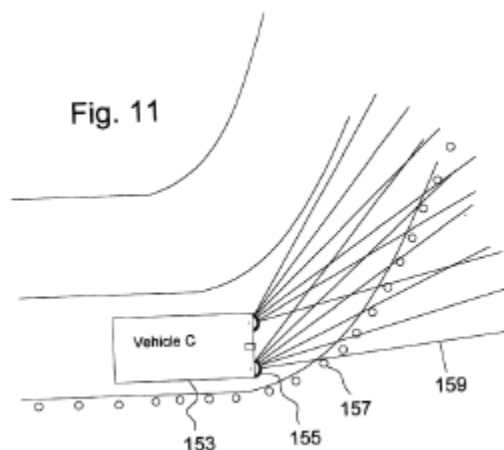
similarly synthesized.” (*Id.*) Finally, Petitioner concludes: “A POSITA would have thus been motivated **to combine the techniques of detecting a road curvature** to maximize successful **detection** in different environments.” (Petition, 25.) Thus, for claim 1 of Petitioner’s combination, all control and planning arguments rely on Alden alone. Kobayashi simply supplies map data to Alden’s control strategy.

2. **Alden-Kobayashi Does Not Teach the Predictive Curve Illumination Limitation**

a. **Alden neither teaches nor enables the ability to increase light in the direction of the road curvature**

161. Independent claim 1 includes the Predictive Curve Illumination Limitation, namely, determine a light change, the change adapting a light pattern of the headlamps in at least one of color, intensity or spatial distribution to increase light in a direction of the road curvature ahead of the motor vehicle. According to Petitioner, Alden’s system “accommodates road curvature ahead of an equipped vehicle by adapting the light pattern to ‘concentrate light to look around corners in response to road conditions.” (Petition, 25.) I note that “accommodates road curvature **ahead of an equipped vehicle**” is not an express teaching of Alden. (*Id.*) While Figure 11 does show a vehicle traveling substantially straight, the vehicle is already within the curve, as shown in Figure 11 below. Though Figure 11 is

probably a generalization, I simply note this discrepancy. Thus, Alden does not state or show a system that “accommodates a road curvature ahead of the vehicle,” as Petitioner contends. (Petition, 25.)



(Petition, 26; Ex. 1005, Figure 11)

162. Regarding the vehicle’s ability to detect the curve based on reflectors, as Dr. Papanikolopoulos explained, Alden does not appear to enable that functionality. In his first deposition for related proceedings IPR2023-01039 and IPR2023-01040 (Ex. 2041), Dr. Papanikolopoulos stated that the “reflectors” in Alden would “have the same appearance on the image like the headlights” and that the system would use the “same logic:”

A: So basically here what is happening, when there is a detection like this, Alden, by using the LEDs described in figure 5 and the corresponding paragraph, makes this dim while the other has full light in order to increase the visibility for the driver.

In figure 11, I believe, the same structural figure 5 can do the dual (phonetic). In other words, I can have dots of the reflectors – instead of having the dots that correspond to the headlights, I have dots that correspond to the reflectors on the side of the road.

So I want to-- as we drive, we want to be able to see this better. So it's going to send as much light as possible to this one by using the same structure.

Q: Okay.

A. So it's the dual problem. Again, one is actually high beam so I don't create glare for the oncoming driver, or **if I'm on a turn the system can use these refractors (sic) by using the same logic of detecting lights** – using the same reflectors in order basically to just have direct LED light in order for the driver to make inferences about the curvature.

(Ex. 2041, 78:16-79:15, emphasis added.)

Dr. Papanikolopoulos further explained:

Q. So using the figure 5 embodiment you're saying that light reflects off these reflectors on the side of the road and the headlamp detects these and then dims those corresponding lights?

A: No. What I'm saying is the following: There are two main use cases in Alden. One is basically headlights maximizing visibility for the driver and minimizing – we discussed this. The second one is actually using the same logic, which is described in figures 3, 4, and

5. I detect that, so my dots here in the figure 3 are going to be the reflectors. The reflectors are going to be something that corresponds – it will have the same appearance on the image like the headlights. So I will have a rectangle like – but instead of having dim light I’m going to have high beam ...

(Ex. 2041, 79:18-80:12.)

163. Alden does not teach any logic for determining the difference between headlights and reflectors, and as Dr. Papanikolopoulos notes, he understands the reflectors to “have the same appearance on the image like the headlights.” (Ex. 2041, 80:7-8.)

164. Thus, without knowing the difference between vehicles and reflectors, and absent a teaching to help differentiate between the two, Alden cannot determine whether it should dim in response to detected light per the Figure 5 embodiment or perform curve-accommodation per Figure 11, to form “concentrated” high-beam emission. Alden lacks any ability to determine whether detected light is a reflector indicative of a curve, which warrants curve-emission, or detected light indicative of a vehicle, which warrants glare reduction.

b. The proposed combination defeats Alden’s primary goal with no reasonable explanation for why a POSA would do so

165. Regarding Alden’s default state, Petitioner’s expert also confirmed the headlamp in the Figure 5 embodiment is already capable of illuminating turns:

Q: So farther down below in that paragraph, you have a sentence here, “Further a POSITA would have understood from Alden that when positioning LEDs along the curve structure in the headlamp, such as shown in Figure 5, LEDs could be positioned to ensure that the beam created by the headlamp is sufficiently wide to illuminate turns.” Do you see that?

