

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VOLKSWAGEN GROUP OF AMERICA, INC.,
Petitioner,

v.

YECHEZKAL EVAN SPERO,
Patent Owner.

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

Case No.: IPR2023-00335

SECOND DECLARATION OF MATTHEW A. TURK PhD

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List of Exhibits

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

Exhibit No.	Description
2013	Ben Wang and Jianzhong Jiao “Optical Transform Limitations in Headlamp Photometric Performance,” SAE Technical Paper Series 2005-01-0861, (April 2005) (Available at https://www.sae.org/publications/technical-papers/content/2005-01-0861/)
2014	Intentionally left blank
2015	Jianzhong Jiao and Ben Wang “High-Efficiency Reflector Optics for LED Forward Lighting,” SPIE Proceedings Vol. 6670, (September 2007) (Available at https://www.spiedigitallibrary.org/conference-proceedings-of-spie/6670/66700M/High-efficiency-reflector-optics-for-LED-automotive-forward-lighting/10.1117/12.730524.short)
2016	Navigant Consulting “Energy Saving Estimates of Light Emitting Diodes in Niche Lighting Applications” Building Technologies Program Office of Energy Efficiency and Renewable Energy U.S. Department of Energy (September 2008) (Available at Energy Savings Estimates of Light Emitting Diodes in Niche Lighting Applications (Technical Report) OSTI.GOV.)
2017	PCT Publication No. WO 86/05147 to Flaaten
2018	Transcript of Deposition of Jianzhong Jiao, Ph.D. taken on August 23, 2023, <i>Volkswagen Group of America, Inc. v. Torchlight Technologies LLC</i> , IPR2023-00315, IPR2023-00318.
2019	Intentionally left blank
2020	Michael Bass, <i>Handbook of Optics</i> 3 RD Edition Volume V, (McGraw-Hill, 2010) (Available at https://www.worldcat.org/title/557121959.)
2021	Texas Instruments/Digikey “How DLP Technology Works,” (Available at https://www.digikey.com/en/product-highlight/t/texas-instruments/dlp-technology.) (Accessed September 12, 2023.)
2022	Texas Instruments “Introduction to +/- 12 Degree Orthogonal Digital Micromirror Devices (DMDs) (Available at https://www.ti.com/lit/an/dlpa008b/dlpa008b.pdf?HQS=dis-dk-null-digikeymode-dsf-pf-null-ww&DCM=yes&distId=10) (Accessed September 12, 2023.)

Exhibit No.	Description
2023	Intentionally left blank.
2024	Intentionally left blank.
2025	Transcript of Deposition of Jianzhong Jiao, PhD taken on October 3, 2023, <i>Volkswagen Group of America, Inc. v. Torchlight Technologies</i> , IPR2023-00197

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

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

3. I previously prepared a declaration in this proceeding dated April 19, 2023, submitted as an exhibit (Ex. 2001) with a Patent Owner Preliminary Response of the ‘503 Patent to a Petition filed on December 23, 2022 by Petitioner Volkswagen Group of America. I understand that on July 17, 2023, the Board instituted the Petition.

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

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

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

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

I. Qualifications and Professional Experience

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

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

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

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

winning the ACM Multimedia Open Source Competition in 2015.

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

13. In 2000, I joined the faculty of the University of California, Santa Barbara, as an Associate Professor. In 2005, I was promoted to Full Professor and served as the Chair of the Media Arts and Technology Graduate Program from 2005 to 2010. In 2017, I was appointed as Chair of the Department of Computer Science. At UCSB, I taught graduate and undergraduate courses related to 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 '503 Patent in light of the prior art.

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

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

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

III. State of the Art as of 2002

A. POSA Considerations for LED Forward Lighting

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

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

B. Regulations and Standards

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

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

(Ex. 2010¹ at 237.)

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

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

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

(Ex. 2010 at 234.)

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

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

(Ex. 2010 at 237.)

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

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

(Ex. 2011² at 40.43.)

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

* * *

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

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

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

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

(Ex. 2012³ at 6-7, emphasis added.)

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

(Ex. 2010 at 237-238.)

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

(Ex. 2010 at 234.)

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

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

for use in increasing output light from vehicle headlamps.

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

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

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

* * *

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

⁴ Available at

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

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

(Ex. 2011 at 18.5.)

C. Design Tradeoffs

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

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

(Ex. 2012 at 4.)

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

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

(Ex. 2010 at 238.)

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

(Ex. 2010 at 240.)

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

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

(Ex. 2012 at 3, emphasis added.)

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

(Ex. 2010 at 238, emphasis added.)

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

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

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

(Ex. 2010 at 238.)

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

(Ex. 2012 at 4, emphasis added.)

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

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

(Ex. 2012 at 3, Abstract.)

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

(Ex. 2012 at 3, emphasis added.)

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

(Ex. 2010 at 242.)

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

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

(Ex. 2012 at 7, emphasis added.)

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

* * *

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

(Ex. 2012 at 8, emphasis added.)

D. Hardware

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

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

(Ex. 2012 at 3.)

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

(Ex. 2012 at 10.)

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

(Ex. 2010 at 237.)

E. Optical System

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

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

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

(Ex. 2010 at 240.)

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

(Ex. 2012 at 3.)

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

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

(Ex. 2010 at 234.)

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

* * *

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

* * *

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

* * *

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

(Ex. 2013⁵ at 10.)

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

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

(Ex. 2012 at 10, emphasis added.)

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

(Ex. 2012 at 11.)

F. Spatial Light Modulator

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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G. Heat management

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

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

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

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

(Ex. 2015⁹ at 7.)

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

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

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

* * *

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

* * *

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

(Ex. 2011, at 18.6.)

H. Packaging

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

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

(Ex. 2010 at 237.)

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

(Ex. 2012 at 3.)

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

(Ex. 2010 at 238.)

I. Cost

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

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

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

(Ex. 2011 at 18.5.)

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

(Ex. 2016¹⁰ at 66.)

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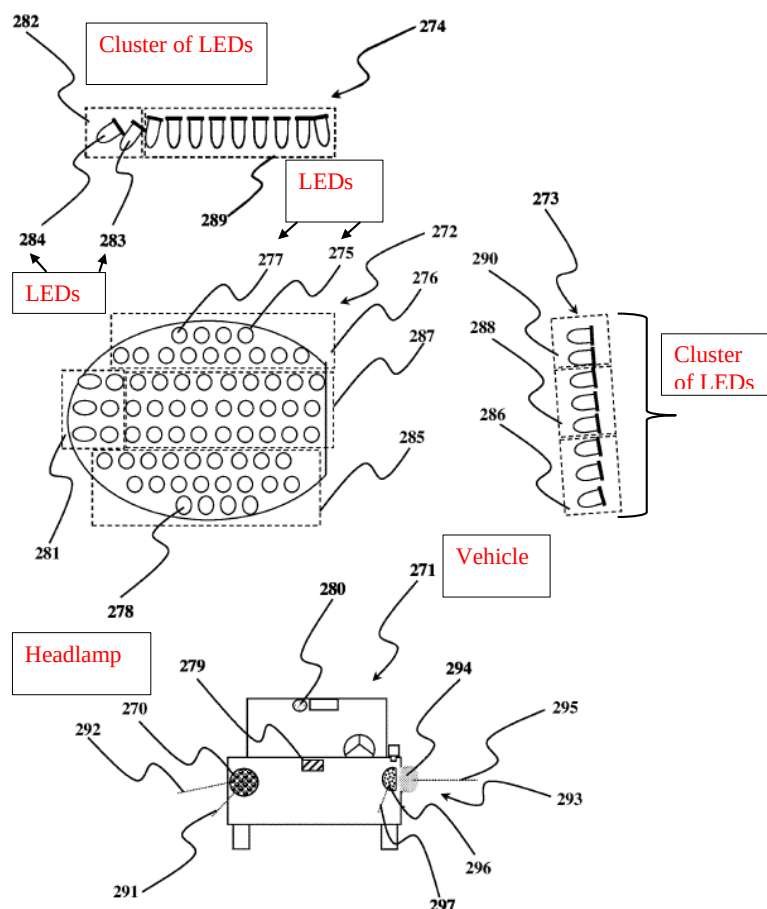
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IV. Overview of the ‘503 Patent

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

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

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



(Ex. 1001, Fig. 15, Annotated)

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

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

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

50. In the context of headlights,

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

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

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

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

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

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

53. The Challenged Claims include independent claims 1 and 37, which are reproduced below with claim identifiers:

[1.P] A vehicle headlight system comprising:
[1.1] one or more headlamps and a vehicle structure, arranged for affixing components of the system to the vehicle;
[1.2] a plurality of light clusters, arranged in each of the one or more of the one or more headlamps,
[1.3] the headlamps capable of projecting light so as to illuminate a plurality of sub-sections of a field-of-view with different illumination characteristics,
[1.4] the subsections determined in response to sensor data, wherein the light

clusters operate to create a headlight beam;
[1.5] electronic control circuitry configured to independently operate the light clusters;
[1.6] one or more sensors configured to obtain and provide the sensor data predefined as pertinent to illumination requirements for the field-of-view; and
[1.7] a logical controller including a processor, the processor in communication with a memory storing one or more algorithms, with the sensors, and with the control circuitry,
[1.8] wherein the processor is configured to process the one or more algorithms and the sensor data to determine an illumination for at least two of the sub-sections,
[1.9] that reduces illumination to reduce glare in at least a first of the at least two subsections and
[1.10] adapt the light emitted from one or more of the light-clusters so as to create the headlight beam that provides the determined illumination.
[37.P] A vehicle headlight system comprising:
[37.1] one or more headlamps affixable to a first vehicle;

