

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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VOLKSWAGEN GROUP OF AMERICA, INC.,  
Petitioner,

v.

YECHEZKAL EVAN SPERO,  
Patent Owner.

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

Case No.: IPR2022-01586

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**SECOND DECLARATION OF MATTHEW A. TURK PhD**

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**List of Exhibits**

<b>Exhibit No.</b>	<b>Description</b>
2001	Declaration of Matthew A. Turk, PhD
2002	Curriculum Vitae of Matthew A. Turk, PhD
2003	Petition challenging U.S. Patent No. 11,208,029, <i>Unified Patents, LLC v. Torchlight Technologies LLC</i> IPR2022-01500, Paper 1, September 22, 2022
2004	U.S. 6,406,172 to Harbers
2005	Comparison of Harbers (Ex. 1011) to Harbers '172 (Ex. 2004)
2006	Supplemental Declaration of Matthew A. Turk, PhD
2007	Transcript of Deposition of Jianzhong Jiao, Ph.D. taken on August 2, 2023
2008	Petition challenging U.S. Patent No. 9,995,551, <i>Volkswagen Group of America, Inc. v. Torchlight Technologies LLC</i> IPR2023-00318, Paper 2, December 22, 2022
2009	Declaration of Dr. Jiao, <i>Volkswagen Group of America, Inc. v. Torchlight Technologies LLC</i> IPR2023-00318, Exhibit 1003.
2010	Jianzhong Jiao and Ben Wang, "Etendue Concern for Automotive Headlamp Using LEDs", SPIE Proceedings Vol. 5187, (January 2004) (Available at <a href="https://www.spiedigitallibrary.org/conference-proceedings-of-spie/5187/0000/Etendue-concerns-for-automotive-headlamps-using-white-LEDs/10.1117/12.504363.short">https://www.spiedigitallibrary.org/conference-proceedings-of-spie/5187/0000/Etendue-concerns-for-automotive-headlamps-using-white-LEDs/10.1117/12.504363.short</a> )
2011	Michael Bass, <i>Handbook of Optics</i> 3 <sup>RD</sup> Edition Volume II, (McGraw-Hill, 2010) (Available at <a href="https://www.worldcat.org/title/555545456">https://www.worldcat.org/title/555545456</a> )
2012	Ben Wang and Jianzhong Jiao "Studies for Headlamp Optical Design Using LEDs", SAE Technical Paper Series 2004-01-0434, (March 2004) (Available at <a href="https://www.sae.org/publications/technical-papers/content/2004-01-0434/">https://www.sae.org/publications/technical-papers/content/2004-01-0434/</a> )

<b>Exhibit No.</b>	<b>Description</b>
2013	Ben Wang and Jianzhong Jiao “Optical Transform Limitations in Headlamp Photometric Performance”, SAE Technical Paper Series 2005-01-0861, (April 2005) (Available at <a href="https://www.sae.org/publications/technical-papers/content/2005-01-0861/">https://www.sae.org/publications/technical-papers/content/2005-01-0861/</a> )
2014	LEDs Magazine “Major contributors in LED and lighting standards have led the SSL revolution”, Jianzhong Jiao February 2018. (Available at <a href="https://www.ledsmagazine.com/manufacturing-services-testing/standards/article/16695802/major-contributors-in-led-and-lighting-standards-have-led-the-ssl-revolution-magazine">https://www.ledsmagazine.com/manufacturing-services-testing/standards/article/16695802/major-contributors-in-led-and-lighting-standards-have-led-the-ssl-revolution-magazine</a> )
2015	Jianzhong Jiao and Ben Wang “High-Efficiency Reflector Optics for LED Forward Lighting”, SPIE Proceedings Vol. 6670, (September 2007) (Available at <a href="https://www.spiedigitallibrary.org/conference-proceedings-of-spie/6670/66700M/High-efficiency-reflector-optics-for-LED-automotive-forward-lighting/10.1117/12.730524.short">https://www.spiedigitallibrary.org/conference-proceedings-of-spie/6670/66700M/High-efficiency-reflector-optics-for-LED-automotive-forward-lighting/10.1117/12.730524.short</a> )
2016	Navigant Consulting “Energy Saving Estimates of Light Emitting Diodes in Niche Lighting Applications” Building Technologies Program Office of Energy Efficiency and Renewable Energy U.S. Department of Energy (September 2008) (Available at <a href="#">Energy Savings Estimates of Light Emitting Diodes in Niche Lighting Applications (Technical Report)   OSTI.GOV.</a> )
2017	PCT Publication No. WO 86/05147 to Flaaten

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

2. I am making this second 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 February 28, 2023, submitted as an exhibit (Ex. 2001) with a Patent Owner Preliminary Response of the ’029 Patent to a Petition filed on October 3, 2022 by Petitioner Volkswagen Group of America. I understand that on May 24, 2023, the Board instituted the Petition on all claims and grounds.

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. Jiao. If called upon to do so, I would testify competently thereto. I supplement my prior declaration (Ex. 2001) with this additional declaration to do so.

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

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

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

**I. Qualifications and Professional Experience**

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



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

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

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

winning the ACM Multimedia Open Source Competition in 2015.

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

13. In 2000, I joined the faculty of the University of California, Santa Barbara (UCSB), 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 lighting, including automotive lighting, and lighting-control systems regarding computer vision, computer imaging, human computer interaction,

probabilistic models and methods, artificial intelligence, computer graphics, machine learning, and other areas. My Computer Imaging, Mobile Imaging, Computer Vision, Computer Graphics, and Computational Illumination courses covered the fundamentals of light and optics, camera sensors, imaging geometry, infrared imaging, optical filtering, image processing, 3D imaging, scene understanding, and structured lighting.

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

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

16. In 2019, I became President of the Toyota Technological Institute at Chicago, an independent graduate research institute, where the research and

education focus of the faculty and Ph.D. students is on computer science theory, machine learning, artificial intelligence, and related areas such as computer vision, speech and language processing, robotics, and computational biology.

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

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

and General Chair of the 2019 International Conference on Multimodal Interfaces (ICMI).

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

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

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

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

## **II. Relevant Legal Standards**

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

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

factual inquiries including the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the prior art and the claimed subject matter.

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

### **III. State of the Art as of 2002**

#### **A. POSA Considerations for LED Forward Lighting**

25. While LEDs were being proposed for use in vehicle forward lighting applications to replace conventional light sources such as halogen and high-intensity discharge (HID) light sources, experts in vehicle lighting were uncertain,

even years later in 2004 and beyond, if or when the significant challenges associated with use of LEDs in these applications could be overcome to meet government regulations and industry standards while satisfying vehicle design aesthetics and operational demands.

**B. Regulations and Standards**

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



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

(Ex. 2010<sup>1</sup> at 237.)

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

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

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

(Ex. 2010 at 234.)

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

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

(Ex. 2010 at 237.)

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

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

(Ex. 2011<sup>2</sup> at 40.43.)

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

\* \* \*

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

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<sup>2</sup> Ex. 2011 Michael Bass, *Handbook of Optics* 3<sup>RD</sup> Edition Volume II, (McGraw Hill 2010.) Ex. 2011 is a true and accurate copy of excerpts of a book that I understand was published by McGraw Hill in 2010.

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

(Ex. 2012<sup>3</sup> at 6-7, emphasis added.)

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

(Ex. 2010 at 237-238.)

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

(Ex. 2010 at 234.)

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

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

for use in increasing output light from vehicle headlamps.

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

Michigan Vehicle Code Act 300 of 1949 § 257.698(4)<sup>4</sup>

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

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<sup>4</sup> Available at

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

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

(Ex. 2011 at 18.5.)

### **C. Design Tradeoffs**

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

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

(Ex. 2012 at 4.)

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

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

(Ex. 2010 at 238.)

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

(Ex. 2010 at 240.)

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

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

(Ex. 2012 at 3, emphasis added.)

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

(Ex. 2010 at 238, emphasis added.)

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

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

(Ex. 2010 at 238.)

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

(Ex. 2012 at 4, emphasis added.)

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. 2012 at 3, Abstract.)

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

(Ex. 2012 at 3, emphasis added.)

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

(Ex. 2010 at 242.)

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

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

(Ex. 2012 at 7, emphasis added.)

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

\* \* \*

In order to achieve the high-beam performance (600 lm inside the beam pattern, and 50,000 cd in the hotspot), it **takes 150% larger effective aperture when using LEDs that have equivalent total lumen output as a tungsten halogen bulb** in aperture 8,000 mm<sup>2</sup>.

(Ex. 2012 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. 2012 at 3.)

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

(Ex. 2012 at 10.)

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

(Ex. 2010 at 237.)

## **E. Optical System**

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. 2010 at 240.)

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

(Ex. 2012 at 3.)

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

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

(Ex. 2010 at 234.)

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

\* \* \*

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

\* \* \*

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

\* \* \*

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

(Ex. 2013<sup>5</sup> at 10.)

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

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

(Ex. 2012 at 10, emphasis added.)

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

(Ex. 2012 at 11.)

#### **F. Heat management**

36. The light output from an LED source varies with temperature and decreases as temperature increases. Similarly, the spectral characteristics or color

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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.

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. 2015<sup>6</sup> at 7.)

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

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<sup>6</sup> Jianzhong Jiao and Ben Wang “High-Efficiency Reflector Optics for LED Forward Lighting”, SPIE Proceedings Vol. 6670, published by the International Society for Optics and Photonics (September 2007). Ex. 2015 is a true and accurate copy of a technical paper that I understand was published by SPIE in September 2007.

chip high drive packages this can be easily exceeded and would cause thermal damage to conventional epoxies.

(Ex. 2011, at 18.6.)

### **G. Packaging**

37. Packaging considerations for automotive headlamps presented challenges even years after the earliest priority date of '029 patent. These included the depth required based on longer focal lengths associated with LEDs, multiple LEDs required to achieve required light output at reduced collection efficiency due to extended array, sufficient heat sinks, driver electronics, and other components required for operation while meeting vehicle design aesthetic requirements.

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

(Ex. 2010 at 237.)

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

(Ex. 2012 at 3.)

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

headlamp is also often restricted. As a consequence, the amount of lumen being collected and projected into the beam pattern through the optical system may not be sufficient to meet all the desires.

(Ex. 2010 at 238.)

#### **H. Cost**

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

[T]he added cost of solid-state white lighting has slowed the market acceptance. A common cost comparison is the first cost of a light source, typically measured in terms of the cost per kilolumen (klm). Incandescent and fluorescent light sources fall in the \$0.5 to \$3.00 per klm, while current light emitting diode sources fall easily in the \$20 to \$30 per klm range.

(Ex. 2011 at 18.5.)

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

(Ex. 2016<sup>7</sup> at 66.)

#### **IV. Overview of the '029 patent**

39. 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, 11:5-13.) 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.* at 2:67-3:5.)

40. 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.

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<sup>7</sup> Ex. 2016 Navigant Consulting “Energy Saving Estimates of Light Emitting Diodes in Niche Lighting Applications” Building Technologies Program Office of Energy Efficiency and Renewable Energy U.S. Department of Energy (September 2008). Ex. 2016 is a true and accurate copy of a technical paper that I understand was published by the DOE in September 2008.

(*Id.* at 9:60-63.)

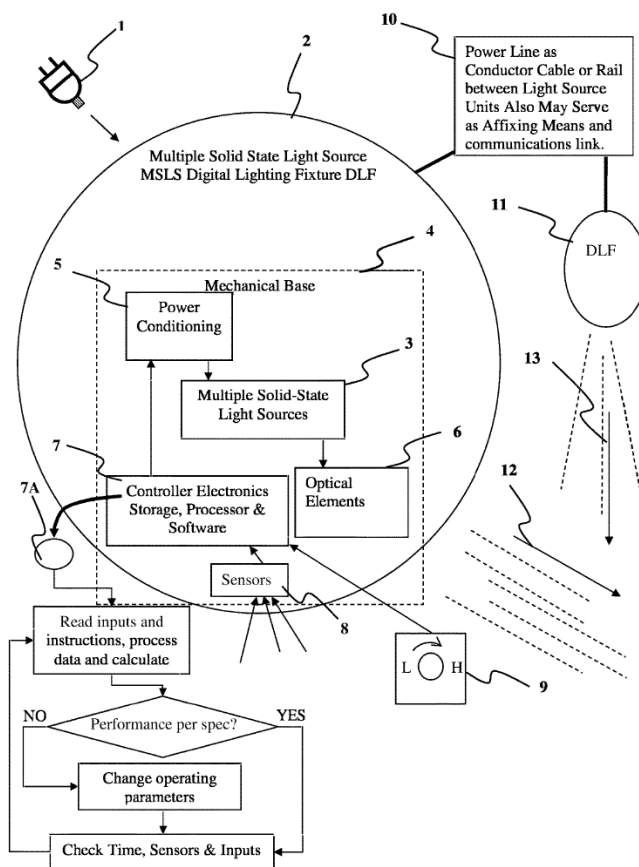


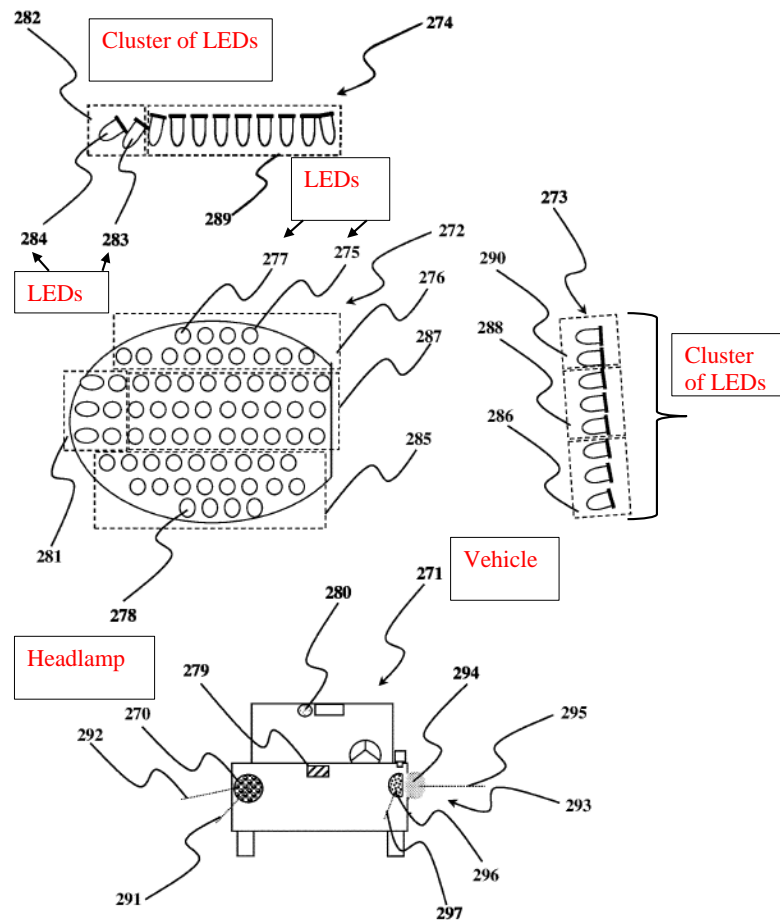
FIG. 1

(Ex. 1001, Fig. 1.)