A: Yes.

Q: Are you proposing adding additional LEDs to what’s shown in Figure 5 or are you saying that’s what is shown in Figure 5?

A: I say such as shown in Figure 5.

(Ex. 2066, 111:18-112:5.)

And, in another deposition, Dr. Papanikolopoulos explained that when there are no other vehicles present, all LEDs are emitting:

Q: Okay, but in normal driving conditions when there’s no oncoming traffic and no curves, the Figure 5 embodiment would illuminate the full pattern shown in Figure 5, is that correct?

A: Yes.

(Ex. 2067, 17:21-25.)

166. The deposition testimony thus confirms that Alden’s LEDs could be positioned “to ensure that the beam created by the headlamp is sufficiently wide to illuminate turns.” (Ex. 2067, 111:18-112:5.) Thus, a POSA would understand that if a curve were to appear ahead of the vehicle, it would have already been

illuminated by the “sufficiently wide” pattern achieved by illumination of the “full pattern shown in Figure 5.” (Ex. 2067, 111:18-112:5.)

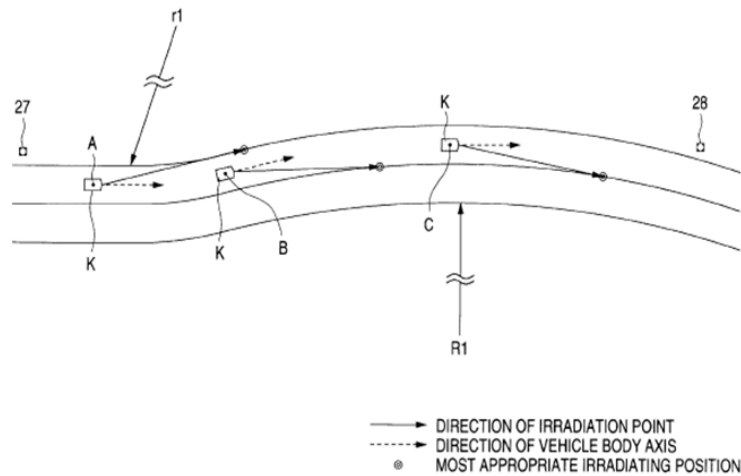
167. Accordingly, I see no evidence that the embodiment of Figure 5 has been shown to “*increase*” illumination prior to the curve, rather, it already includes sufficient LEDs to “ensure that the beam created by the headlamp is sufficiently wide to illuminate turns.” (Ex. 2067, 111:18-112:5.)

**(1) Petitioner’s proposed combination
actually reduces forward illumination
of the roadway**

168. Also, in the placement of the vehicle shown in Figure 11 of Alden, where there is essentially no road ahead of the vehicle, at least the driver’s ability to see **the road** is not substantially impacted by the proposed change to Alden. (Ex. 1005, Figure 11.) If Petitioner’s proposed change was made using Figure 5, it would be done so at a point where the vehicle is in the curve, so that the loss of forward-aimed illumination and rightward (in this example) aimed illumination would have minimal impact on the driver’s view of the roadway.

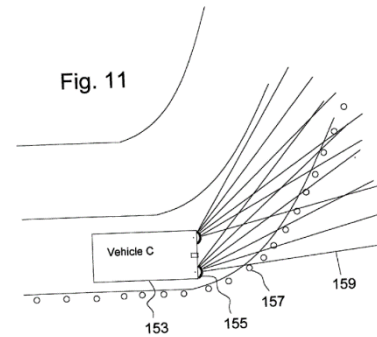
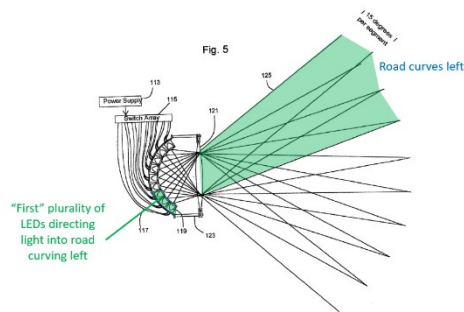
169. That is no longer the case when such changes are performed based on map data as shown in Figure 10 of Kobayashi. Modifying Figure 11 of Alden at the points indicated by Kobayashi’s Figure 10 would negatively impact Alden’s goal of “maximum illumination” when there is still roadway ahead of the driver.