[37.2] a plurality of light clusters arranged in each of the one or more of the headlamps and

[37.3] capable of illuminating sub-sections of a field-of-view with different illumination characteristics,

[37.4] wherein at least two of the light clusters operate to create a headlight beam;

[37.5] one or more sensors configured to obtain and provide sensor data,

[37.6] at least a portion of the sensor data indicating a second vehicle within the field-of-view; and

[37.7] at least one processor configured to: receive the sensor data; process the sensor data to determine a light distribution pattern for an adaptive headlight beam,

[37.8] such that a headlight beam adapted to the pattern substantially illuminates a first subsection of the field-of-view including at least a portion of the second vehicle with an illuminance below a predefined threshold value,

[37.9] while the beam substantially illuminates at least the one or more second subsections of the field-of-view to either side of the first subsection with an illuminance above the predefined threshold value; and

[37.10] instruct operation of at least two of the light clusters to create the adapted headlight beam.

54. The dependent claims include additional innovative features that specify illumination strategies for a myriad of driving situations—for example, increasing illumination in a direction of the road curvature or a turn (claims 15-17, 54-56), and identifying vehicles or determining the position of vehicles (claims 7, 8, 11, 47, 48, 50).

V. Qualifications of one of ordinary skill in the art

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

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

ordinary skill:

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

(Petition at 6.)

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

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

(DI at 8.)

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

VI. Proposed Claim Constructions

59. In order to properly evaluate these claims, I understand that the terms of the claims must first be construed. For purposes of this declaration, I am applying the following claim construction for my analysis regarding patentability. I understand that the proposed construction of the term "*light source*" is "any system

that is capable of receiving an electrical signal and producing light in response to the signal.”

VII. Overview of the Prior Art

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

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

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

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

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

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

From the viewpoint of the driver of an automobile equipped with AABH, it will be like having bright high beams on at all times but

without concern that the other motorists within the extent of his headlight beam will be dazzled.

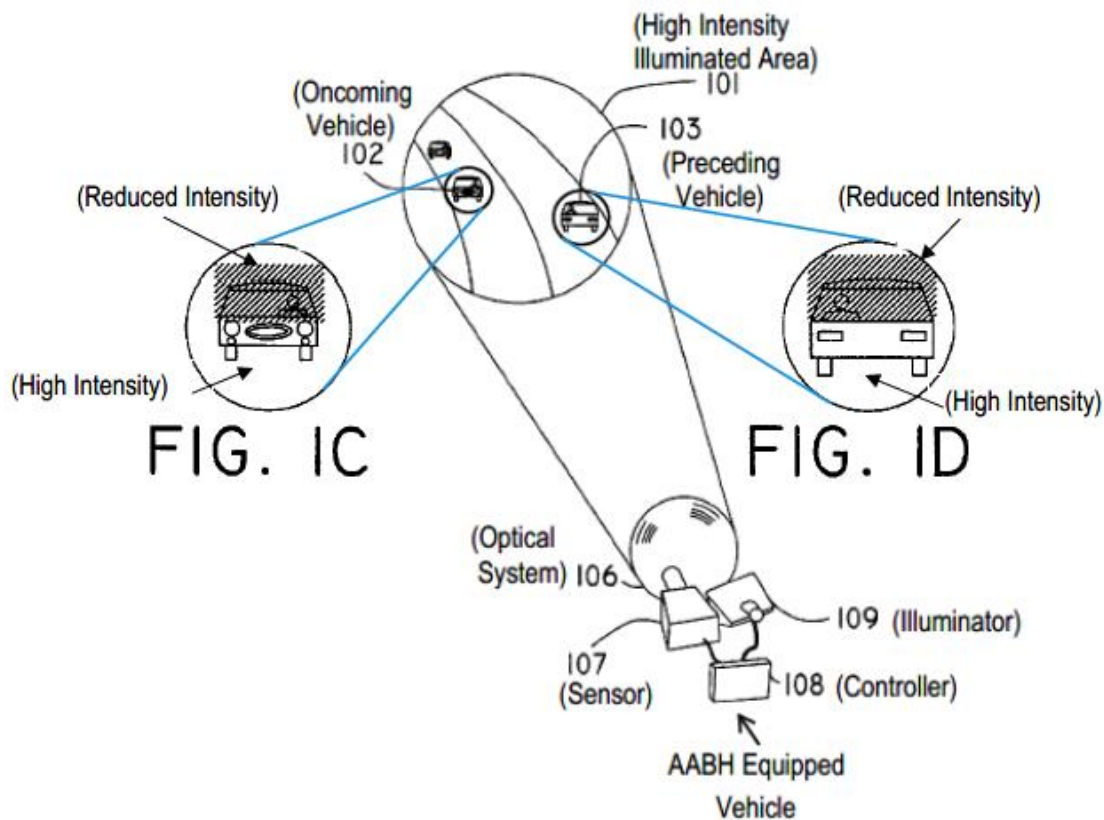
* * *

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

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

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

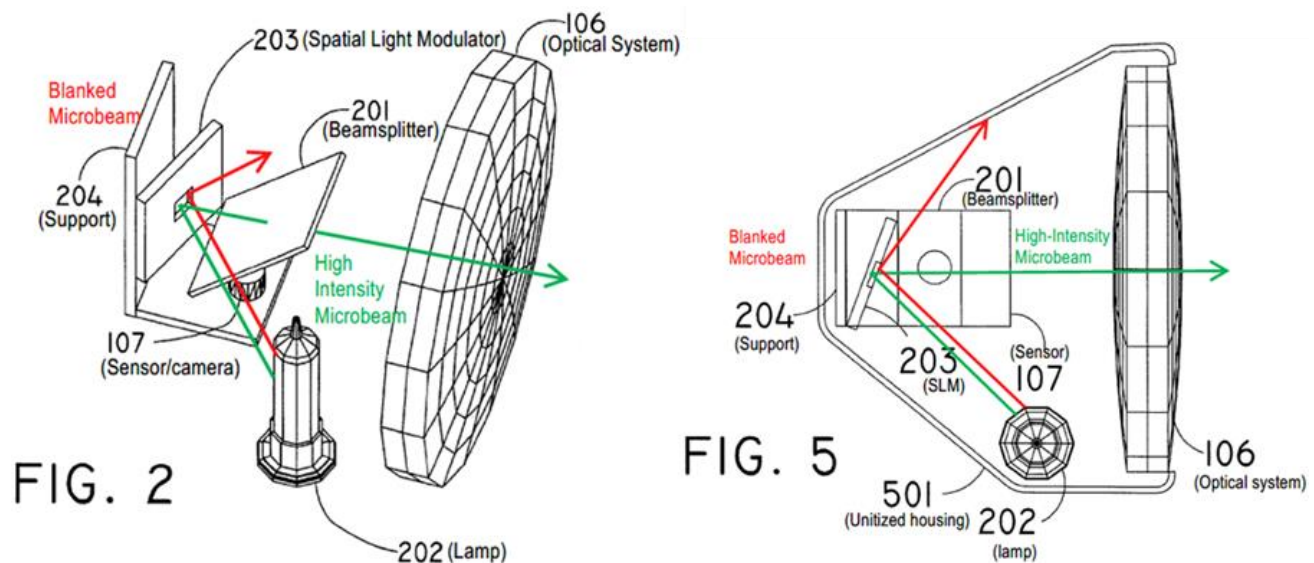
63. Beam provides significantly **reduced** illumination only in those portions of the headlight beam that would otherwise dazzle or annoy other drivers. This is accomplished by “darken[ing] those microbeams that would otherwise illuminate areas near to the source of the impinging beam, thus eliminating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