41. 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.* at 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.* at 25:17-21.)

42. 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.” (*Id.* at 11:5-7.) “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.* at 11:45-49.) “The added controllability offered by breaking the total light output up into **discrete (‘digital’) specifically aimable and dimmable elements** which can be addressed by control electronics to effect intensity, spectrum and spatial distribution of intensity and spectrum, yields a lighting fixture (vs. lamp) of unparalleled performance.” (*Id.* at 11:56-62.) “The invention embraces LED-illuminating devices covering a wide scope of applications,” including transportation. (*Id.* at 11:14-21, 4:18-20, 50:49-50.)



(Ex. 1001, FIG. 15, Annotated)

43. The claimed invention of the '029 Patent, titled “Adaptive Headlight System,” is directed to multi-LED headlight systems that provide predictive curve illumination with the receipt of *map data indicating a road curvature upcoming along a road on which the motor vehicle is traveling*. The '029 claimed invention solves the problem of how to provide a digital lighting solution that can “provide the optimal lighting solution in real-time” to predictively illuminate an upcoming road curvature. (Ex. 1001, 57:43-49.) The '029 Patent describes using a digital light fixture (DLF) to provide multiple functions, for example “[i]n a DLF it is

possible to combine a task light having a very narrow ‘spot’ beam at the correct aiming with a general area lighting ‘flood’ beam into one fixture.” (*Id.* at 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.)

44. 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*:

**A. Challenged Independent Claims**

45. The Challenged Claims include independent claims 1, 12, and 23, which are reproduced below with claim identifiers:

[1.P] A system, for a motor vehicle, comprising:
[1.1] a plurality of headlamps, each comprising a plurality of LED light sources;



<b>[1.2]</b> one or more processors; and
<b>[1.3]</b> a memory storing instructions that, when executed by one or more of the one or more processors, enable the one or more processors to:
<b>[1.4]</b> receive first data, including at least map data, indicating a road curvature upcoming along a road on which the motor vehicle is traveling;
<b>[1.5]</b> 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
<b>[1.6]</b> 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.
<b>[12.P]</b> A non-transitory computer-readable storage medium, storing instructions that, when executed by one or more processors of a motor vehicle that includes a plurality of headlamps that each comprise a plurality of LED light sources, enable the one or more processors to:

[12.4]<sup>8</sup> receive first data, including at least map data, indicating a road curvature upcoming along a road on which the motor vehicle is traveling;

[12.5] 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

[12.6] 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.

[23.P] A computer-implemented method for adapting light from headlamps of a motor vehicle to accommodate road shape changes, the headlamps including a plurality of LED light sources, comprising:

[23.4] determining an upcoming shape change of a road, ahead of the motor vehicle, based on first data, including map data, indicating the shape change;

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<sup>8</sup> I'm using the same claim identifiers as VW's Expert, however he did not explain why he skipped claim identifiers [12.1] - [12.3] and [23.1] – [23.3] in the sequence. (See Ex. 1001, ¶65.)

[23.5] 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 shape change ahead of the motor vehicle and shaping light based on the shape change; and

[23.6] 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.

46. The '029 Patent describes multiple 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.) More specifically, these systems predict upcoming curves in the road based on “instantaneous road conditions” and map data. (*Id.* at 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 [sp] 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.*)

**B. Qualifications of one of ordinary skill in the art**

47. I have been asked to provide my opinion as to the level of skill of a person having ordinary skill in the art (“POSA”) of the ’029 Patent at the time of the claimed invention. In determining the characteristics of a hypothetical person of ordinary skill in the art of the ’029 Patent at the time of the claimed invention, I was told to consider several factors, including the type of problems encountered in the art, the solutions to those problems, the rapidity with which innovations are made in the field, the sophistication of the technology, and the education level of active workers in the field. I also placed myself back in the time frame of the claimed invention and considered the skill level of colleagues with whom I had worked at that time.

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

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

(Petition at 10.)

49. I understand that Patent Owner accepts Petitioner’s proposed level of ordinary skill in the art. At the time of filing of the priority application of the ’029

Patent, a skilled artisan developing a lighting system utilizing LEDs and corresponding controls would have encountered new challenges with respect to both optics and LED controls. Accordingly, it is my opinion that a POSA would have had experience with both, i.e., engineering and optics.

**C. Proposed claim constructions**

50. In order 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 do not include any terms that require specific construction. Instead, each of the claims includes terms that an ordinary artisan would understand according to their plain and ordinary meaning.

**V. Overview of the prior art**

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

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

systems which attempt to control the intensity profile of the beam by using a reflector or lens shaped to control the output beam in some predetermined way; systems to move the headlamps in response to changes that occur to the automobile on which they are mounted; . . .

movement of headlight beams in response to changes in the vehicle's steering mechanism, etc.

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

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

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

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

\* \* \*

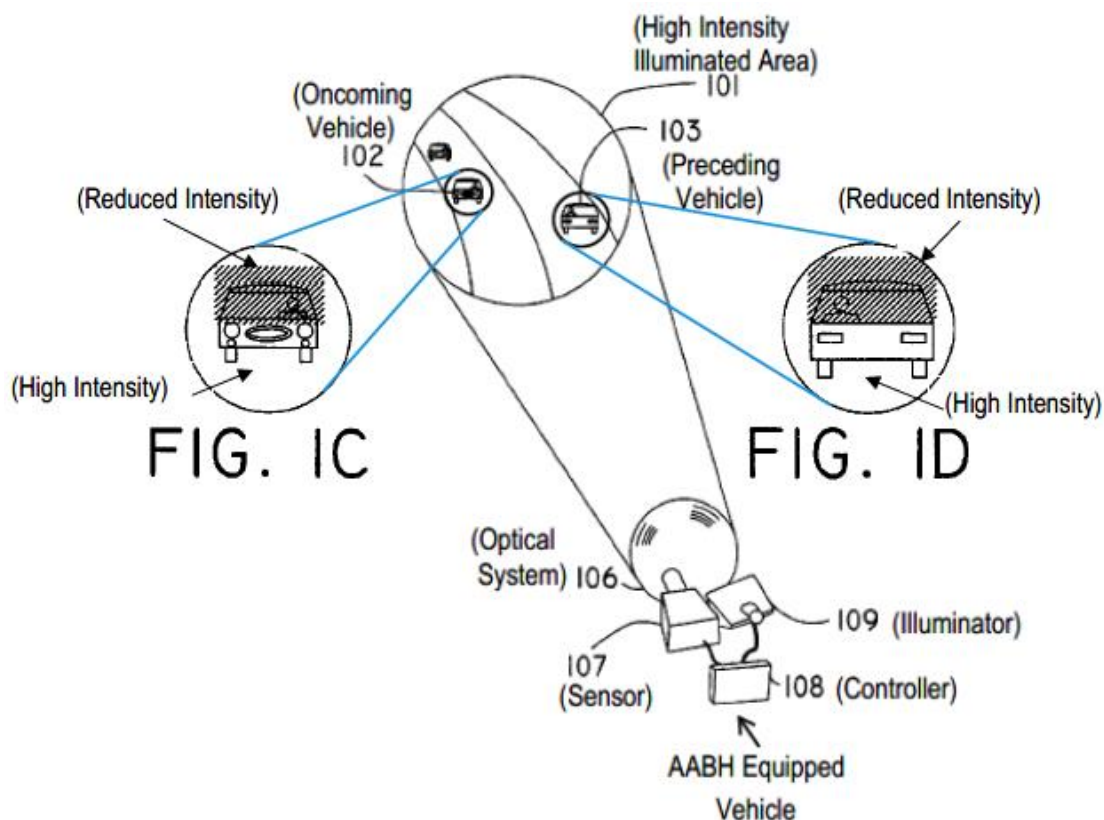
Accordingly, several objects and advantages of this invention are to provide greatly improved safety and comfort to the motoring public, in particular, and to others who may be affected by them by providing the driver of an automobile equipped with the instant invention with a far brighter headlight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

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

53. A POSA would have understood that Beam teaches providing a high beam operating at maximum intensity at all times in the illuminated region, other

than any areas around detected light sources from other vehicles.

54. Beam provides significantly **reduced** illumination only in those portions of the headlight beam that would otherwise dazzle or annoy other drivers. This is accomplished by “darken[ing] those microbeams that would otherwise illuminate areas near to the source of the impinging beam, thus eliminating the blinding of a driver in an oncoming vehicle, while continuing to provide intense forward illumination.” (Ex. 1005, 1:15-19, Claims 4, 5, emphasis added.) While Beam discloses blanking or darkening microbeams that would otherwise dazzle other drivers, it does not disclose or teach changing direction of any microbeams exiting the lamp.

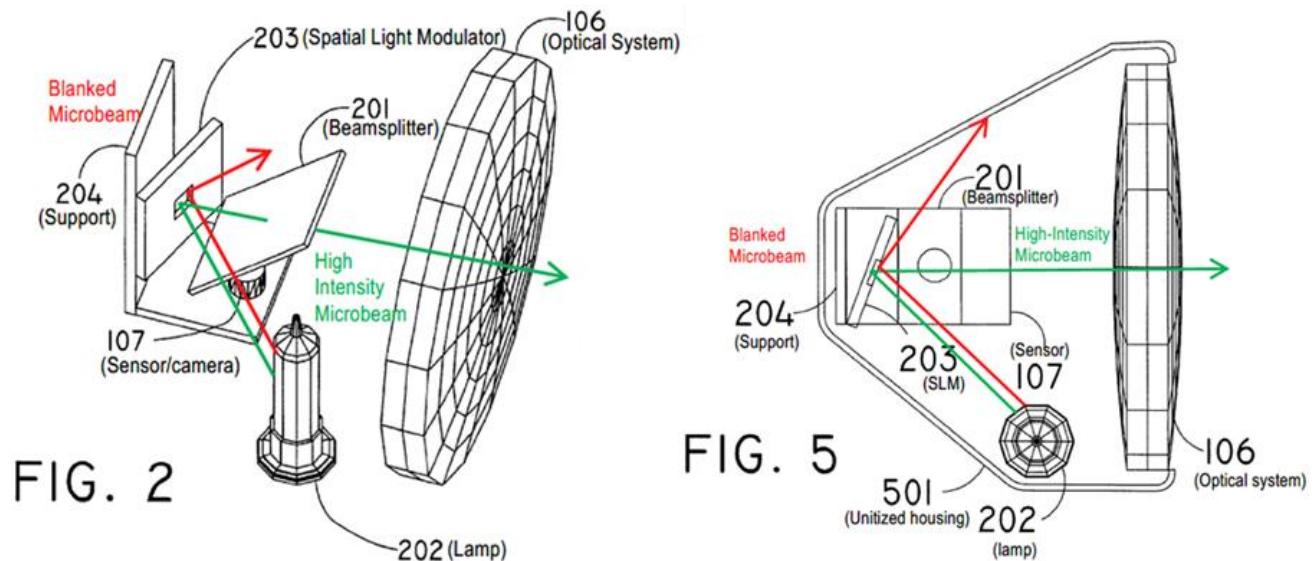


**(Ex. 1005, FIG. 1C, 1D, Annotated)**

55. In the AABH system, illuminator 109 projects individually controlled narrow-angle microbeams to provide high-intensity illumination of illuminated area 101. Headlights of an oncoming vehicle 102 and/or taillights of a preceding vehicle 103 are transmitted through optical system 106 and detected by a sensor (camera) 107. Data from sensor 107 is used by controller 108 to map the “angular position of the vehicles ahead” to a corresponding position/size of microbeams that must be significantly reduced in intensity corresponding to the shaded areas shown for oncoming vehicle 102 in Fig. 1C, and preceding vehicle 103 in Fig. 1D. (Ex. 1005, 4:9-24, 53-59, 62-64.)