FIG. 10



(Ex. 1006, Figure 10)

170. Kobayashi **shows** a different irradiating direction (solid arrow) from the vehicle traveling direction (dashed arrow). (Ex. 1006, Figure 10; 15:20-23.) Notably, however, Kobayashi **teaches** that the vehicle is turning at point A: “As shown at point A in FIG. 10, when the vehicle turns to left, the left shoulder is irradiated,” (Ex. 1006, 15:21-22) creating some confusion between Figure 10 and the related description. Nonetheless, assuming that what Figure 10 shows occurs, Petitioner is proposing is applying to Figure 10, the pattern shown in Figure 11 of Alden, or, alternatively, the even more aggressively curved pattern shown in Petitioner’s annotated Figure 5. (Petition, 29.)



(Ex. 1006, Figs 5, 11)

171. For this combination, as only the “map data” of Kobayashi is being used, Alden’s processor has to decide what to do with this additional map data. (Petition, 23-25.) According to Petitioner, “Alden would continue to **perform the same control of LEDs to shape the light pattern to direct light into the curve**, only now it would do so based on received map data indicating the road curve.” (*Id.*, 30.) However, if either pattern shown in annotated Figure 5 or Figure 11 was utilized, some amount of forward illumination would be lost. Petitioner explains for Figure 5 that the “controlled ‘first plurality’ of LEDs would be those shaded in green.” (*Id.*, 29.) There is no illumination shown for other LEDs, and rightward forward illumination is missing in Fig. 11.

172. Accordingly, the proposed combination does not match with Alden’s goal of “maximizing the amount of light a driver can use.” As there is road ahead of the driver (in Figure 10 at point A) that the driver needs to see, per Alden’s goals, Petitioner’s proposed use of map data in this manner results in an unsuitable

modification of Alden, placing Kobayashi's irradiation placement goals above Alden's maximum illumination goals, which further raises potential safety concerns.

173. Petitioner also never explains what Alden would do if rotation sensing were included in the combination. For example, at point B of Kobayashi's Figure 10, if the vehicle is steering left and the "curve ahead" is rightwards, it is unclear how the combined system would function and which control goal would prevail. Petitioner proposes that where map data is **less reliable**, steering wheel sensors may be preferred, but there are many reasons to understand why steering would take precedent over map data and Petitioner does not address these issues in its combination. (Petition, 25.) Instead of addressing the complexities associated with adding the map data input, Petitioner imports the map data and assumes that Alden will synthesize the data (Petition, 24.)

174. Notably, Alden has no strategy for control prior to turning. In such instances, the steering "rotation sensor" would be at 0 degrees, and the lamp would be controlled forward in accordance with the vehicle's "calculated" "direction." (Ex. 1005, ¶[0058]). This aligns with Alden's goals of maximum illumination because roadway in a straight direction would still be maximally illuminated. Since the curvature is already illuminated by the lamp, as Petitioner's expert noted above, there is no need to illuminate the curve pre-emptively. When the vehicle

enters the turn, and the wheel turns (as Petitioner states), Petitioner's control change may apply, but not preemptively. Further, because Alden is unable to distinguish between reflectors and headlamps, Alden's teachings fail to support Petitioner's proposed combination.

175. Because the default operating state of the LED elements 119 in headlight 123 is the emission of high intensity beam segments (*i.e.*, high beam) to provide maximum illumination of the distribution area ahead of the equipped vehicle, all light directed to the curve already covers the curve and is all at high beam illumination. In this state, illumination cannot be increased. If anything is modified, it decreases illumination in one way or another.

176. Since Petitioner's proposed combination ultimately reduces the overall illumination and Alden already illuminates curves, in my opinion, the proposed combination lacks motivation to combine, when assessed from the perspective of a POSA.

177. Regarding claims 6/17/28, which include the limitations related to the Predictive Curve Illumination Limitation and the Control Limitation of their respective independent claims 1/12/23, while these claims seem to incorporate a general iterative "technique" of Kobayashi (introduced for the first time in claim 3), iterative control does not automatically provide control prior to reaching the curve. "Road profile calculating means" is different from "irradiation control

means;” the latter decides where to place illumination (Ex.1006, 4:60-5:12.)

178. Petitioner does not combine Kobayashi’s “irradiation control means” with Alden. Accordingly, even if Alden did iteratively control two different turns, Alden’s strategy would not cause such control to occur prior to the vehicle reaching the turn. For example, considering the control shown in the annotated figures, in virtually every location shown in Figure 10 of Kobayashi, were such control implemented prior to the vehicle reaching a curve, the driver would lose illumination of some portion of the road ahead—which would directly conflict with the control attempted in the actual steering direction.

179. Regarding Claims 21 and 32, both claims require use of the control elements to control light in some manner. Claim 21 requires that the processor be able to use the control elements and claim 32 includes “utilizing” the control elements as part of a method. Thus, a simple lens, such as 121, does not control light, as required by claims 21 and 32. Petitioner also offers, as an alternative explanation, use of a “variable refractive element.” (Petition, 66.) The refractive element from the third embodiment in Alden is, however, not suitable for combination with the Figure 5 LED embodiment, as discussed above. As such, the arguments presented fail to meet the limitations of claims 21 and 32.

XVIII. Conclusion

180. 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.

181. 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: April 11, 2024



Matthew A. Turk PhD