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

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

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

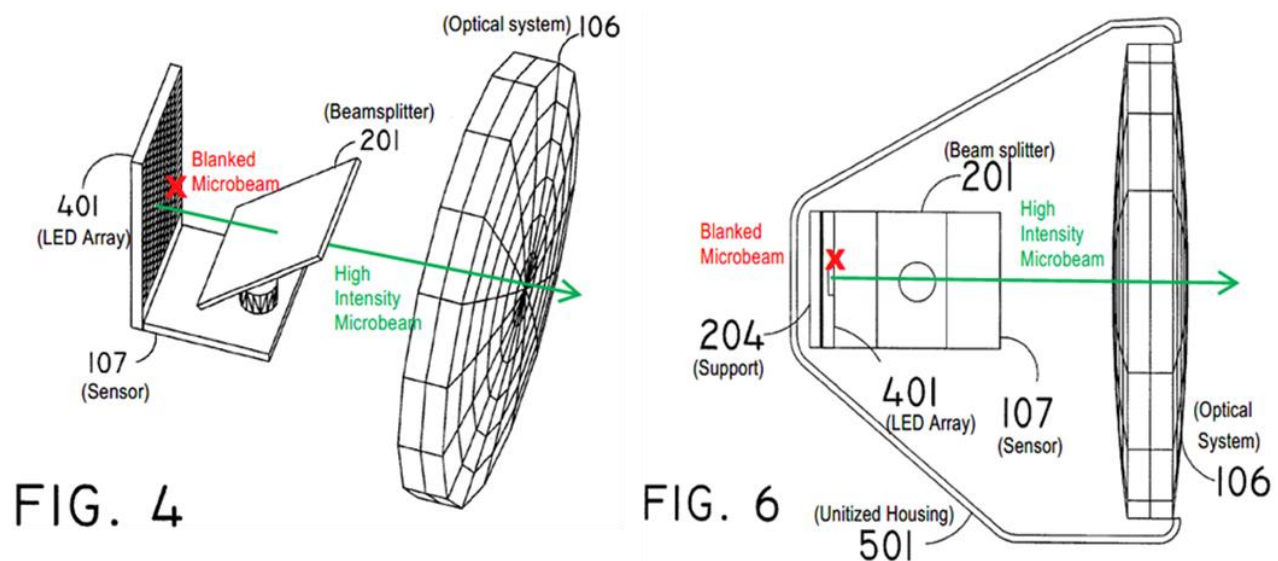


(Ex. 1005, FIGs. 2, 5, Annotated)

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

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

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



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

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

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

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

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

70. Intentionally left blank.

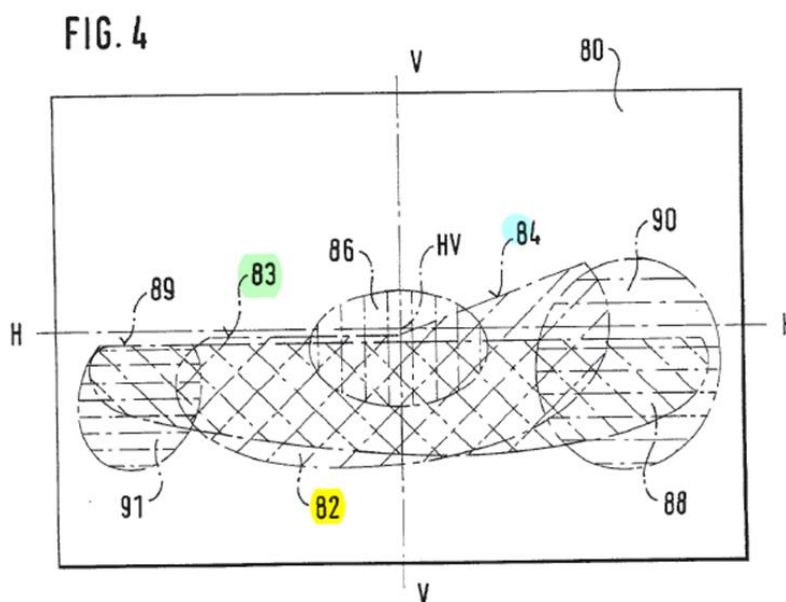
B. Thominet: U.S. Application Pub. No. 2001/0019486

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

72. While Thominet discloses that LEDs can be arranged in one plane or distributed “over a concavely curved surface or a stepped surface,” Thominet does not suggest any advantages, disadvantages, functional differences or other reasons

to select any of the possible arrangements for any particular application. (Ex. 1006, claim 8, ¶0018.)

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



(Ex. 1006, Fig. 4, Annotated)

74. On review of Thominet, a POSA would understand that the LEDs of the array are neither controlled as a single group (as in the recognized prior art) nor as individual light sources as in Beam's AABH system to create the different illumination patterns as shown in Fig. 4. Rather, predefined groups of LEDs are actuated depending on the associated desired functions to be operated. A POSA would also understand that by segmenting the LED array into sections with

different functions, the intensity of the resulting beam is necessarily reduced relative to a maximum attainable intensity associated with actuation of the entire array of LEDs.

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

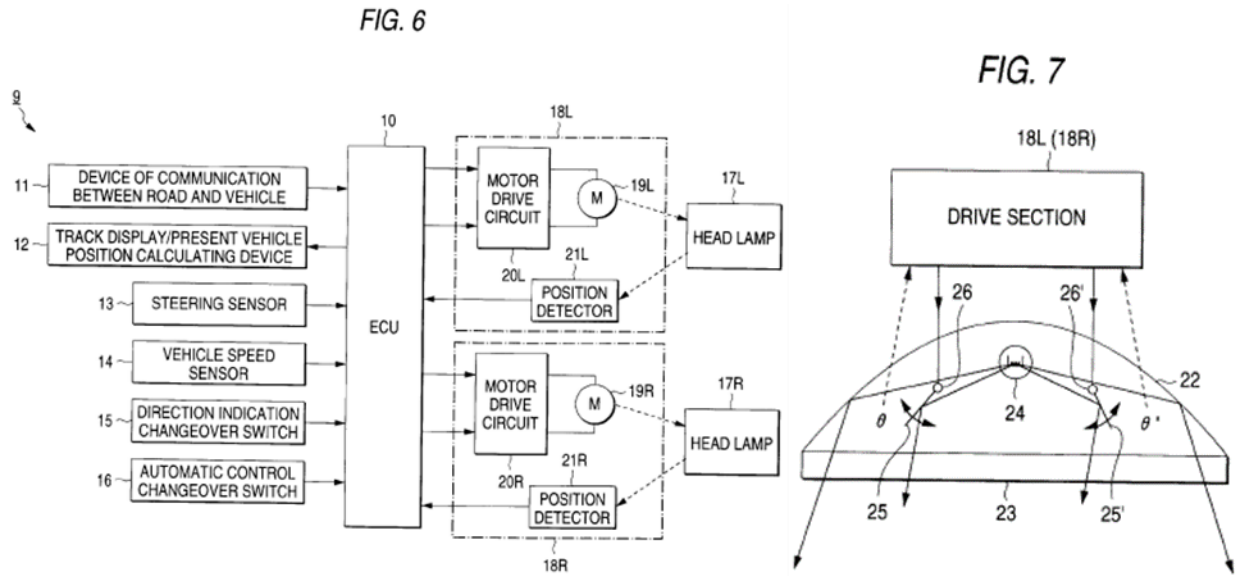
76. A POSA would also understand that Thominet describes conceptual arrangements and generalized automatic switching between illumination functions based on parameters such as speed, steering wheel action, wiper system, or a sensor system for recognizing counter traffic without describing any processing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

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

77. Kobayashi discloses a “Lighting Device for a Vehicle.” (Ex. 1008.) Kobayashi is directed to a headlight control system that changes direction or range of a headlight beam using map information unless a predicted vehicle travel direction as indicated by a turn indicator, steering angle, and vehicle speed/acceleration differs from the map data, i.e., “[w]hen the vehicle advancing direction at which the driver aims does not coincide with the profile of the road.”

(Ex. 1008, 3:10-27.) More specifically, Kobayashi discloses a headlamp system with moveable components to control irradiation (illumination) direction and range in accordance with a road profile when the vehicle travels along a scheduled course, or in accordance with a steering angle and vehicle speed when the predicted advancing direction of the vehicle deviates from the scheduled course (Ex. 1008, 6:4-10; 17:59-67.) A “mechanical” and “moveable” system as used in this context refers to a system with moving parts and/or mechanisms to position the light beam.

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



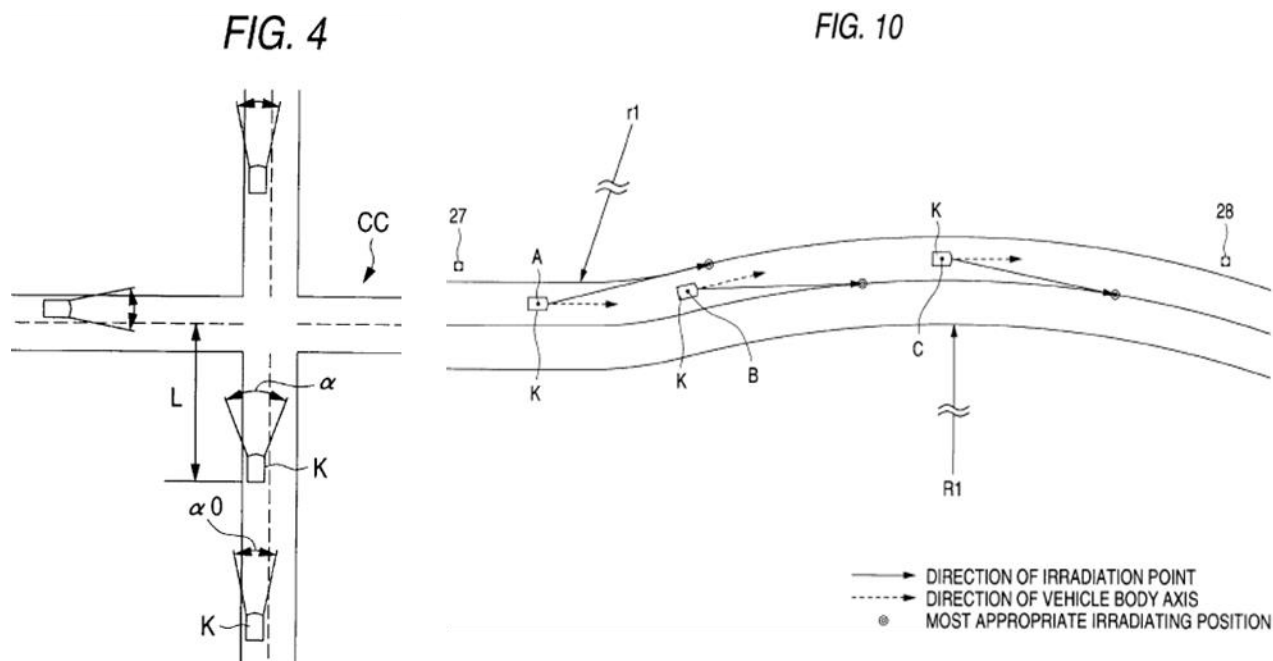
(Ex. 1008, FIGs. 6, 7)