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

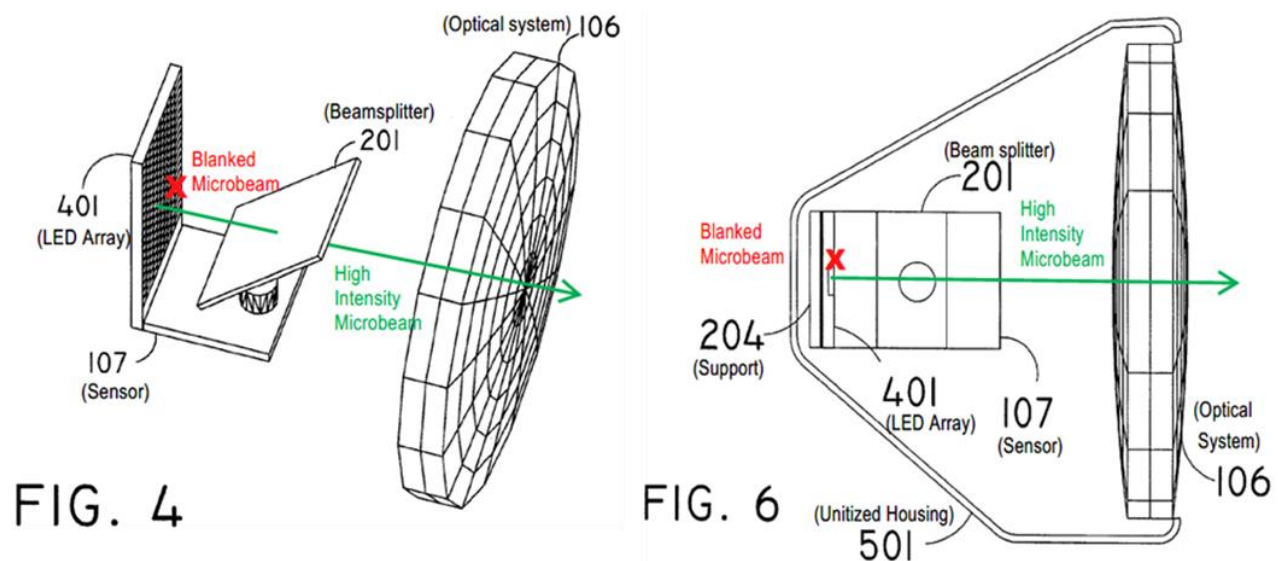


(Ex. 1005, FIGs. 2, 5, Annotated)

57. In the first embodiment illustrated in Fig. 2 (perspective view) and Fig. 5 (top view), light from lamp 202 falls on spatial light modulator (SLM) 203, which is controlled so that the associated individual microbeams are either 1) reflected by SLM 203 at full intensity through beam splitter 201 and out through headlamp optical system 106, or 2) “blanked (attenuated by being either absorbed or deflected [by SLM 203] to an absorbing surface” so that they do not exit the

headlamp optical system 106. (Ex. 1005, 4:36-40, 5:65-66, emphasis added.)

While SLM 203 blanks one or more microbeams by deflecting the blanked microbeams to an internal absorbing surface of the headlamp 501, it does not change direction or angular position of the headlamp beam exiting optical system 106 because the blanked microbeams are “diverted or attenuated at the source” and never exit the headlamp optical system 106. (*Id.* at 5:66.) The Beam SLM 203 appears to work in a similar fashion as a digital light processing (DLP) chip that was in existence on or before the time of filing of the Beam Patent and is used in DLP projectors.



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

58. The second embodiment is illustrated and described with respect to Fig. 4 (perspective view) and Fig. 6 (top view). The second embodiment replaces both SLM 203 and lamp 202 used to generate and modulate (reduce) intensity of

the microbeams of the first embodiment, with an array of light sources 401, such as an LED array, that generates the narrow-angle microbeams. Microbeam blanking is accomplished by dimming one or more of the LEDs making the modulator of the first embodiment superfluous, and it is thus omitted from the second embodiment.

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

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

61. As detailed in Section VI.A., Petitioner relies on a combination of their own creation, in which the spatial light modulator, 203 in the embodiment of

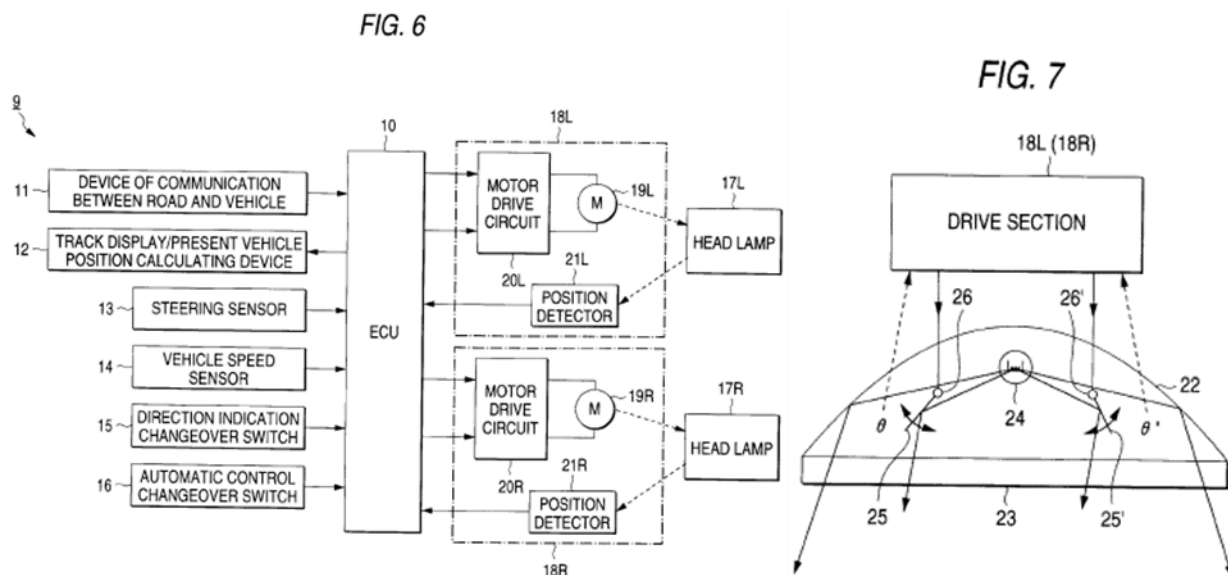
Figures 2 and 5, is inserted into the LED array embodiment of Figures 4 and 6. In doing so, Petitioner conflates the functionality of the embodiments and ignores Beam's express teaching that the lamp AND modulator are replaced by the LED array in the second embodiment. A POSA would never interpret the SLM as being included in the LED embodiment because the functionality of the two components is redundant, and thus unnecessary.

**B. Kobayashi: U.S. Patent No. 6,049,749**

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

light beam.

63. Kobayashi changes irradiation direction using a motor to either rotate the entire lighting device about its axis, or to change relative position among internal lighting device components, such as a reflecting mirror, lens, light source, or shielding member. (Ex. 1008, 6:11-39.) Irradiation range is controlled by either combining different lighting devices with each other (such as a fog lamp, head lamp, and cornering lamp), or by controlling a motor to change position of the internal components (such as reflecting mirrors lenses, or shades) relative to one another. (Ex. 1008, 6:40-7:14.) Irradiation range may be changed responsive to a branch (intersection) ahead on a road by moving the internal lighting device components to change a horizontal irradiating angle  $\alpha$ . (Ex. 1008, 8:1-32.)



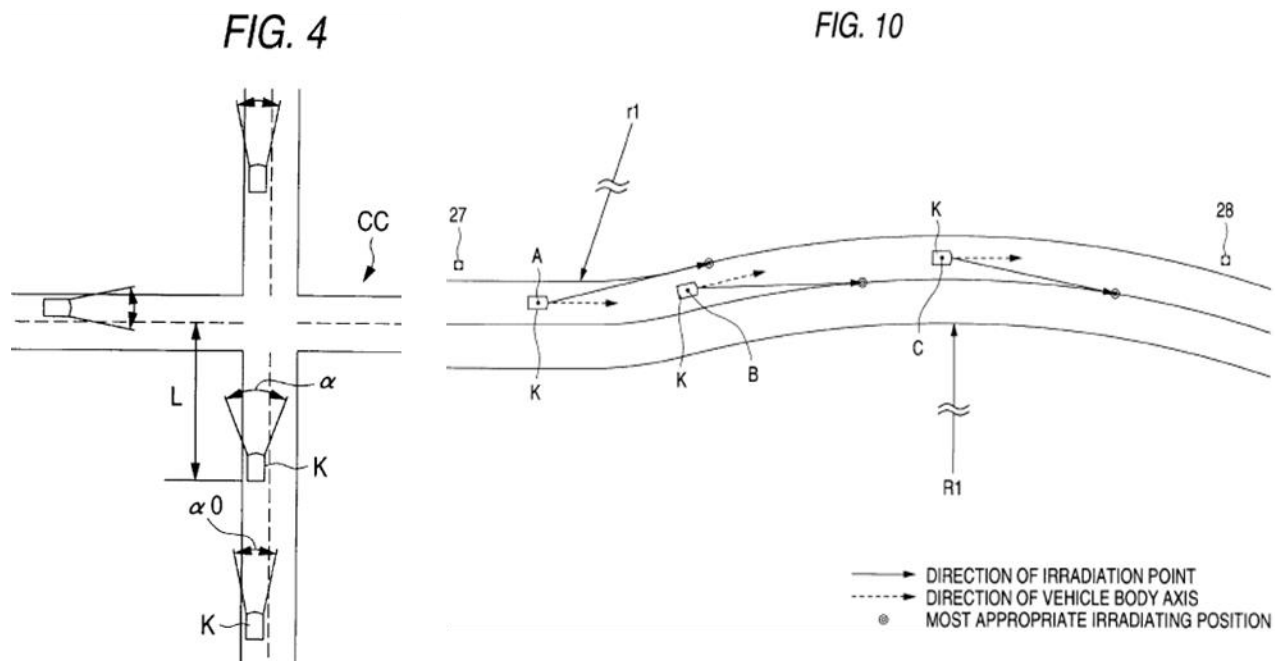
(Ex. 1008, FIGs. 6, 7)

64. Kobayashi's ECU 10 receives signals from: communication device 11

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

65. 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 ( $\theta$ ,  $\theta'$ ) to provide partial direction control of irradiating light. (Ex. 1008, 11:5-14.)

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



(Ex. 1008, FIGs. 4, 10)

67. As shown in Figure 4, Kobayashi's headlamp motors are operated to increase horizontal irradiating angle  $\alpha_0$  to  $\alpha > \alpha_0$  based on a distance  $L$  from intersection  $CC$  and vehicle speed. (Ex. 1008, 8:14-25.) In Figure 10, the headlamp motors are operated according to road profile information and vehicle speed to change the irradiating direction toward a determined irradiating position for the driver's line of sight at each position of the vehicle. When the vehicle turns to the left at point A, the left shoulder is irradiated. When the vehicle turns to right, the right shoulder is irradiated, etc. If the driver operates the steering wheel by an angle larger than necessary for the curve, irradiation control is conducted in accordance with the vehicle advancing direction predicted by the steering angle. (Ex. 1008, 14:53-15:39.)

68. Kobayashi clearly does not disclose: 1) LEDs or any other “digital” lighting sources; 2) a light sensor or detecting light for any purpose; or 3) any control of headlight irradiation direction or range related to anti-blinding or preventing glare for preceding or oncoming vehicle drivers.

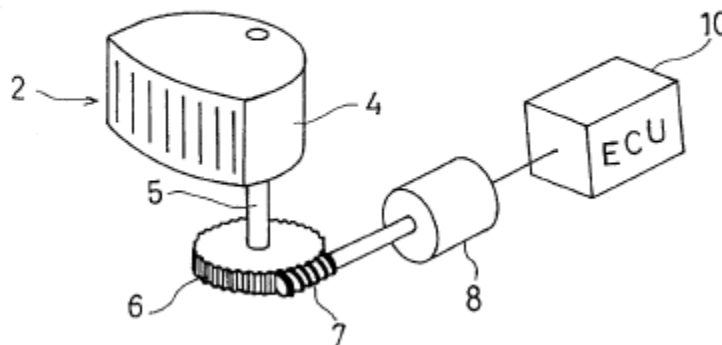
**C. Gotou: U.S. Patent No. 5,588,733**

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

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



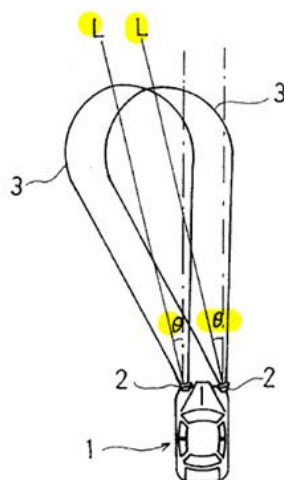
FIG. 2



**(Ex. 1012, FIG. 2)**

71. As shown below in Figure 1 of Gotou, each headlight 2 provides light along a single optical axis L. “The right and left headlights 2 and 2 are swung together in the same direction by the same angle and shown in FIG. 1, angles of their optical axes L and L, with respect to the advancing direction of the vehicle, i.e. optical axis angles are both set to be  $\theta$ .” (Ex. 1012, 3:31-35.) Optical axes L and L are imaginary straight lines that pass through the center of the corresponding headlight projection, resulting in light output that is symmetric with respect to the optical axis at the chosen angle. Notably, while Gotou relies on adjustments to the optical axes to change the lighting region “in front of the vehicle in rightward and leftward directions,” it does not contemplate turning lamp unit 4 on/off or otherwise changing its intensity. (Ex. 1012, 1:60-64.)