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

80. Figure 7 illustrates a headlamp with moveable composing members to control the direction and range of irradiation. Light source 24 and movable

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

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



(Ex. 1008, FIGs. 4, 10)

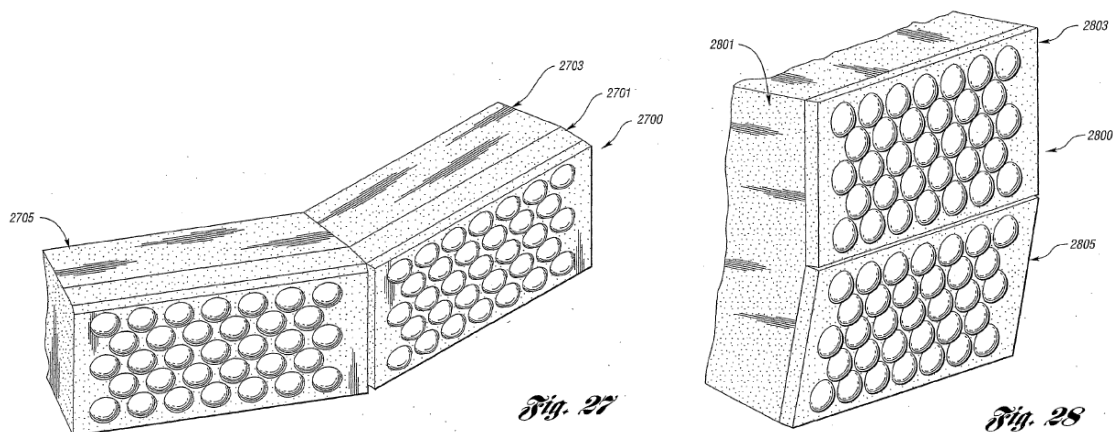
82. As shown in Figure 4, Kobayashi's headlamp motors are operated to increase horizontal irradiating angle α_0 to $\alpha > \alpha_0$ based on a distance L from intersection CC and vehicle speed. (Ex. 1008, 8:14-25.) In Figure 10, the headlamp

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

83. Intentionally left blank.

D. Stam: WIPO Publication No. 2001/1070538

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



(Ex.1007, Figs. 27, 28)

E. Braun: WIPO Publication No. 2002/004247A

85. Braun discloses a “Method and Apparatus for Providing Adaptive Illumination.” (Ex. 1009, Title.)

86. Intentionally left blank.

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

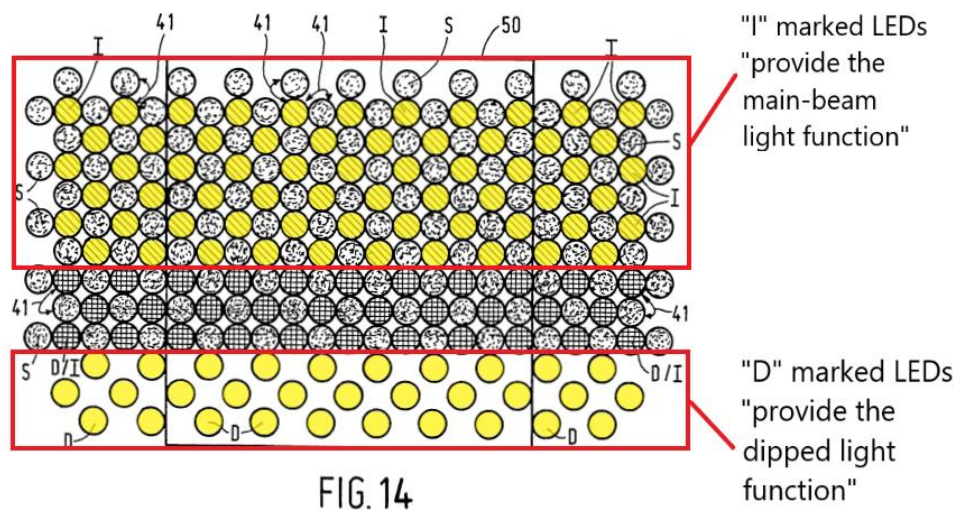
87. Karlsson discloses a “Lighting Device Having a Controllable Lighting Pattern,” wherein light sensors are interspersed with the LED “spotlight beams” to provide anti-blinding functionality, and the LEDs are dimmed during light sensor measurements so light from the LEDs doesn’t interfere with detecting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

88. Despite the lack of details, one consistent and reasonable interpretation emerges from the Karlsson reference when viewed in totality along with the referential prior art, contemporaneous evidence, applicable regulations

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

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

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



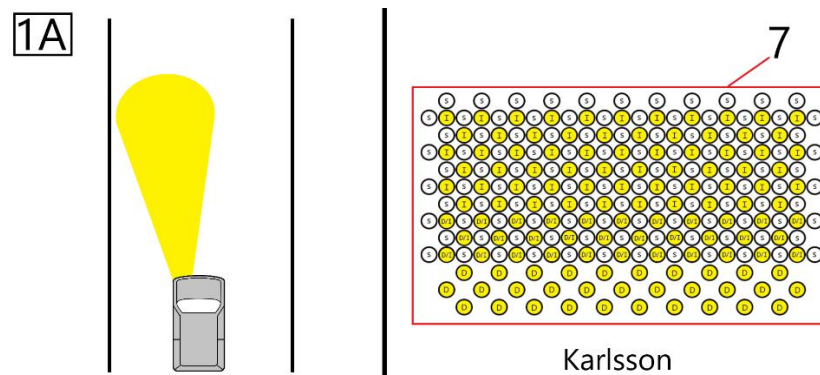
(Ex. 1010, Fig. 14, Annotated)

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

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

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

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



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

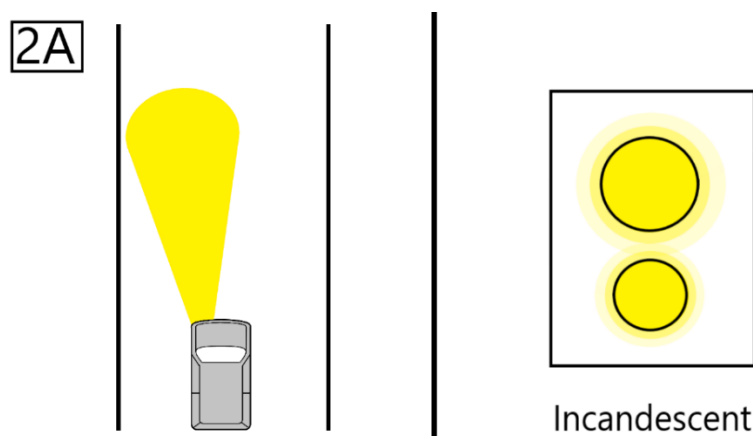


Figure 2A

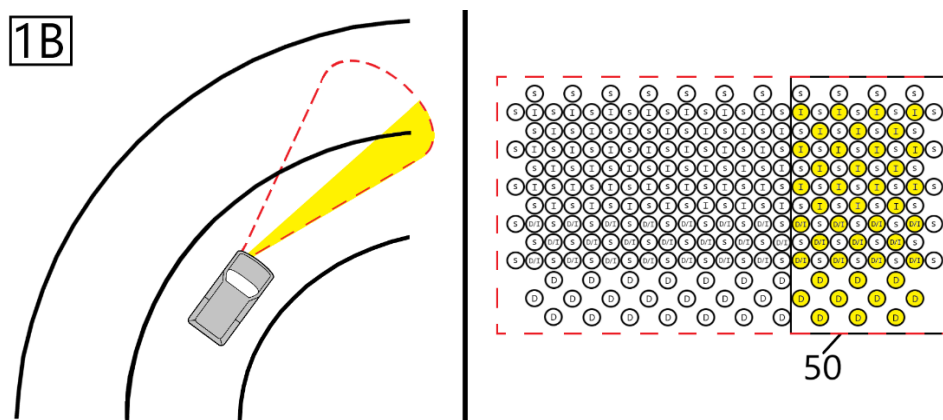
93. Karlsson then uses Fig. 14 to illustrate a “reduction” control strategy to reduce emitted beam 7 in a manner that provides anti-glare functionality for specific situations, and allows for expanded usage of the main/high beam light. (Ex. 1010, 20:6-11.) The situationally adjustable beam 50 illustrates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

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

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

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

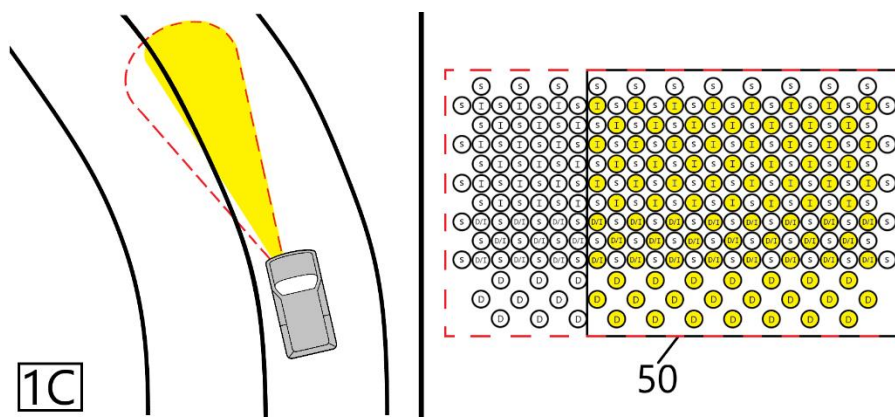
96. Karlsson addresses glare caused when a vehicle is taking a curve, the beam may be “adapted” (shifted) away from the other lane. (Ex. 1010, 1:34-2:1; 20:29-32.) This shift, however, is not a shift of the entire main driving beam 7, it is a temporary **reduction** of the beam aimed at the opposite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



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

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

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

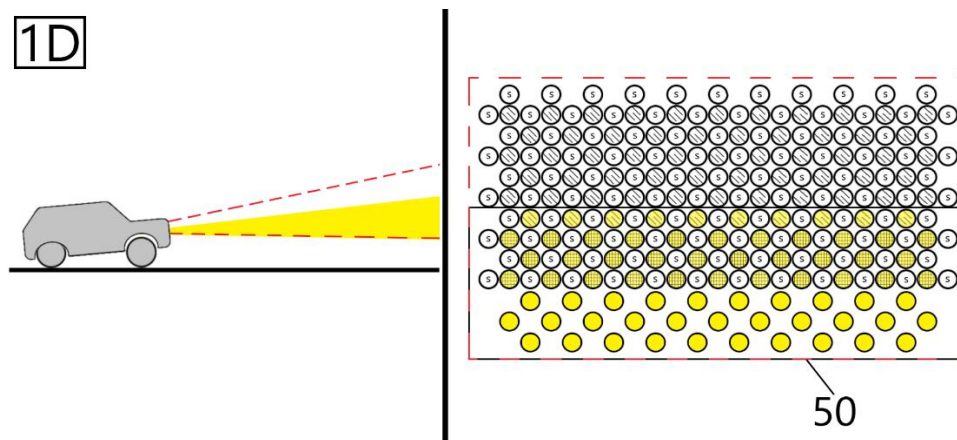


(Ex. 1010, Fig. 14, Annotated)

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

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

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



(Ex. 1010, Fig. 14, Annotated)

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

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

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

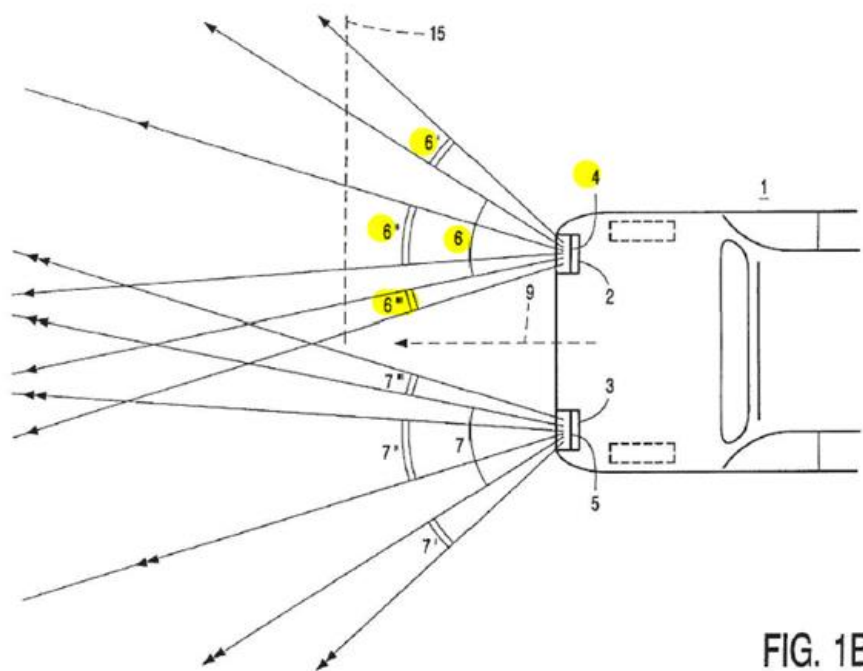
device of the “type known from” WIPO Patent Publication WO 86/05147 (“Flaaten,” Ex. 2017), which uses light sensitive detectors and a control unit to detect and control the light distribution pattern of a headlight “based on the distribution of detected light.” (Ex. 2017, Abstract; Ex. 1010, 1:1-7) Flaaten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

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

G. Harbers: WIPO Publication No. 2001/001038

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

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



(Ex. 1011, FIG 1B, Annotated)

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

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

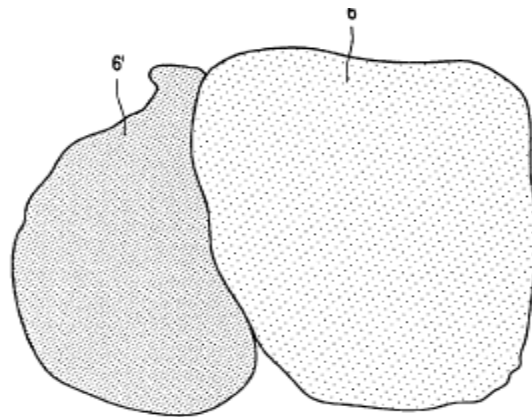


FIG. 3A

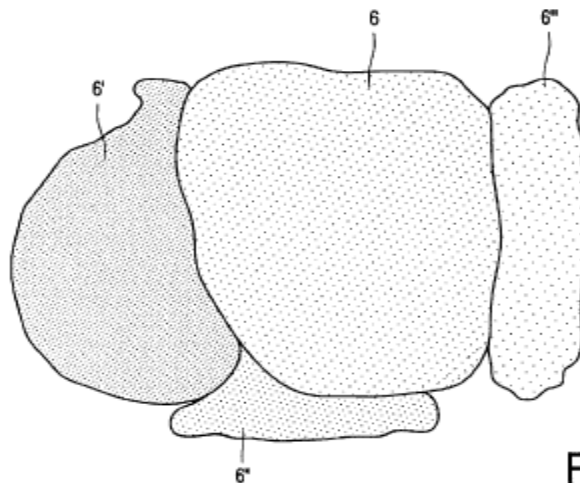


FIG. 3B

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

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

34.)

106. In another embodiment, Harbers discloses that:

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

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

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

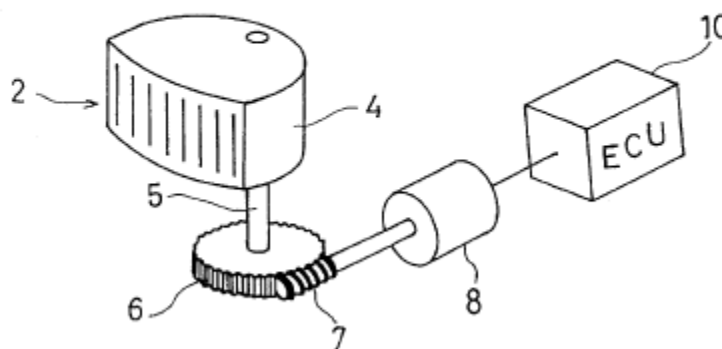
H. Gotou: U.S. Patent No. 5,588,733

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

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

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

FIG. 2

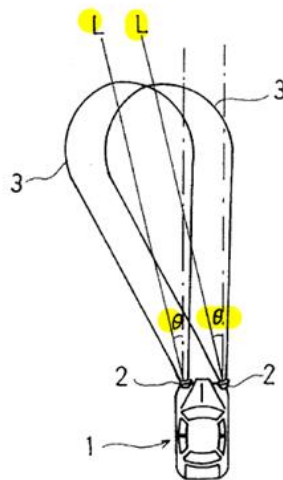


(Ex. 1012, FIG. 2)