FIG. 1



**(Ex. 1012, FIG. 1, Annotated)**

72. The driving of motor 8 is controlled by a light distributing control ECU 10, depicted in FIG. 3. Under the mechanical control system of Gotou, the ECU processes a series of inputs from the map information and vehicle signals such as a “direction indicating signal,” “a steering angle signal” and a “vehicle speed signal” and “processes the information and signals to determine a requisite optical axis angle  $\theta$  and an indicating signal is outputted to a motor driver 14 so as to achieve the optical axis angle  $\theta$ , and thereby the right and left motors 8 and 8 are controlled in driving with the motor driver 14.” (Ex. 1012, 3:51-66.) When the “winker lever is operated, the optical axis angle is changed at once to a predetermined angle for lighting the turning direction of the vehicle early, and the determined optical axis angle is larger as the vehicle speed is faster.” (Ex. 1012, 4:58-64.)

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

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

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

74. On review of the Gotou reference in its entirety, a POSA would also understand that Gotou does not disclose: 1) LEDs or any other “digital” lighting source; 2) fixed or non-moveable light sources, 3) headlamps with multiple light sources with corresponding multiple optical axes; 4) any light sensor or other sensor to detect forward vehicles, or 5) any functions related to anti-blinding or preventing glare.

**D. Karlsson: PCT Application Pub. No. WO1998/054030**

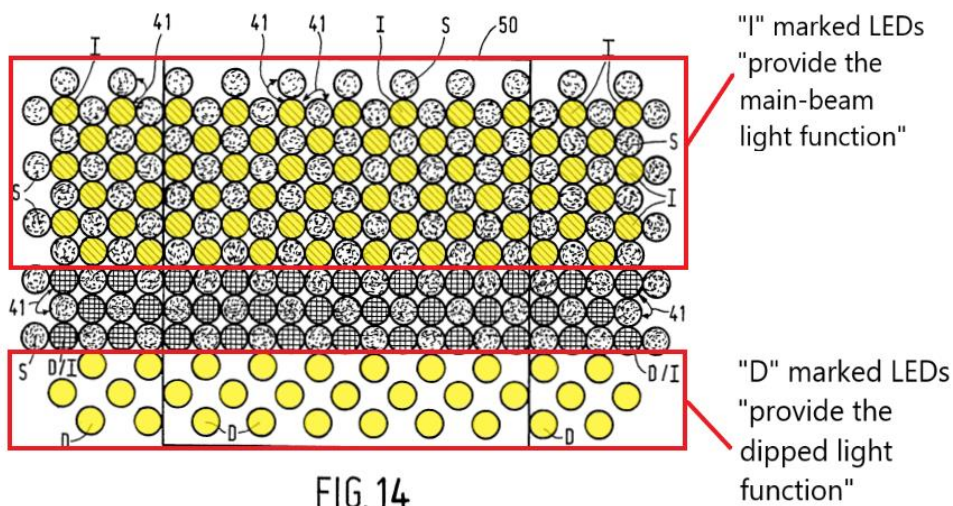
75. Karlsson discloses a “Lighting Device Having a Controllable Lighting Pattern,” wherein light sensors are interspersed with the LED “spotlight beams” to provide anti-blinding functionality, and the LEDs are dimmed during light sensor measurements so light from the LEDs doesn’t interfere with detecting light from

oncoming traffic. (Ex. 1010, Abstract, 2:10-29.)

76. Despite the lack of details, one consistent and reasonable interpretation emerges from the Karlsson reference when viewed in totality along with the referential prior art, contemporaneous evidence, applicable regulations and Petitioner's own admissions (described in Section VI.B.1.): Karlsson, like Beam, forms emitted beam 7 (Fig. 1) by using the entire beam array at full intensity, except when avoiding glare, at which point, window 50, of reduced illumination (Fig. 14) is created to address glare situations. Per Karlsson, this configuration creates an "optimum" lighting effect — which, in Petitioner's words, results from "maximiz[ing] the area that is fully illuminated." (Ex. 1010, 2:7-9; Ex. 2008 at 67.) Moreover, per Karlsson, main beams are optimized for long range illumination (Ex. 1010, 1:19-20) and "constant" main beam usage is "highly desirable" (*Id.*, 1:21-24). Karlsson's removal of situational glare permits this.

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

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



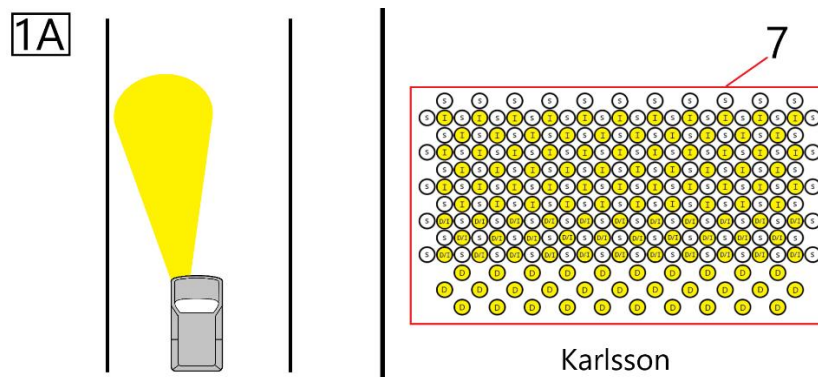
(Ex. 1010, Fig. 14, Annotated)

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

79. In normal driving situations where glare adjustment is not needed, Karlsson’s array would operate “**to the greatest extent possible**” (as Petitioner admits), i.e., the entire main beam and dipped beam would be on full intensity—to “perform the function of existing headlights.” (Ex. 1010, 19:22-28; Ex. 2008 at 66.)

80. For example, Figure 1A below illustrates Karlsson’s Fig. 14 LED

array with all spotlight sources activated to collectively emit a beam of light 7; and Figure 2A illustrates an “existing headlight” with incandescent dipped (Low) and main (High) beam light sources activated to provide a comparable beam of light. While Figure 1A illustrates exemplary operation with all LEDs for the dipped and main beams on, operation of a main beam mode with only the “I” LEDs or “I” and “D/I” LEDs, but without the dipped beam LEDs results in the same analysis and conclusions.



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

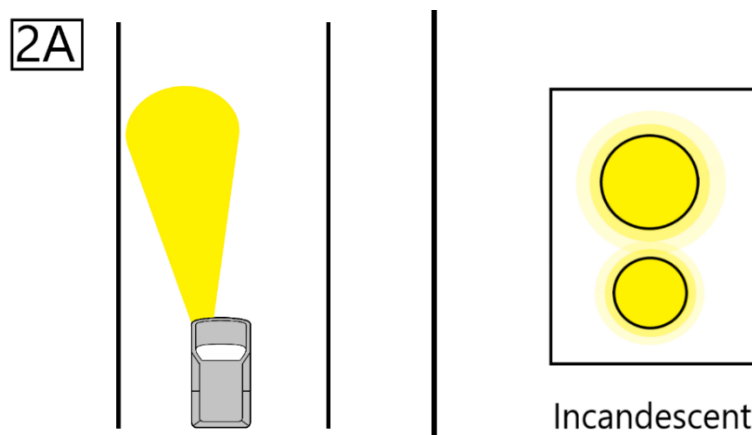


Figure 2A

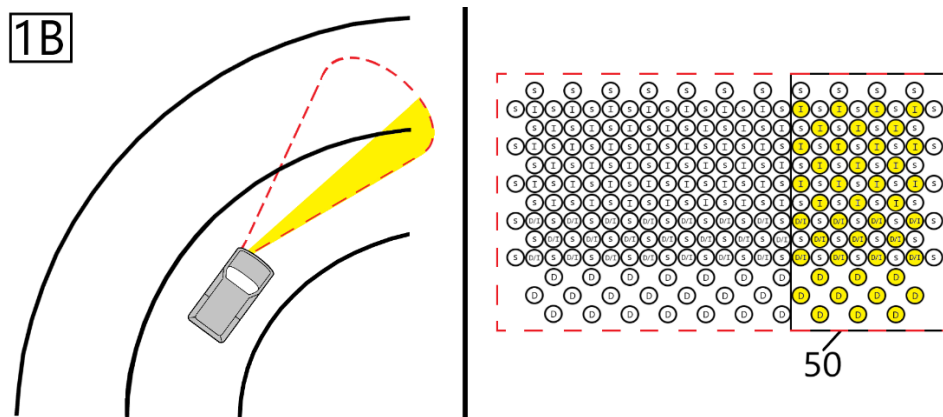
81. Karlsson then uses Fig. 14 to illustrate a “reduction” control strategy to reduce emitted beam 7 in a manner that provides anti-glare functionality for specific situations, and allows for expanded usage of the main/high beam light. (Ex. 1010, 20:6-11.) The situationally adjustable beam 50 illustrates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

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

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

Figures 1B – 1D, the shifting window can be used to temporarily reduce the full beam 7 in order to adapt to possible glare in exactly the situations Karlsson describes. When there is no risk of glare, beam 50 would expand its dimension to the greatest extent possible – i.e., to fully utilize the array and create full beam 7.

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

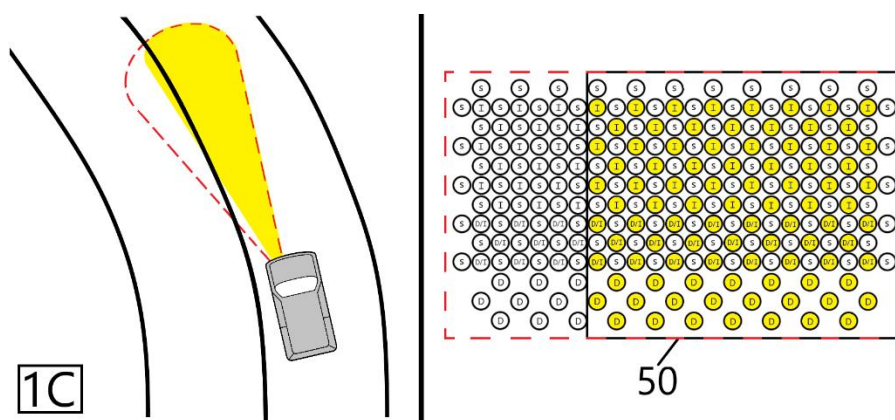


(Figure 1B, Ex. 1010, Fig. 14, Annotated)

85. The above Figure 1B illustrates a full beam in dashed red-line as the



vehicle takes a sharp right turn. Figure 1B also illustrates a reduced beam portion in yellow line, according to Karlsson's Reduction Control Strategy to avoid glaring illumination spillover onto the opposing lane. This beam reduction may be achieved by deactivating the LEDs on the left side of the array, "shifting" the window 50 to the right, as illustrated above. (Ex. 1010, 20:23-32.)

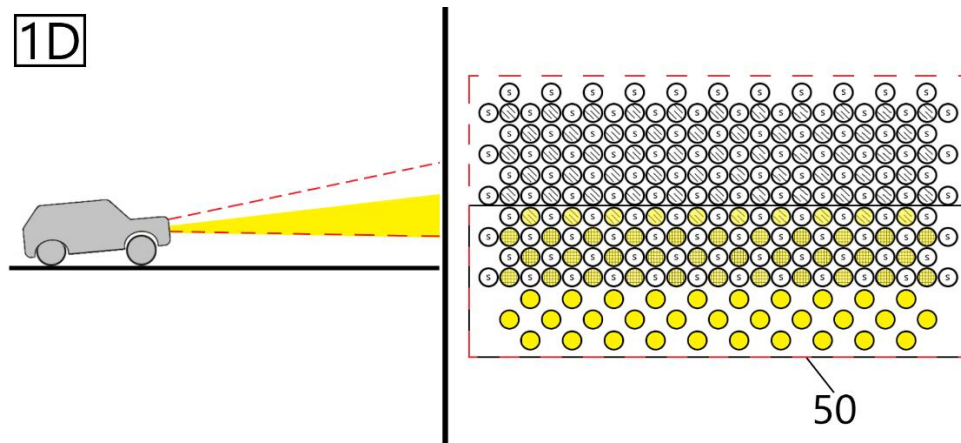


(Ex. 1010, Fig. 14, Annotated)

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

87. In reference to Figure 16, Karlsson also addresses glare caused when a

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



(Ex. 1010, Fig. 14, Annotated)

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

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

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

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

91. Intentionally Left Blank.

92. Intentionally Left Blank.

## VI. Grounds for Challenge

### A. Ground 1

1. **Independent Claims: 1, 12, 23 - The combination of Beam and Kobayashi does not teach *increas[ing] light in a direction of the road curvature ahead of the motor vehicle***

93. Independent claim 1 is representative of claims 12 and 23 and requires: “*one or more processors to: . . . determine a light change . . . to increase light in a direction of the road curvature ahead of the motor vehicle . . . and 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.*”

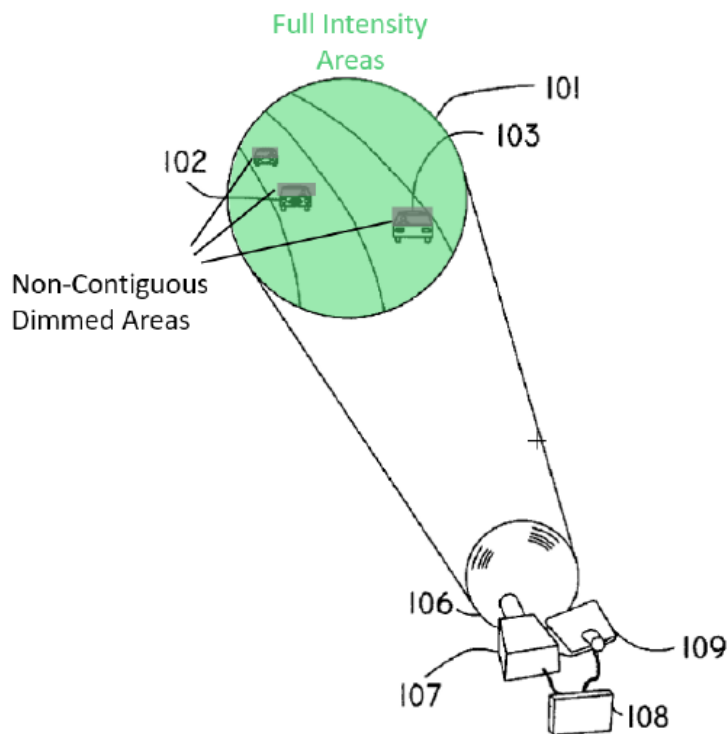
94. Petitioner relies on Beam’s processor 1105 for satisfying the “processors” limitation, Beam’s disclosure in claims 4 and 5, 2:53-3:3, 4:10-59 for satisfying the “LED” limitations, and Beam’s disclosure at 17:8-15, 1:21-29, 4:6-21, 15:15-28 for satisfying the “*determine a light change . . . to increase light in a direction of the road curvature ahead of the motor vehicle*” limitation. (Petition at 31-32, 37.)