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

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

FIG. 1



(Ex. 1012, FIG. 1, Annotated)

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

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

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

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

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

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

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

VIII. The Petition Lacks Particularity

114. The Petition presents at least two different obviousness combinations to challenge each of the Challenged Claims. When unpacked, it becomes clear that Grounds 1 and 7 are each actually at least five distinct sub-grounds as illustrated in the following table:

Ground	References
1A	Beam Lamp+SLM
1B	Beam LEDs
1C	Beam Lamp+SLM + Thominet Software (SW)
1D	Beam SW + Thominet LEDs (HW)
1E	Beam LEDs + Thominet Curved Substrate
7A	Karlsson LEDs + Mod
7B	Karlsson LEDs
7C	Karlsson LEDs+Mod+ Harbers SW
7D	Karlsson LEDs + Harbers SW

7E	Karlsson SW + Harbers HW
7F	Karlsson Mod+ Harbers Curved Substrate

1. Ground 1A (Beam Lamp+SLM); Ground 1B (BeamLEDs).

115. Although Ground 1 is presented as an obviousness ground, Petitioner argues that Beam alone teaches the limitations: “[i]f Patent Owner argues, incorrectly, [that] Beam does not disclose [1.2], Beam-Thominet renders it obvious.” (Petition at 17.) Petitioner argues two discreet embodiments of Beam: a light source plus spatial light modulator (SLM) embodiment and an LED embodiment where Petitioner contends that the LED array “has the same functionality as lamp 202 and SLM 203.” (*Id.*, 9.) Petitioner does not explain how or why a POSA would have combined elements of Beam’s distinct embodiments, indicating that Petitioner argues them as separate grounds (1A, 1B). Beam does not disclose that these embodiments are interchangeable; instead Beam discloses that in its LED array embodiment, the conventional “lamp 202 and spatial light modulator 203 are replaced by an array of light sources 401” (Ex.1005, 5:3-6.)

2. Ground 1C: (Beam+ThominetSW)

116. Petitioner also uses disjunctive (at times in concert with conjunctive) terminology to combine each primary reference with one or more teachings of a

secondary reference, creating multiple additional grounds. For example, regarding Ground 1, Petitioner proposes combining Beam with Thominet’s “either software or hardware” teachings. (Petition, 10.) Thominet’s software is described as an “additional control technique” that is “implemented with Beam’s controller 108/illuminator 109 (including SLM 203).” (Petition, 11-12.)

3. Ground 1D: (Beam+ThominetHW)

117. Petitioner also proposes combining Beam with Thominet’s hardware: “Second, a POSA would have sought to incorporate known components (hardware implementation) of Thominet’s semiconductor light sources 10 on curved surface 12 . . . into Beam (with flat array of light sources 401).” (Petition at 13.) Petitioner describes the combination as “combining”, “substitut[ing]”, and “modify[ing]” Beam: “This would have been combining prior-art elements or a simple substitution of one known element for another (Beam’s LED array on a flat surface and Thominet’s semiconductor sources 10 on a curved surface 12).” (Petition, 14.)

4. Ground 1E: (Beam+Thominet Curved Substrate)

118. Petitioner also proposes modifying Beam’s substrate to provide a curved substrate in view of Thominet: “A POSA would have had a reasonable expectation of success combining Beam and Thominet, for example, by modifying the flat surface of Beam’s LED array with Thominet’s curved surface 12 to provide multiple light clusters/sources (e.g., beam regions 22, 24, 26, 28) for different

functions.” (Petition, 14-15.).

5. Ground 7A: Karlsson Lamp + SLM; Ground 7B: Karlsson LED Array.

119. Similarly, regarding Ground 7, Petitioner argues that “[i]f Patent Owner argues, incorrectly, that Karlsson does not disclose [1.2]/[37.2], Harbers does.” (Petition at 94.) Petitioner argues two discrete embodiments of Karlsson: a lamp + SLM embodiment, and an LED array embodiment. (Petition, 93-95, 147.)

6. Ground 7C-7D: Karlsson + Harbers Software

120. Petitioner proposes combining Karlsson with Harber’s “either software or hardware” teachings. (Petition, 96.) Harbers’ software is described as an “additional control technique.” (Petition at 96-97.)

7. Ground 7E: Karlsson + Harbers Hardware

121. Petitioner also proposes combining Karlsson with Harbers hardware: “Second, a POSA would have sought to incorporate known components (hardware implementation) of Harbers’s opto-electronic elements 11-14 on a “curved substrate” (with differently aimed opto-electronic elements 11-14 . . .) into Karlsson.” (Petition at 99.) Petitioner describes the combination as “combining”, “substitut[ing]”, and “modify[ing]” Karlsson: “This would have been combining prior-art elements or a simple substitution of one known element for another (Karlsson’s lighting means 2, 3 on a flat substrate and Harbers’s opto-electronic elements on a curved substrate) according to known methods to yield predictable

results.”

8. Ground 7F: (Karlsson+Harbers Curved Substrate)

122. Petitioner also proposes modifying Karlsson’s substrate to provide a curved substrate in view of Harbers: “A POSA would have had a reasonable expectation of success combining Harbers with Karlsson, for example, by simply modifying the Karlsson’s flat substrate as in Harbers’s curved substrate to provide multiple light clusters/sources for different functions.” (Petition, 100.)

123. I understand that the sub-grounds of Grounds 1 and 7 cascade through Grounds 2-6, and 8-9 to collectively provide **forty-seven grounds**.

124. Intentionally left blank.

125. Intentionally left blank.

IX. Grounds for Challenge

A. Ground 1 – Beam and Thominet

1. Independent Claims

a. Claim 1 – The Beam/Thominet Combinations do not teach “*determin[ing] an illumination . . . to reduce glare.*”

126. Claim 1 requires “*wherein the processor is configured to process the one or more algorithms and the sensor data to determine an illumination for at least two of the sub-sections, that reduces illumination to reduce glare.*”

127. The plain meaning of illuminate is “to supply or brighten with light”

or “to make luminous or shining.” (www.merriam-webster.com/dictionary/illuminate.)

128. This plain meaning is consistent with the ‘503 Patent specification which teaches three different operating states for the light emitting elements: 1) operating at full power; 2) operating at a fraction of full power at a reduced intensity and 3) not operating. (Ex.1001, 19:30-37.) Per the ‘503 Patent, shutting off a light element is distinct from reducing intensity. (Ex.1001, 65:37-41.)

129. Petitioner relies on Beam’s disclosure at 6:12-19 for satisfying this limitation. (Petition at 32.)

(1) All Sub-Grounds

130. Beam discloses “AABH headlights [that] will operate at maximum intensity at all times.” (Ex. 1005, 6:11-12.) Beam further discloses that 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.” (Id., 6:14-19.)

131. Beam does not teach “*adapt[ing] the light emitted*,” it teaches zeroing or blanking emission. Beam generates a darkened area of reduced illumination by blanking or inactivating associated LEDs so they are not “active emitters,” it determines areas not to be illuminated, it does not determine areas to be

illuminated nor reducing the intensity of LEDs to “adapt the light emitted.” Beam teaches a binary system – “dimmed” emitters that are blanked to become inactive and active emitters that output “maximum intensity” emission “at all times”: the controller 108 “uses the data to determine the size and position of the light emitters to be dimmed. The output of the active emitters is projected through the optical system.” (Ex.1005, 5:13-16.) This understanding corresponds with Beam’s teaching about blanking light and the description of both “dimming” an area and describing that area as a “blanked” area. (Id., 5:66-6:27.)

132. Because Beam teaches a binary system, where the changed LEDs are zeroed or blanked, the system no longer emits light, Beam fails to teach “adapt[ing] the light emitted . . . that provides the determined illumination” as required by Claim 1.

133. Intentionally left blank.

2. Dependent Claims

b. Claim 2 – Beam-Thominet Combinations do not teach “*control of . . . light modifying elements.*”

134. Claim 2 depends from claim 1 and requires “*one or more light modifying elements provided in the path of light . . . further controlling the light-source characteristics; wherein the structure combined with control of the light sources and light modifying elements . . .*”

135. Petitioner argues that “Beam’s SLM 203 is a ‘light modifying element[.]’ . . . Beam’s optical system 106 (bi-convex lens) and/or Beam-Thominet’s lens 43, 46 of semiconductor source 10 (LED) is a ‘light modifying element[.]’ without specifying which specific reference/embodiment it is relying on for satisfying the “*light modifying element*” limitation in each sub-ground. (Petition, 36-37.)

(1) Ground 1B (BeamLEDs)

136. Beam discloses that in the LED Array embodiment, the conventional “lamp 202 and spatial light modulator 203 are **replaced** by an array of light sources 401.” (Ex.1005, 5:3-6.) Beam discloses that the LED array embodiment includes the optical system 106 (Ex. 1005, Fig. 4), which is a passive optic. The Beam LED Array embodiment does not teach “*control of . . . light modifying elements.*”

(2) Ground 1D (Beam+ThominetHW)

137. Thominet discloses passive optical element 43 and passive lenses 46. (Ex. 1006, [0029]-[0030], Figs. 5,6.) Thominet does not teach controllable “*light modifying elements*” hardware, therefore the Beam+ThominetHW combination does not teach all claim limitations.