95. Beam discloses a headlamp that provides “the equivalent of high beam headlights or brighter on at all times,” greatly enhancing the ability to see at

night” except for areas where incoming light is detected. (Ex. 1005, 6:53-56; emphasis added.) Beam further discloses that “[t]he resulting beam is at full intensity except in areas that would dazzle a driver ahead.” (Ex, 1005, 4:57-59.) Petitioner admitted, in a related proceeding, that this disclosure teaches providing a “Full Intensity” beam outside of the anti-glare region, including annotating Figure 1 of Beam to identify the “Full Intensity Areas”:

Thus, Beam maintains ‘a first level of illumination’ in the areas around the traffic ahead, while preventing glare to the other driver. EX1003, ¶¶145-146. This high-intensity area is created by a “second cluster” of LEDs (microbeam sources) as claimed. *Id.* As shown below, the reduced-intensity area is in a field of higher intensity that extends on both sides, above, and below, the reduced-intensity area.

(Ex. 2008 at 36; Ex. 2009, ¶¶145-146.)



EX1005, FIG. 1 (annotated); EX1003, ¶.

(Ex. 2008 at 39; Ex. 2009, ¶149 Annotations in Original)

96. Similar to the European approach to adaptive driving beam (ADB) technology, Beam operates the high-beam at all times and includes anti-glare strategies, to avoid blinding oncoming traffic when needed. (Ex. 2007, 69:6-12, 69:22-71:4.) Since Beam discloses providing maximum intensity light everywhere it could be needed, there would be no reason to increase light or provide the ability to change the direction of microbeams in the AABH system.

97. Accordingly, the combination of Beam and Kobayashi does not teach “one or more processors to: . . . determine a light **change** . . . to increase light in a direction of the road curvature ahead of the motor vehicle” as claimed, and claims

1, 12, and 23 are patentable over the combination.

**2. Dependent Claims: 5, 6, 9, 16, 20, 27, 31- The Beam-Kobayashi Combination Does Not Teach All Claim Limitations**

**a. Claims 5, 16, and 27**

98. The same general flaws noted below regarding Ground 2 apply to Petitioner's interpretation of claims 5 and 27 as being patentably indistinct.

99. As previously noted, Beam utilizes the full LED array prior to any curve to provide maximum illumination at all times. However, even if this were not the case, claims 5, 16, and 27 are distinguishable.

**i. Claims 5 and 16**

100. Again, the paraphrasing of the claims includes similar inaccuracies as described with respect to Karlsson in Ground 2. Here Petitioner states that the claims "amount to merely directing any light (other than high-beam) in the direction of the road curvature." (Petition at 43.) However, this paraphrase does not address the claimed limitation of increasing light in the direction of the road curvature.

101. Petitioner's first argument seems to misquote Beam using a portion of the quoted sentence out of context — "Beam's AABH provide 'a default illumination level will be the equivalent of today's *low beams*'" (Petition at 44 quoting Ex. 1005, 6:30-33.)

102. However, in the context of the entire sentence, it is clear that the situation described relates to a failure mode or non-functioning version of Beam, i.e., when something breaks. The complete sentence reads “The system will be designed to be fail-safe; *if there is a control system failure*, the default illumination level will be the equivalent of today’s low beams.” (Ex. 1005, 6:30-33, emphasis added.) As such, the low-beam is used when the control system of Beam fails and lacks all other control over light, rendering the controller of Beam incapable of meeting any other claim limitations.

103. Petitioner’s other argument that Beam’s “illumination in the ‘darkened’ or ‘shaded areas’ is ‘significantly less than with current low beams’” (Petition at 44) relates to anti-glare portions and is also irrelevant. In the absence of another vehicle, Beam never establishes such a region.

104. Kobayashi’s Fig. 8 merely shows a shift in luminous intensity achieved using the mirror system of Fig. 7. (Ex. 1008, 11:5-19.) Since Petitioner’s combinations remove such moving parts, it is unclear how any of this is applicable to the combination. The remainder of the discussion about Fig. 8 presents an alternative embodiment where the whole optical system is rotated as in Gotou. (Petition at 44-45.) Petitioner never explains how the combination would achieve such changes using LEDs – Beam never contemplates such a shift and Kobayashi achieves the shift by relying on using movable mirrors and/or a movable entire



optical system, both of which would utilize the motors for which Petitioner has presented motivation to remove.

**ii. Claim 27**

105. As explained with respect to Ground 2M (¶¶142-146 below), either the Board agrees with Petitioner about the meaning of claim 27, in which case the above analysis about claim 5 applies, or the Petitioner simply fails to address the alternative language of claim 27. Nothing in the prior analysis of claim 5 deals with an output that increases light having the claimed characteristics. Nor did Petitioner ever try to make this argument.

**b. Claims 6, 17, and 28**

106. Petitioner's whole argument never once makes a statement that any control would involve the claimed "*at least one LED light source **different from the first plurality of LED light sources.***" (Petition at 45.) Merely discussing control of various LEDs does not prove what is claimed, nor is it explained to prove what claimed, nor is it even **alleged** to prove what is claimed.

**c. Claims 9, 20, and 31**

107. Petitioner states that the "control of the second plurality of LED light sources," which is done for purposes of non-glaring illumination (claim 8), can be based on "map data" as the claimed non-camera data. Again, Petitioner never explains is how "map data" can be used to "control the second plurality of LEDs

light sources” to “diminish glare to a driver of the other vehicle” in any manner. Claims 9, 20, and 31 are thus not proven obvious over the combination.

### **3. Rationale to Combine**

#### **a. The Proposed Combination Defeats Beam’s High-Intensity Illumination “At All Times” and Renders Beam Inoperable**

108. I understand 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.

109. Petitioner admits on pages 26-27 of the Petition that “Beam does not disclose using map data, such as from GPS or navigation beacons, as an input to control the intensity, shape, and/or angular position of the LEDs (or their resultant beam)” but Petitioner asserts that “it would have been obvious to a POSA to do so” to make “Beam’s system even more active than prior systems”—parroting unsupported expert opinion devoid of any actual evidence.

110. Beam contravenes Petitioner’s unsupported arguments. Beam expressly disparages prior art devices that control “the shape and direction of the headlight beam” “in a predetermined profile that is expected to cause the fewest problems to the oncoming drivers under a variety of circumstances”—referring to them as a “compromise, at best between reducing glare and providing enough light to the driver for adequate visibility.” (Ex. 1005, 2:15-22.) Contrary to Petitioner’s

assertions, Beam has no need for map data to provide curve illumination or beam shaping and would not benefit in any way from having the map data or control strategies disclosed by Kobayashi.

111. Beam sought to solve the problems associated with systems such as the one provided in Kobayashi “which attempt to control the intensity profile of the beam by using a reflector or lens shaped to control the output beam in some predetermined way” and systems that control “movement of headlight beams in response to changes in the vehicle's steering mechanism, etc.” (*Id.* at 1:60-2:5.)

112. Petitioner's proposed modification of Beam by adding map data and associated control complexity from Kobayashi would render Beam's AABH system inoperative or unsatisfactory for its stated purpose. In particular, Petitioner's proposed combination would: 1) defeat Beam's stated purpose of providing high-intensity illumination all the time with the only exception being microbeam portions of the headlight beam that would otherwise dazzle other driver, 2) be inoperative in that Beam's AABH system is incapable of changing the direction of light from the headlamps, or of increasing light beyond maximum intensity of the light source(s), and 3) not accomplish Petitioner's proffered purpose of “improving driver safety” as a result.

113. Petitioner concludes that the AABH system controls the direction or steering of one or more microbeams to **increase** light, apparently based solely on

the limitations of the Challenged Claims. (Petition at 38.) However, Beam is abundantly clear beginning with the title and extending throughout the detailed description and claims that it is an anti-blinding system that darkens or blanks individual microbeams to **reduce** illumination based on direction of an incoming beam of light, e.g., from an oncoming vehicle, preceding vehicle and/or any other light source.

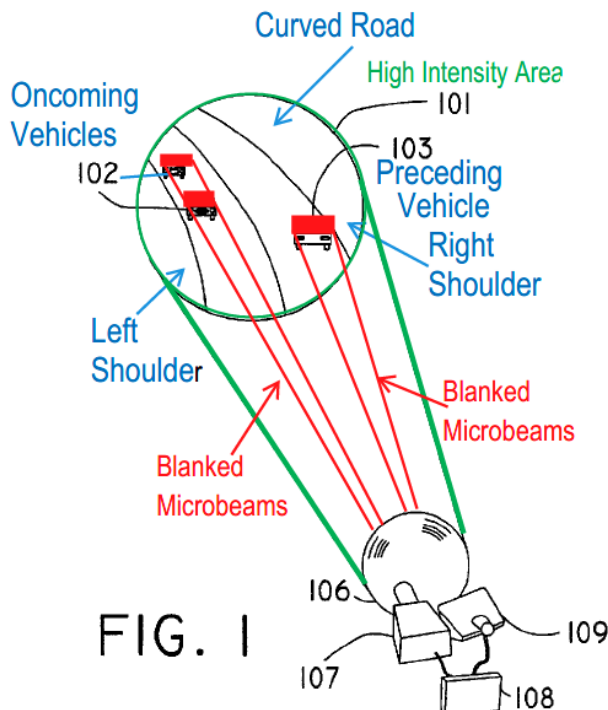
114. Beam specifically recognizes and disparages prior art attempts to control the direction of the headlight beams, whether in response to vehicle loading, steering wheel, etc. (Ex. 1005, 1:60-2:6.) In contrast to the prior art systems:

The instant invention solves all of the enumerated problems by automatically sensing the presence and location of headlights and taillights ahead of the car on which it is mounted. It will then control the light output of a group selected from a multiplicity of narrow angle beams (microbeams) which comprise the overall headlight beam pattern. By controlling an area determined by analyzing the position of the lights sensed ahead, the area of the beam that would dazzle the driver will be darkened, **while maintaining [full] intensity elsewhere.**”

(Ex. 1005, 2:52-64, emphasis added.)

115. The prior art, according to Beam, had problems because it had to choose where to put light, and it was not always correct and/or subject to

misalignment. (*Id.* at 2:15-26.) Beam's solution to the prior art problems associated with changing direction of the headlamp beam is to provide "the equivalent of high beam headlights or brighter on at all times, greatly enhancing the ability to see at night" (*Id.* at 6:53-56), except for areas where incoming light is detected. Since Beam is already putting high-beam or brighter light everywhere light could be needed, there would be no reason to provide the ability to change the direction of microbeams in the AABH system. As illustrated in Beam's Figure 1 as annotated below, the high intensity illumination area 101 is sufficient to illuminate oncoming vehicles 102 and preceding vehicle 103, as well as both lanes of the curved road including the left shoulder and right shoulder. The AABH system prevents blinding drivers of the oncoming vehicles 102 and preceding vehicle 103 by blanking associated microbeams at corresponding angular positions of the X-Y matrix/array of LEDs. As such, there is no need for the AABH system to point or direct light in any particular direction.



**Ex 1005, Fig. 1 (Annotated)**

116. Even if changing the direction of microbeams in response to map data as proposed by Petitioner was possible, it would allow the microbeams to illuminate areas outside the field-of-view (FOV) of sensor 107 and thus defeat the anti-blinding operability in at least part of the illuminated area 101. It would also reduce the maximum intensity of illumination of regions within the road ahead, contrary to Beam's stated purpose. For example, changing the direction of microbeams in the direction of an upcoming left hand curve in response to map data would reduce illumination below the maximum possible in regions to the right of oncoming vehicles 102 and would defeat anti-blinding operability for any vehicles outside of the intersection of the illumination and sensor fields of view.

117. The specification details the central tenet of the Beam reference - to darken the area of the beam that would dazzle the driver, “**while maintaining [full] intensity elsewhere**”:

These AABH headlights will operate at maximum intensity at all times. **An imaging sensor (such as a video camera) faces forward, boresighted with the headlight.** The output of the sensor is connected to the controller. The controller module uses the sensor spatial data (video) **to determine whether there are illumination sources (headlights or tail lights) present in the headlight's field-of-view**, determines their location relative to the Adaptive Anti-Blinding Headlights beam, and uses these data to control the Illuminator. When an oncoming vehicle's headlights are detected (whether or not it is equipped with the AABH system), an area slightly wider than the headlight spacing and approximately six feet high, and whose bottom edge is centered on the oncoming headlights, is **dimmed** in the beam-bundle of the vehicle equipped with the AABH system.

(Ex. 1005, 6:11-24, emphasis added.)