138. Claim [2.2] also requires “one or more light emitting sources, each

having a variable light-source characteristic dependent on power, and wherein the control circuitry is arranged to alter said light-source characteristic via power control.”

139. Petitioner does not rely on Thominet’s hardware (LEDs) for satisfying this limitation. (See Petition at 35-36.) Accordingly, the Beam+ThominetHW Combination does not teach all claim limitations.

140. Intentionally left blank.

c. Claim 5 – The Beam+Thominet Combinations do not teach “*illuminat[ing] . . . with a different color of light*”

141. Claim 5 depends from claim 1 and requires “*a plurality of light sources, wherein one or more of the plurality of light sources comprises at least one of multiple light-emitting-diodes (LEDs) or organic light-emitting-diodes, each light source having a spectral power distribution characteristic and wherein the control circuitry is configured to alter the overall light-cluster spectral power distribution to illuminate at least one of the at least two sub-sections of the field-of-view with a different color of light from another of the at least two sub-sections.*”

142. Petitioner relies on Beam’s LEDs, Thominet’s semiconductor light sources and disclosure of mixing color in paragraphs 26-29 for satisfying this limitation, without specifying which reference/embodiment it is relying on for each

sub-ground. (Petition, 43-44.)

(1) Grounds 1A-1B (Beam)

143. Beam does not disclose that its lamp or LEDs provide multi-color light. Accordingly, Beam does not teach “*illuminat[ing] . . . with a different color of light.*”

**(2) Grounds 1C (Beam+ThominetSW),
and 1E (Beam+Thominet Curved
Substrate)**

144. Since Beam does not teach different color lamps or LEDs, a POSA would have understood that Thominet’s software would not have been able to control Beam’s single color light source to provide “*different color of light.*” Curving Beam’s substrate would not have changed this.

(3) Ground 1D (Beam+ThominetHW)

145. Since Beam does not teach the control of different color LEDs, Beam’s software would not be able to control Thominet’s LEDs to provide “*different color of light.*”

146. The Beam+Thominet Combinations do not teach “*illuminat[ing] . . . with a different color of light,*” and claim 5 is non-obvious over the combinations.

147. Intentionally left blank.

**d. Claim 11 - The Beam+Thominet Combinations do not
teach “*identify[ing] entities including at least one of***

beings, vehicles.

148. Claim 11 depends from claim 1 and requires “*a computer vision processing unit configured to use the sensor data and one or more of the algorithms to identify entities including at least one of beings, vehicles, roadway, or street signs and wherein the logical controller is further configured to modify the headlight beam to change illumination of the identified entity.*”

149. Petitioner relies on Beam’s disclosure at 4:10-25, 5:33-54, 6:12-27, FIGS. 1C-1D for satisfying this limitation. (Petition, 48.)

(4) All Sub-Grounds

150. Beam discloses that “[b]y 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.” (Ex.1005, 2:56-3:3.)

151. Further, Beam discloses that “[a]s the positions of both vehicles move, the blanked area tracks the location of the oncoming vehicle, dynamically varying in position and in size.” (Id., 6:24-27.) Beam has no ability to associate detected light with a particular target. Beam simply detects illumination sources within the field-of-view and blanks all associated microbeams around the illumination sources. Each subsequent detection of light is performed anew, with no relationship to a prior detection.

152. The Beam+Thominet Combinations do not “*identify . . . vehicles*” as

claimed.

153. Intentionally left blank.

**3. A POSA Would Not Have Been Motivated to
Combine Beam and Thominet**

**a. Petitioner Fails to Explain Why a POSA Would Have
Combined Beam and Thominet Absent Hindsight**

154. As explained below, the use of Thominet's clustered regions for predefined functions, when coupled with Beam's LED array, would compromise the ability of the combined system to deliver forward illumination. Because groupings of LEDs would be assigned to predefined functions, e.g., to produce light of different colors (for a signal function and a headlight), a concentric high beam, a horizontally dispersed light beam with wider front illumination or to provide "one-side oriented light", in operation, entire LED clusters would be unavailable to provide forward illumination. Furthermore, Beam's blanking of LEDs associated with detected light to avoid glaring would further reduce the number of active LEDs within the cluster providing forward illumination. Considering the relevant state of the art, and limitations surrounding white LED lumen output, which Petitioner's expert Dr Jiao repeatedly discussed in articles from the early 2000s, a combined system that relies on only certain segments of LEDs for forward illumination would fail to provide sufficient forward illumination and most likely result in a non-functional system. (Ex. 2015.) Given

the state of the art at the time (¶¶25-44), without creating issues with packaging, heat degradation and cost, additional LEDs could not simply be added to preserve forward illumination and multi-functional LED clusters.

155. As I explained in my state of the art section above (¶¶25-44), in the early 2000s, LED headlamp design posed a complex set of challenges and tradeoffs involving optics, heat management, white LED lumen output and packaging issues, all of which affected cost. Per Petitioner's expert, in 2004, the efficiency of available white LEDs was a fraction of a conventional bulb, creating significant technical challenges for their use in headlight applications. For example, as Petitioner's expert points out in 2004, multiple LEDs (e.g., more than 30) were required to generate lumen output similar to a typical tungsten filament halogen bulb because "currently available white LED's lumen output [was] around 30 lm (maximum), which [was] about 3% of the typical tungsten halogen bulb's light flux output (1000 lm for 9006 bulb)." (Ex. 2012 at 3.)

156. Moreover, given the state of the art, suitable versions of the proposed combinations would be beyond the skill of a POSA.

157. Intentionally left blank.

**(1) Grounds 1A-1B (Beam):
Combining Beam's Embodiments Results
in an Unsuitable Headlamp.**

158. Although Beam alone was not expressly presented as a ground in the

Petition, Petitioner argues that Beam alone teaches the claim 1 limitations: “[i]f Patent Owner argues, incorrectly, [that] Beam does not disclose [1.2], Beam-Thominet renders it obvious.” (Petition at 17.) Additionally, the Board instituted on Beam alone without considering the rationale to combine with Thominet. (DI, 11.)

159. Beam discloses two discreet lamp embodiments: 1) a conventional light source with a SLM, and 2) an LED array. (Ex. 1005, Figs. 2, 5; Figs. 4, 6.) Beam discloses that the conventional “lamp 202 and spatial light modulator 203 are replaced by an array of light sources 401.” (Ex.1005, 5:3-6.) Thus Beam teaches separate embodiments, not combinable embodiments.

160. Petitioner cites to either or both Beam embodiments throughout the Petition without explaining how or why a POSA would have combined these embodiments. For example, for claim 1.5, Petitioner relies solely on Beam’s lamp/SLM embodiment for satisfying the “electronic control circuitry configured to independently operate the light clusters” claim limitation. (Petition, 22-23, “Beam’s controller/processor sends control signals (blanking/non-blanking) to illuminator (SLM 203) to control microbeams.”) However for claim 18, Petitioner relies solely on Beam’s LED array embodiment for teaching a “laser diode.” (Petition, 52-53.)

161. As I explained in the state of the art section, a POSA would have

understood that a light modulator is not needed with an array of LEDs because the LEDs themselves can be controlled or modulated and therefore a light modulator is redundant, and further unsuitable with an LED array as it decreases optical efficiency and adds expense and packaging challenges. (¶¶35-39.) A POSA would thus not have been motivated to combine Beam’s teachings of the LED array and light modulator embodiments.

162. Further, such an inefficient and cost-prohibitive combination would be unsuitable, especially in the extremely cost-conscious automotive industry.

163. Intentionally left blank.

(2) Ground 1C (Beam+ThominetSW)

164. Petitioner argues that “including an additional control technique (software implementation) for Beam—Thominet’s known technique of using multiple directional beam regions for different functions—would have added different functions to Beam’s system for different situations.” (Petition, 11.) Petitioner further posits that “Thominet’s express control of having multiple directional beam regions (clusters), implemented with Beam’s controller 108/illuminator 109 (including SLM 203), would have provided Beam’s system with different spatial distributions for different driving situations beyond reducing glare for drivers.” (Petition at 12.)

165. Thominet discloses minimal “automation” of selecting LEDs for

different functions. (Ex.1006, [0026].) Thominet’s disclosure is limited to “a control device” that performs “switchover” depending on “speed and/or steering wheel position, or wiper, or recognizing counter traffic.” (Id., [0026].) Thominet thus solves the problem of “improving visibility” by using different segments for different situations. Beam solves the same problem by providing maximum intensity at all times. (Ex. 1005, 6:11-12.) Petitioner never explains how or why a POSA would combine the markedly different approaches for solving the same problem.