In operation, the AABH produces a multiplicity of individually directed narrow-angle beams which are herein referred to as microbeams, each being controlled by a processor responsive to incoming data from an imaging sensor. Any microbeams that would blind the oncoming driver **are diverted or attenuated at the source.** Selection of the particular microbeams **that form the dimmed area** is performed continuously and dynamically (they would be adjusted

based on input to the sensor, as opposed to older systems which shape the intensity profile of the beam following a presupposed distribution requirement.) The AABH system will also sense taillights of a vehicle being followed and control those microbeams that would otherwise dazzle or annoy its driver when reflected by a rear-view mirror.

(Ex. 1005, 5:61-6:8, emphasis added.)

118. The Beam specification further underscores that “[t]he primary advantage of the present invention over the prior art is that it produces a beam of high intensity light that enables the driver to see more clearly at night, while simultaneously protecting drivers in front from dangerous glare.” (Ex. 1005, 3:37-41, emphasis added.) Accordingly, the fixed direction of the microbeams operating at maximum intensity would obviate the need to change the direction or angle of illumination to accommodate a curve or any other road feature as alleged by Petitioner to increase illumination, because Beam’s AABH system already operates at maximum intensity and already illuminates such road features while detecting incoming light from forward headlights/taillights. Additionally, Beam’s AABH system processes sensor inputs to significantly reduce, not increase, illumination based on sensor data.

119. Moreover, Beam’s AABH system is incapable of operating as Petitioner contends. Beam’s AABH embodiments provide fixed, non-movable components controllable to reduce intensity of individual microbeams in response



to detecting incoming headlights/taillights or other light sources. In the first embodiment illustrated in Figures 2 and 5, the spatial light modulator (SLM) is controlled so that the individual microbeams are either 1) reflected at full intensity out through the headlamp, or 2) any microbeams that would blind the oncoming driver are blanked by being absorbed or deflected to an absorbing surface so that they do not exit the headlamp, i.e., “microbeams that would blind the oncoming driver are diverted [] at the source.” (Ex. 1005, 5:65-66, emphasis added.) The SLM is thus not capable of pointing or otherwise changing direction of microbeams exiting the headlamp.

120. Similarly, the second embodiment illustrated and described with respect to Figures 4 and 6 *replaces* the SLM 203 and lamp 202 with individually controllable light sources, such as an array of LEDs, that generate the narrow-angle LED beams, and are selectively attenuated or blanked to prevent blinding/dazzling other drivers. As a POSA would understand from review of the Beam reference, the disclosed LED array has no controllable elements capable of changing the position or otherwise pointing or steering the associated microbeams illuminating the road.

121. As such, Petitioner’s proposed combination renders Beam’s AABH system unsatisfactory for its intended purpose of providing maximum intensity illumination everywhere (other than regions surrounding detected light sources) all

the time without the use of moving components. Furthermore, the proposed combination is inoperable in that, unlike Kobayashi's system that changes position of components (such as reflecting mirrors lenses, or shades) relative to one another to change a horizontal irradiating angle  $\alpha$  (Ex. 1008, 8:1-32), Beam's LED embodiment of Figures 4 and 6 has no way of controlling the direction of output light in response to Kobayashi's map data. Perhaps more importantly, it has no *need* to control the direction of emitted light, as it already fully illuminates the FOV of the headlights (and FOV of the aligned, bore-sighted sensor) at "maximum intensity." Accordingly, there is no suggestion or motivation to make Petitioner's proposed combination and modification.

**b. Petitioner Does Not Explain How a POSA Would Have Used Kobayashi's Map Data to Control the Direction of Beam's Maximum Intensity Microbeams to Increase Light**

122. I understand that an obviousness determination is improper where the record lacks a clear, evidence-supported account of how the combination would work.

123. Petitioner does not explain how the AABH system of Beam could use the map data of Kobayashi to determine a light change to increase light as Beam's embodiments operate at maximum intensity and only disclose significantly reducing illumination. Petitioner does not explain how a POSA would convert

Kobayashi's mechanical headlamp motor control signals for "rotating the entire lighting device about its axis" or "controlling the posture of a member composing the lighting device such as a reflecting mirror, lens, light source and shielding member" in response to map data to control blanking of microbeams in Beam's LED array to increase illumination based on the map data. Petitioner also does not:

- 1) explain how the combined Beam-Kobayashi system would determine which microbeams to blank as compared to which microbeams to change direction;
- 2) explain how Beam's AABH system would control the direction of the microbeams of Beam's LED array using Kobayashi's motor control signals;
- 3) explain how the system would change direction of some microbeams based on Kobayashi's road profile data "while continuing to provide intense forward illumination" as the AABH system already operates at maximum intensity to provide "bright high beams on at all times"; or
- 4) provide Beam's anti-blinding feature for microbeams that change direction based on a road profile and are therefore no longer aligned with the field-of-view of Beam's sensor/camera.

124. As previously described, Beam disparages controlling direction of the headlight beam. Beam's AABH system is directed to high-intensity forward illumination. As such, neither of the embodiments disclosed by Beam control direction of the headlight beam. Rather, both the SLM and LED embodiments are controlled to blank selected microbeams to provide the anti-blinding features of the

AABH system “while continuing to provide intense forward illumination.” Petitioner does not explain how to reconcile Beam’s stated goal of providing maximum intensity all the time with providing even more than maximum intensity when approaching a curve identified by Kobayashi’s map data.

**c. Petitioner Fails to Identify Why a POSA would Add Map Data to Beam’s AABH System, which Already Illuminates Curves, Without Hindsight Bias**

125. I understand that a determination of obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention. Instead, there must be a teaching or suggestion within the prior art, or within the field of the invention, to look to particular sources of information, to select particular elements, and to combine them in the way they are combined by the inventor.

126. As clearly shown in Figure 1 of Beam and acknowledged by Petitioner, Beam’s AABH system provides higher than high-beam intensity that illuminates both lanes of the roadway including oncoming vehicles, a preceding vehicle, left shoulder, right shoulder, and the upcoming curve (and would also illuminate upcoming intersections and any other road feature). As such, Beam’s AABH system is agnostic to the road profile. There is simply no plausible reason to add superfluous map data and related control complexity of Kobayashi’s

moveable mechanical system to Beam's superior AABH LED system that provides high intensity illumination of the driver's entire field of view, other than using hindsight bias in a failed attempt to meet the limitations of the Challenged Claims of the '029 patent.

**B. Ground 2**

**1. Independent Claims: 1, 12, and 23 - the Gotou-Karlsson Combination Does Not Teach  
“Increasing Light in a Direction of the Road  
Curvature”**

127. Independent claim 1 is representative of claims 12 and 23 and requires: “one or more processors to: . . . determine a light change . . . to increase light in a direction of the road curvature ahead of the motor vehicle.” Petitioner relies on Gotou's headlamp device for satisfying the “headlamp” limitations, Karlsson's LED arrays for satisfying the “LED” limitations, Gotou's ECU 10 for satisfying the “processor” limitation and Karlsson's control functions for the actual control of the LEDs (i.e., generation of the emitted beam). (Petition at 66-69, 79.)

128. Karlsson discloses a headlight assembly having a controllable lighting pattern, that provides a high-beam or “main-beam” lighting pattern as a default setting. (Ex. 1010, 1:1-7, 1:18-23.) Karlsson further discloses reducing the high beam to a partial beam, (e.g., as depicted by a window 50 in Figure 14) under limited circumstances, in this case to avoid blinding oncoming drivers. For example, Karlsson discloses “retaining an optimum light for the driver of the

vehicle” while automatically suppressing “that part of the light beam which might cause inconvenience to oncoming traffic.” (Ex. 1010, 2:7-9.) Karlsson also notes that “main-beams are designed and optimized for long-range illumination” (Ex. 1010, 1:19-20) and that this light is “highly desirable” to include use of the longer range main beam “constantly,” in “many cases.” (Ex. 1010, 1:21-24.) When there is not a risk of glare from a particular situation, Karlsson has a preference for “optimum” light (Ex. 1010, 2:7-10, 4:17-21, 9:23-26).

129. Karlsson discloses that the “light beam 7 ... [is] controlled in such a manner that **no light at all or light having a low intensity** is emitted in those directions from which light is detected ... [thus] **glaring or blinding of oncoming traffic is effectively prevented.**” (Ex. 1010, 9:18-26.) Petitioner admitted, in a related proceeding, that this disclosure teaches that the “remaining areas of light beam 7 are left at full intensity (‘main-beam’ or ‘high beam’ in Karlsson’s terms), ‘permitting a light intensity which is generally *higher than that of conventional dipped headlights.*’) (Ex. 2008 at 66, emphasis in original, citing Ex. 2009, ¶280.) Petitioner continues the explanation and interpretation of Karlsson by admitting that:

A POSA would also have understood that positioning the main beam **(full-intensity)** LEDs all around the **reduced illumination area** provides the “**optimum lighting effect**” for the driver because doing so maximizes the area that is fully illuminated. EX1003, ¶281;

EX1010, 2:7-9. In the alternative, it would have been obvious to a POSA to configure Karlsson's system to surround the reduced illumination area with full illumination to the greatest extent possible for the same reason. EX1003, ¶¶281-282.

(Ex. 2008 at 67.)

130. “The greatest extent possible” that “surrounds” a reduced illumination area, of course, is use of the full LED array whenever possible, to provide the driving beam 7. Per Karlsson and Petitioner's admissions, the only reasoned and consistent interpretation is that Karlsson uses full illumination “to the greatest extent possible” to achieve an “optimum lighting effect” by “maximizing the area that is fully illuminated”— i.e., use the entire array just as Beam does, except for portions dimmed to avoid glare under Karlsson's specified circumstances.

131. With reference to Figure 14, Karlsson states: “In this embodiment non-shaded spotlight sources indicated at D provide the dipped light function in accordance with existing vehicle headlights, whilst the single-shaded spotlight sources indicated at I provide the main-beam light function of existing vehicle headlights. (Ex. 1010, 19:22-28, emphasis added.) As illustrated in Figure 14 below, the dipped light sources (D) and main-beam light sources (I) extend beyond the window 50. The “sources,” collectively, provide “existing vehicle” light beams. Therefore, creation of the window 50 is the result of blanking a subset of the overall beam.

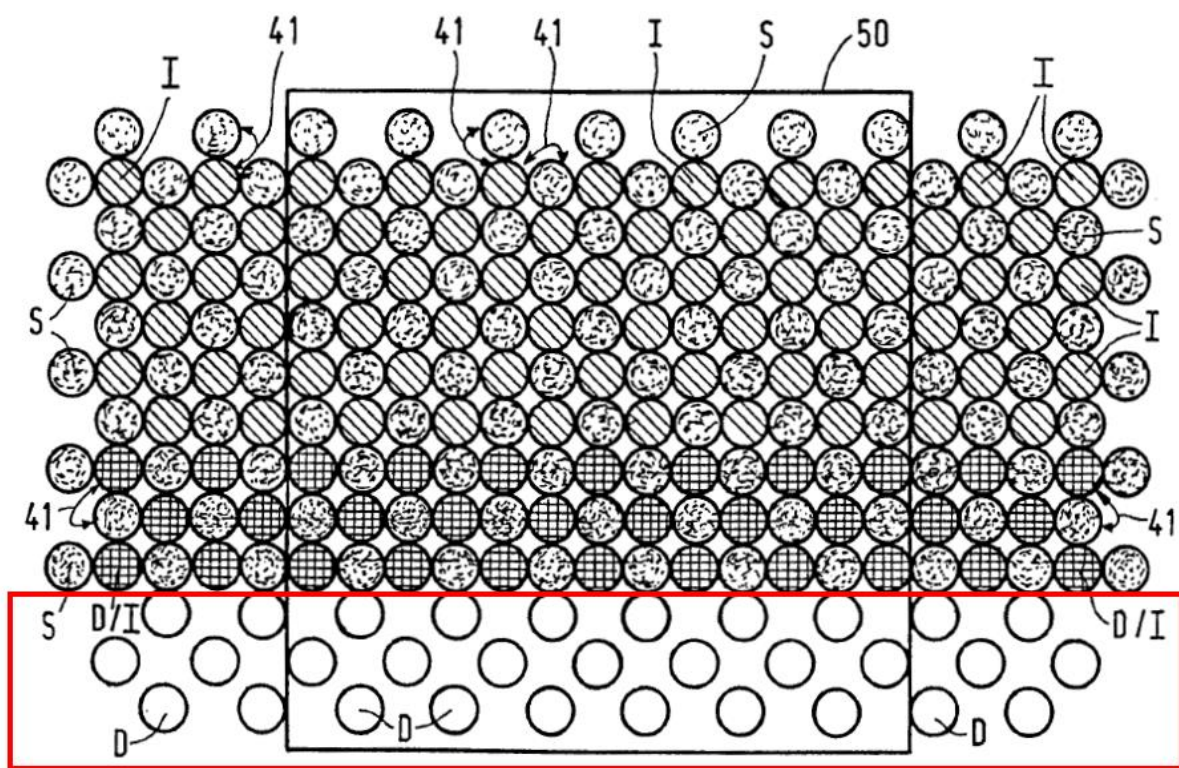


FIG. 14

(Ex. 1010, Fig. 14, Annotated)

132. This interpretation further comports with Figure 16's description of sensors, to prevent glare based on vehicle movement, in situations, such as a curve, where another vehicle's lights may be difficult to detect due to relative positioning and/or sensors to modify light to meet regulatory requirements. If Karlsson's vehicle is pitched, e.g., during sharp velocity changes or "overloaded", the light beam 7 is adapted for pitch — i.e. certain LEDs are blanked causing the window 50 to vertically shift as described with reference to Fig. 14. (Ex. 1010, 20:25-29.) If the vehicle is taking a curve, the light beam 7 is adapted to prevent glaring the opposite lane, i.e., certain LEDs are blanked causing the window 50 to horizontally



shift as described with reference to Fig. 14. (Ex. 1010, 20:29-33.)

133. Under any of these situations, the resulting beam would be less (for the duration of the event) than the full normal beam of an incandescent lamp (being diminished in some regard, vertically or horizontally), except that Karlsson makes these accommodations to allow the main (high) driving beam to continue to operate everywhere else not accommodating glare, which maintains sufficient illumination of the road ahead of the driver.

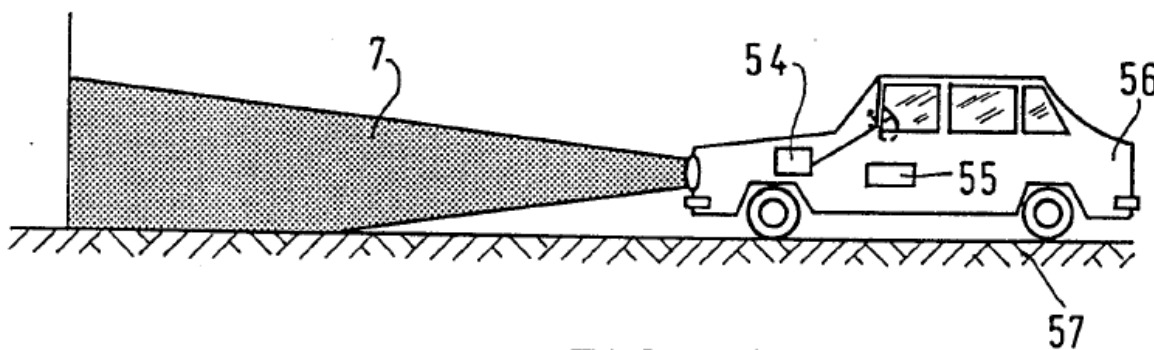


FIG. 16

(Ex. 1010, FIG. 16)

134. The reduced illumination provided by window 50 also comports with Karlsson's desire to "retain an optimum lighting effect," per Flaaten — the base device, which Karlsson seeks to improve. (Ex. 2017.) Karlsson explains that the Flaaten "prior art lighting device" "retain[s] an optimum lighting effect for the driver of the vehicle", by enabling "such control of the light that only the portion of the light that would inconvenience the driver of meeting cars is removed,

leaving as much as possible of the roadway and the surroundings illuminated.” (Ex. 1010 at 1-2; Ex. 2017 at 1.) There is nothing in Karlsson to suggest that window 50 is the actual beam that would be used for driving. On the contrary, as contemporaneous publications from Petitioner’s expert establish, given the state of the art and the numerous technical challenges with incorporating extra LEDs to the headlamp system, all LEDs in the Karlsson array would be used to achieve sufficient lumen output for driving.

135. Given the challenges in the late 90’s-early 2000’s of creating an LED headlamp array with sufficient brightness to meet high beam standards, it not reasonable to think that a headlamp designer would have the luxury of incorporating extra LEDs into a high beam array — D and I located on either side of the window — due to the resultant cost, thermal degradation complications, the need for a heat sink and related packaging concerns, for the limited instances of avoiding glare.

136. As both parties agree, Karlsson discloses providing full or maximum intensity light in the remaining areas outside of the anti-glare region to the greatest extent possible, i.e., everywhere it could be needed. Under such circumstances, there would be no reason to increase light in the direction of the curve, or unlit LEDs remaining with which to achieve the increase. Accordingly, the Gotou-Karlsson combination does not teach “*one or more processors to: . . . determine a*

*light change . . . to increase light in a direction of the road curvature ahead of the motor vehicle*” as claimed, and claims 1, 12, and 23 are patentable over the combination.

**2. Dependent Claims: 5-7, 9-10, 16-18, 20-21, 27-29, 31, 32 - The Gotou-Karlsson Combination Does Not Teach All Claim Limitations**

**a. Claims 5, 16, and 27**

137. Claim 5 is representative of claim 16 and further defines the “increase light” limitation of claims 1 and 12: “*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.*” Claim 27 uses different language and is directed to an increase to already-emitted light: “output that **increases** light emitted at a level below high-beam light and directed in the direction associated with the shape change.”

**i. Claims 5 and 16**

138. Petitioner incorrectly contends that “Karlsson’s LEDs would implement the same type of light level [as Gotou] towards the curve,” without any explanation of why Karlsson would mimic Gotou’s incandescent light source output. (Petition at 84.) Assuming, for the sake of argument only, that Karlsson had remaining LEDs to use for a “change,” there is no reason why Karlsson would not, for example, provide high-beam illumination, instead of low-beam illumination,

into a curve.

139. Gotou discloses turning a headlamp that emits the same light output after the turn that it was emitting before the turn. Gotou's controller does not control the lamp **output**, only the lamp **angle**. Incidentally, Gotou does not even **specify** a light level, rendering Petitioner's statement about "the same type of light" unclear.

140. Lacking any emission parameters or control from Gotou, it is only reasonable to conclude that Karlsson would illuminate the curve with the best light available, which is main/high beam emission. Again, Patent Owner contends that this is already being achieved without need for a change (i.e., because all the LEDs are already being used), but even in Petitioner's alternative interpretation, Petitioner provides literally no reasoning for recreating Gotou's emission, or where indication of such emission characteristics would even come from.

141. Without any reason as to **why** or **how** Karlsson would replicate Gotou, and with good reason for Karlsson to do something Karlsson can do (i.e., choose emission type, using Petitioner's construction), but Gotou cannot, the conclusion is specious. The entire analysis then fails, being predicated on the false conclusion and otherwise being unsupported.

## **ii. Claim 27**

142. Regarding claim 27, either the Board agrees with Petitioner about the

meaning of claim 27, in which case the above analysis about claim 5 applies, or the above contentions by Petitioner actually demonstrate that claim 27 is not met, by establishing that not a single emitting LED has its illumination increased.

143. Patent Owner contends that claim 27 requires an increase of illumination emission from sources of light already emitting light below low beam and in the direction of the curve. Hence the use of the active verb “increases.”

144. Petitioner proposes, with respect to claim 1, that Karlsson achieves the increase by “shifting” the window 50 of Karlsson in the direction of the curve. (Petition at 77.) Petitioner also contends that this light behaves as Gotou’s type of light – i.e., unchanged by horizontal movement. (Petition at 84.)

145. To follow Petitioner’s argument against claim 5 to its logical conclusion, if the window of light 50 shifted towards the curve, and the intensity was “unaffected” by such horizontal movement, then only one of two things would happen to LEDs on the curve-side of the lamp under Petitioner’s construction. 1) They would be left as-is, being a part of the new shifted window; or 2) they would be freshly lit, having never been previously illuminated. Not one LED would be *increased* in intensity because, according to Petitioner, Karlsson would “implement the same type of light as Gotou” and “Gotou’s variation of high-beam and low-beam is... not affected by horizontal movement.” (Petition at 84.)

146. Either the claims are patentably indistinct from claim 5 and the

argument fails for the reasons presented with respect to claim 5, or the claims are distinct and the argument about claim 5 actually demonstrates why an emitting LED **would not** be increased as required by claim 27. In both scenarios, the Gotou-Karlsson combination does not teach claim 27.

**b. Claims 6, 17, and 28**

147. Claim 6 is representative of claims 17 and 28 and further requires “control[ling] at least a second plurality of the LED light sources, having at least one LED light source **different** from the first plurality of 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.” Petitioner again states that Gotou-Karlsson combination teaches an iterative process, but does not ever explain how iteration would require the claimed use of “at least one LED light source **different from** the first plurality of LED light sources.” (Petition at 84-85.) The argument fails to even mention this limitation, let alone demonstrate its presence in the combination, and claims 6, 17 and 28 are patentable over the combination.

**c. Claims 7, 18, and 29**

148. Claim 7 is representative of claims 18 and 29 and requires “wherein 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.” Petitioner relies on Karlsson’s disclosure in Figures 6 and 14, Abstract, 13:24-14:4, 2:29-35, 9:18-26 for satisfying this limitation. (Petition at 85; Ex. 1003, ¶¶317-320.) As explained for independent claims 1, 12, and 23, and admitted by Petitioner, Karlsson discloses providing full or maximum intensity light in the remaining areas outside of the anti-glare region. (Ex. 1010, 9:18-26, 1:21-24, 2:7-9; Petition at 67.) Karlsson also discloses reducing, not expanding, a light pattern in the presence of an oncoming vehicle while turning. (Ex. 1010, 20:22-32.)

149. Further, Petitioner treats the language of 7.1 as though it is covered by 7.3 or 7.4, despite those not being sub-clauses to 7.1 and addressing different aspects of the concept. (Petition at 85, 126-128.) Petitioner only ever attempts to prove that: 1) the LEDs are separately controllable; 2) intensity can be adjusted; and 3) pattern and intensity can be changed by switching LEDs on and off and/or adjusting intensity. Petitioner never once shows 7.1’s requirement that the increase of claim 1 either result from an expanded beam or increase to intensity of light directed in the direction of the curve.” It is possible Petitioner’s reference to the 24 pages contained in Section VII.A is supposed to include this analysis, but that is hardly an argument made with particularity, and it is not the job of the Board or Patent Owner to go back to those 24 pages and decide what arguments might apply. This is a prime example of incorrect paraphrasing, a failure to specify where

each element of the claim is found in the prior art (as required by 37 C.F.R. § 42.104(b)(4)), and a general failure to address a limitation of the claim.

150. The Gotou-Karlsson has not been shown to teach, or even argued to teach, “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,” and Petitioner’s argument fails.

**d. Claims 9, 20, and 31**

151. Claims 9, 20, and 31 depend from claims 8, 19, and 30. Claim 9 is representative of claims 20 and 31 and requires “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.” Claims 8, 19, and 30 require controlling the “second plurality of LED light sources providing light directed towards an area including at least a portion of the other vehicle to diminish glare to a driver of the other vehicle.” Thus, the “control of the second plurality,” in claim 9 refers to control to diminish glare to other detected vehicles. In claim 8, that control was based on vehicle detection using camera data, here, it is based at least in part on data from a non-camera sensor.

152. Petitioner relies on Gotou’s map data for satisfying this limitation. (Petition at 88.) Petitioner fails to explain how “map data” can be used in any manner regarding controlling the second plurality of LEDs to diminish glaring



illumination of another vehicle. The Gotou-Karlsson combination does not teach “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,” and claims 9, 20 and 31 are not obvious over the combination.

153. Also, again in a failure to even address a claim limitation, let alone show its location in the prior art as required by 37 C.F.R. § 42.104(b)(4). The Petition references [9.6]/[20.6]/[31.6] on page 90 but the argument presented therewith references the claim limitations of [9.4]/[20.4]/31.4]. The Petition does not address the limitations of claims [9.6]/[20.6]/[31.6], and therefore the argument fails to address all claim limitations.

**e. Claims 10, 21, and 32**

154. Claim 10 is representative of claims 21 and 32 and further requires “one or more optical control elements for controlling light from one or more of the LED light sources.” Petitioner relies on Gotou’s reflectors/sub-reflectors and Karlsson’s reflectors and lenses for satisfying these limitations. (Petition at 91.) Petitioner does not identify which optics it is relying on for this combination.

**3. Rationale to Combine**

**a. Petitioner Fails to Explain Why, Absent Hindsight, a POSA Would Have Combined Gotou and Karlsson**

155. LED headlamps were under development in the early 2000’s, a

myriad of complex, interrelated technical issues were being solved at the time and thus there were no known techniques to address known problems in the LED headlamp art using prior art elements according to their established functions. As explained below, LED headlamps are significantly different devices than conventional headlamps, and therefore in the early 2000's each LED headlamp design required optical, heat management, and packaging considerations, all of which affected cost. Petitioner does not explain how a POSA would have combined Gotou and Karlsson. Further, Gotou and Karlsson describe headlamps that provide adaptive lighting in significantly different ways, therefore the combination would render Gotou unsuitable for the purpose of adjusting illumination direction. By ignoring these issues, the Petition illustrates clear hindsight bias.

156. Petitioner's hindsight theory undermines the Petition's alleged motivation for combining the references as proposed to "improve driving safety." (Petition at 64.) Except for identifying elements of the Challenged Claims to engage in hindsight reconstruction, Petitioner fails to explain why in Ground 2 it would be obvious to add an LED array from Karlsson to Gotou —. Petition at 55. Indeed, Petitioner fails to explain why a POSA would be motivated to combine Gotou and Karlsson, when the combination results in an uncontrollable, and therefore unsuitable, form of curve illumination. The only *actual* motivation to add

Karlsson's LED array was to meet the claim limitations.

**b. Petitioner Does Not Explain How a POSA  
Would Have Combined Gotou and Karlsson**

157. I understand that a Petitioner must explain how and why a POSA would have modified or combined the prior art. I also understand that a POSA must provide a clear, evidence-supported account of how the combination would work.

158. Petitioner states that “A POSA would have had a reasonable expectation of success combining Gotou and Karlsson.” (Petition at 64.) Petitioner further states that “a POSA would have understood how to combine the teachings of Gotou and Karlsson by simply substituting Gotou's system with Karlsson's LED array and control.” (Petition at 64.) Petitioner further states that “Replacing Gotou's controllable non-LED light sources with Karlsson's controllable LED light sources would have also merely been applying a known prior-art solution from a finite number of identified, predictable solutions, with a reasonable expectation of success.” (Petition at 67.)

159. The Gotou-Karlsson combination replaces Gotou's light sources with Karlsson's LED array, however, it is unclear what other features of Gotou's “System” and Karlsson's “Control” are included in the proffered combination.

160. LED headlamps were in their infancy in the early 2000's, therefore

there were no predictable solutions, nor was there a reasonable expectation of success. Designing an LED Headlamp for a vehicle application requires consideration of optics, heat management, white LED lumen output, packaging, and cost issues. Petitioner considerations, resulting in a combination having no reasonable expectation of success.

**i. Optical System**

161. An optical system for a lighting system is designed based on the light source and the application. The '029 Patent describes, with reference to Figure 1, that 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.” (Ex. 1001, 25:17-21.) A light having an array of LED light sources may also include “a collimating lens for narrow beam generation.” (Ex. 1001, 78:60-62.)

162. Dr. Jiao explained that LEDs “use very unique optics” as compared to the optics for conventional light bulbs, and that “LED source-operated headlamps **always** use specific optics that's associated with that specific LED source.”

Q Did this Lexus headlamp assembly include different optics for the high beam that used incandescent light bulb as compared to the optics for the low beam that used LED light source?

MR. FITZSIMMONS: Objection. Form. Objection. Scope.

A LED, at least the LED portions use very unique optics. I don't recall the high beam.

(Ex. 2007, 28:15-29.)

Q Are these optics different than what would be used in a headlamp assembly that has incandescent bulbs or some other type of conventional light bulb?

MR. FITZSIMMONS: Objection. Form.

A LED source-operated headlamps always use specific optics that's associated with that specific LED source.

(Ex. 2007, 85:11-18.)

163. Dr. Jiao further agreed that “different optics are typically required for different beam patterns” and explained that “in almost all cases” LEDs use multiple optics, like, primary, secondary, tertiary, optics to provide certain functionality. (Ex. 2007, 63:15-22; 85:6-10.)

Q Okay. Does the headlamp need different structure, such as optics, to provide low-beam functionality versus fog-lamp functionality?

A Their beam patterns are different. Usually, the optics are different.

Q So different optics are typically required for different beam patterns?

A Yes.

(Ex. 2007, 63:15-22.)

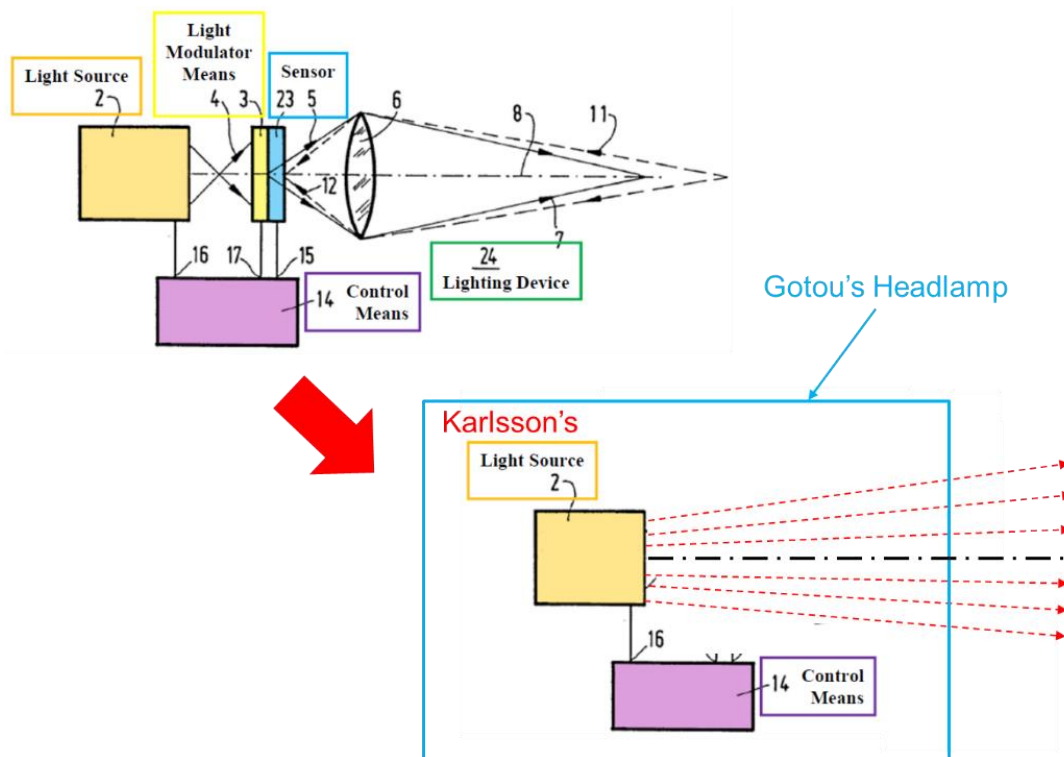
Q Do you typically use multiple optics, like, primary, secondary, tertiary, optics to provide high beam functionality?

MR. FITZSIMMONS: Objection. Form.

A Almost in all cases.

(Ex. 2007, 85:6-10.)

164. Petitioner discloses modifying Gotou to include Karlsson's light source 2; but does not disclose that the combination includes Karlsson's light modulator means 3 and lens 6 (See Figure 1). Karlsson's LED array without the associated optics would provide uncontrolled light along multiple axes as illustrated in the figure below.



Ex. 1010, Fig. 3 (Annotated)

165. Dr. Jiao explained that a headlamp assembly includes a single optical axis, and each light source includes an optical axis that is correlated to the headlamp assembly optical axis by “beam contributors” or optics. (Ex. 2007, 92:10-93:2.)

Q . . . Does the headlamp assembly have one optical axis?

A One assembly only had one optical axis.

Q Right. So how does the optical axis of each light source correlate to the optical axis of the headlamp assembly?

A It's all based on the beam contributors. Additively, if you have multiple sources, regardless where the optical axes are, additively, as long as they can meet that beam pattern in a center point or any other points. That center point of additive, of old optical access or optical sources -- I mean, LED sources, is not relevant. It's the lamp assembly will be tested using that lamp level optical axis.

(Ex. 2007, 92:10-93:2.)

166. Even if the Gotou-Karlsson combination did include Karlsson's optics, the optics would need to be redesigned to provide a different beam pattern, i.e., to illuminate an upcoming curve.

## **ii. Heat Management**

167. LEDs are temperature-sensitive devices, requiring heat management controls to maintain output performance. As explained by Dr. Jiao:

[An] 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.)

168. LED lighting systems often include additional structure “to carry away heat from the electronic components”, such as “heat sinks”, “forced circulation cooling” systems that include “a fan or pump” etc. (Ex. 1001, 35:58-60; Ex. 2007 at 47.)

169. Petitioner does not describe adding additional heat management structure to the Gotou-Karlsson combination to manage heat, and without such structure the combination would not provide predictable light output.

### **iii. Packaging**

170. Adding additional heat management structure would create packaging challenges because “it takes space.” (Ex. 2007 at 53.)

Q Now, this additional structure for the heat management, would that be included in the headlamp assembly itself?

A Almost all cases. It's very adjacent to LEDs.

Q Because it's by conduction, correct, so it heats?

A LED-generated conductive heat, conductive heat transferring.



Q Did these additional heat structures create any challenges with your packaging requirements?

A It does. It takes space.

(Ex. 2007, 53:6-9.)

#### iv. Control

171. Petitioner does not explain how “[s]imply substituting Gotou’s system with Karlsson’s LED array and **control**” (Petition at 64) would reconcile the different control strategies of Gotou and Karlsson during a turning maneuver. Karlsson’s control includes reducing light during a turning maneuver: “direction sensor 54, which is for example connected to the steering wheel . . . for determining when the car is taking a bend, so that the light beam 7 can be adapted to prevent the traffic on the other side of the road from being blinded.” (Ex. 1010, 20:22-32.) Gotou discloses swinging the headlamp along “the optical axis toward the planned running direction at an early stage before the steering wheel is actually turned” to increase light in a turn. (Ex. 1012, 6:40-44.) The ambiguity and lack of particularity of the Petition led the Board to excuse the inconsistencies in the references and find that Petitioner was not relying on Karlsson’s control strategy despite Petitioner expressly stating that it was:

[A] POSA would have understood how to combine the teachings of Gotou and Karlsson by simply substituting Gotou’s system with

Karlsson's LED array and control, as shown, for example, in Karlsson's Figures 14 (see also FIGs. 3 and 15).

(Petition at 64, emphasis added.)

As we understand the combination, Petitioner does not include Karlsson's direction sensor or control strategy as part of its combination. Pet. 73–75. Therefore, Petitioner did not have to explain any inconsistency between Karlsson's control approach and Gotou's.

(Decision of Institution (DI), Paper 7 at 15.)

172. Because Petitioner failed to explain how the proposed Gotou-Karlsson combination would operate with respect to: 1) exactly what elements of Karlsson's "LED array and control" are being substituted into Gotou's system; 2) controlling Karlsson's LED array along multiple optical axes to achieve Gotou's optical angle determination; and 3) controlling Karlsson's LED array using Karlsson's direction sensor while the steering wheel is being turned, Petitioner has failed to meet their burden of explaining how and why a POSA would have modified or combined Gotou and Karlsson.

**c. Modifying Gotou, as Proposed by Petitioner,  
Would Render Gotou Inoperable For Its  
Intended Purpose of Adjusting Illumination  
Direction**

173. Petitioner states that a "POSA would have been motivated to combine Gotou's adaptive vehicle headlamp that uses map data as a control input to predict and adjust illumination direction with Karlsson's controllable LEDs as a light

source.” (Petition at 55.) Petitioner further states that “Karlsson’s controllable LEDs would have simplified controlling the illumination direction and beam shape by removing Gotou’s moving parts (e.g., motors), while also providing expanded beam shaping abilities.” (*Id.*) The applied references contradict Petitioner’s assertions as Karlsson’s “controllable LEDs” are not controllable by Gotou’s ECU and the illumination direction and beam shaping abilities are not readily available without redesigning the optical system, thereby rendering Petitioner’s combination and modification inoperable for its intended purpose of adjusting illumination.

**d. Input Controls**

174. Although LEDs are controllable, they are controlled differently than conventional light bulbs with respect to the input voltage and waveform. LEDs are typically controlled, individually or in groups, using pulsed power to provide digital control. The ’029 Patent describes that the DLF includes power conditioning circuitry 5 to condition the power supplied to the light sources 3. (Ex. 1001, 25:14-16.) For example, the LEDs may be “operated on DC as well as 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.” (Ex. 1001, 23:22-25.) The power conditioning circuitry for an LED circuit is commonly referred to as an LED driver. An LED driver is typically designed to provide between three to twelve volts to an LED circuit of a headlamp assembly,

depending on number of LEDs and electrical circuit configuration. (Ex. 2007 at 20-21, 33-35, 174-176.)

175. Gotou discloses a “light distributing control ECU 10” that controls the motor 8 of a “swinging mechanism” to adjust the lamp unit 4 based on an optical axis angle  $\theta$ . (Ex. 1010, 3:24–67.) Gotou’s lamp unit includes a conventional light source that receives 12-Volt DC power for a vehicle battery. Such conventional light sources are typically supplied with constant voltage, not pulsed power, because the time constants associated with such sources do not switch rapidly. As explained by Dr. Jiao “incandescent filament take time to cool down or heat up . . . [y]ou cannot turn off immediately, like LED does.” (Ex. 2007 at 90.) Petitioner does not disclose that the Gotou-Karlsson combination includes Karlsson’s “control means.” Accordingly a POSA would not have been motivated to combine Gotou and Karlsson as proposed, because Gotou’s ECU, with its limited control capability, would not have been capable of providing digital control of Karlsson’s LED array at the correct input voltage.

176. Petitioner includes Karlsson’s control means in one of its many alternative grounds. (Petition at 69; DI at 9 FN 8.) However, such a combination would still fail because a POSA would not have included two controllers for the headlamp in view of the cost restrictions in the Automotive industry. As explained by Dr. Jiao, cost is a significant consideration in the auto-industry and the

additional components, such as the driver, added significant cost. (Ex. 2007 at 31:21-33:19.) Accordingly, a POSA would not have included Karlsson's LED driver, in addition to Gotou's ECU, because the redundant controller would make the Gotou-Karlsson combination cost-prohibitive for an automotive application.

**e. Output Controls**

177. Petitioner did not argue that the Gotou-Karlsson combination includes Karlsson's optics. Even if the Gotou-Karlsson combination did include Karlsson's optics, the optics would need to be redesigned to accommodate the Gotou beam pattern toward an upcoming curve. Without these additional optical system changes, Petitioner's proposed modification to Gotou would render Gotou unsatisfactory for its intended purpose of "varying the optical axis . . . before the steering wheel is actually turned." (Ex. 1012, 6:40-44.) Furthermore, there would be no adjustment to the optical axis by an angle  $\theta$  as required by Gotou. Accordingly, there is no suggestion or motivation to make Petitioner's proposed modification. Rather, there are good reasons not to make the proposed modification. (*Id.*) See *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).

**VII. Conclusion**

178. In my opinion, a POSA would not be motivated to replace an incandescent or other single light source with an extended source such as an LED

array due to the complexities and challenges associated with redesigning the entire system to accommodate such an extended source, particularly for an extended source implemented by an array of LEDs.

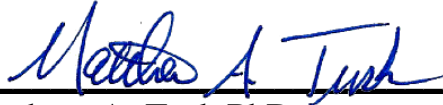
179. In my opinion, the complexities and challenges associated with LEDs and substituting an LED array for a conventional light source to make a forward lighting system that meets applicable regulations and standards would be beyond routine for a POSA and there would be no reasonable expectation of success for the resulting forward lighting system.

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: August 16, 2023

  
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Matthew A. Turk PhD