166. Any “automatic” segmentation control immediately conflicts with Beam’s goal of maximum illumination. Thominet’s speed-based adjustments switch between high-intensity beams and wide beams (neither using the full array as Beam would) based on corresponding high and low vehicle speeds (Id., [0023]-[0024]) Thominet does not describe “counter-traffic” control in detail, but implies that it refers to automatic switching to lower-intensity narrower beams – i.e., conventional automatic dimming.

167. The two contradictory control systems, both present in Petitioner’s “software” combination are unsuitable in virtually every situation, expressly because they solve “improving visibility” differently. Petitioner never addresses these contradictions in teachings, and instead simply suggests that Beam’s software would have been modified “to organize Beam’s microbeam array into multiple

beam regions (clusters) for different functions.” (Petition, 13.) Petitioner does not explain what those “functions” are, what SLM portions would be used, when they would be used, and how all of these functions with work with Beam’s strategy.

168. Recognizing these conflicts, a POSA would not have been motivated to combine the two disparate control strategies as Petitioner proposes.

169. Intentionally left blank.

**(3) Grounds 1D-1E
(Beam+ThominetHW) and 1E) /
(Beam+Thominet / Curved Substrate):**

170. Petitioner states that “a POSA would have sought to incorporate known components (hardware implementation) of Thominet’s semiconductor light sources 10 on curved surface 12 (arranged in different beam regions 22, 24, 26, 28 . . .) into Beam (with flat array of light sources 401)” to provide “different spatial distributions for different situations, improving visibility and thereby safety.” (Petition, 13.) Petitioner thus relies on Thominet’s curved substrate to provide different spatial distributions.,

171. However, without any particular advantages or use scenarios, Thominet describes the curved substrate as an optional feature. See Ex. 1006 ¶18 (“The semiconductor light sources 10 can be arranged approximately in one plane, or can be distributed over a concavely curved surface or a stepped surface.”) Since Thominet’s curved substrate is optional, a POSA would have understood that it is

not needed to provide Thominet's different spatial distributions – therefore a POSA would not have been motivated to combine Beam with Thominet's unnecessary hardware.

172. A curved substrate would not add any capability, and it wouldn't provide “different spatial distributions for different situations” any more than a flat substrate would. Additionally, adding a curved substrate would negatively impact packaging limitations, further discouraging a POSA from making Petitioner proposed modification.

173. Intentionally left blank.

**b. The Proposed Beam-Thominet Combinations
Renders Beam Inoperable and Defeats Beam's High-
Intensity Illumination “At All Times” Purpose**

**(4) Grounds 1C-1D
(Beam+ThominetSW/HW)**

174. Petitioner's proposed modification of controlling Beam's LED array with Thominet's software and controlling Thominet' light sources with Beam's software would be inoperable because the software would need to be modified to accommodate different light sources. As explained by Petitioner's expert, software is used to control changes in light direction and intensity:

Q. . . . [T]o achieve the control, specifically intensity and direction, in Thominet, that requires software controls?

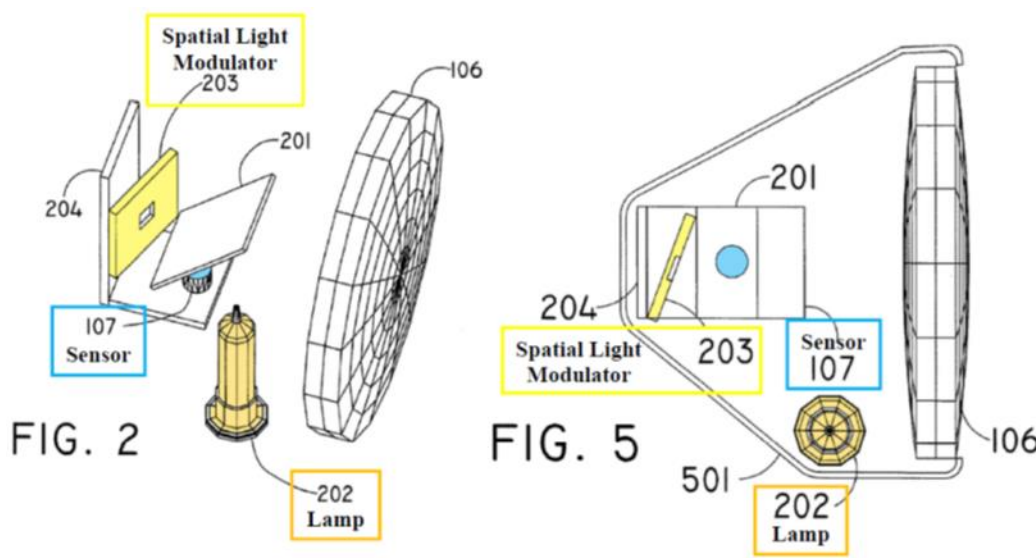
A It is always software control the light direction and intensity change, both Beam and Thominet.

(Ex. 2025, 65:13-19.)

175. Intentionally left blank.

(5) Ground 1C (Beam+ThominetSW)

176. The proposed combination of Thominet's software is with Beam's lamp 202 and SLM 203 as annotated by petitioner and reproduced below. (Petition, 11.)



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

177. Beam uses lamp 202 (operating at “maximum intensity at all times”) for all “active” (non-blanked) microbeams to provide maximum illumination to the field-of-view. (Ex.1005, 6:11-19.) Were Petitioner to attempt to create any beam segment as described by Thominet using less than all illumination via Beam's

lamp/SLM control, Beam's primary purpose of maximum forward illumination would be defeated. Petitioner never addresses these issues. Since Thominet is intentionally using various segments at different times, it frequently defeat Beam's maximal illumination objective and thereby would have rendered Beam inoperable for its intended purpose of providing "maximum intensity at all times".

178. Intentionally left blank.

179. Intentionally left blank.

B. Ground 2 – Beam, Thominet, and Stam

1. Independent Claims:

c. Claim 37 – The Beam/Thominet/Stam Combination does not teach “*substantially illuminat[ing] a first subsection of the field-of-view including at least a portion of the second vehicle.*”

180. Claim 37 requires “*at least one processor configured to: . . . process the sensor data to determine a light distribution pattern for an adaptive headlight beam, such that a headlight beam adapted to the pattern substantially illuminates a first subsection of the field-of-view including at least a portion of the second vehicle with an illuminance below a predefined threshold value.*”

181. The definition of illuminate is “to supply or brighten with light” or “to make luminous or shining.” (www.merriam-webster.com/dictionary/illuminate.) Therefore the claimed beam that is adapted to “substantially illuminate[] . . . a portion of the second vehicle” is created by controlling the headlight to emit or

supply light.

182. Petitioner relies on Stam’s for satisfying the “predefined threshold value” limitation and Beam for satisfying the remaining limitations. (Petition, 59-61.) The Board stated in the institution decision that “on this record at least, that Beam satisfies the predefined illuminance limitations.” (DI, 12.)

(1) All Sub-Grounds

183. As explained for claim 1, Beam teaches a binary system – in which emitters are blanked to become inactive and active emitters output “maximum intensity” emission “at all times”: the controller 108 “uses the data to determine the size and position of the light emitters to be dimmed. The output of the active emitters is projected through the optical system.” (Ex.1005, 5:13-16; 4:36-57; 2:60-62; 6:23-27.) The “active” emitters are the emitters that remain after the “dimmed” emitters are deactivated – hence the use of “active.” Further, Beam provides “The present invention generally relates to a method and apparatus for automatically reformatting the pattern of a beam from a light source to prevent it from illuminating certain areas...” (Id., 1:5-8.)

184. Because Beam teaches a binary system, where the changed LEDs are zeroed or blanked, the system no longer emits light, and Beam fails to teach “*substantially illuminat[ing] a first subsection of the field-of-view including at least a portion of the second vehicle*” as claimed.

185. Intentionally left blank.

2. Dependent Claims:

- a. Claim 38 – The Beam+/Thominet+/Stam Combination does not teach determining that “*at least one first subsection of the field-of-view, ... include[s] at least a portion of the second vehicle.*”**

186. Claim 38 depends from claim 37 and requires “*wherein at least one of the at least one processors is further configured to process the sensor data to determine illumination for at least one first subsection of the field-of-view, determined to include at least a portion of the second vehicle, based on the sensor data, and for at least one second subsection determined not to include the second vehicle, based on the sensor data.*”

(1) All Sub-Grounds

187. Petitioner relies on Beam’s disclosure at 5:34-36 and 8:29-38 for satisfying this limitation. (Petition, 64.)

188. Beam discloses sensing light. (Ex.1005, 2:56-3:3; 6:24-27.) However, As explained for claim 11, Beam has no ability to associate sensed light with a particular target. Beam simply detects illumination sources within the field-of-view and blanks all associated microbeams around the illumination sources. Each subsequent detection of light is performed anew, with no relationship to a prior detection.

189. The Beam+Thominet+Stam Combinations do not determine that “*at least one first subsection of the field-of-view, ... include[s] at least a portion of the second vehicle*” as claimed.

190. Intentionally left blank.

b. Claims 39, 40, 41 – The Beam/Thominet/ Stam Combination does not teach determining/defining different “*illumination*” at multiple locations.

191. Claim 39 depends from claim 37 and requires “*wherein the plurality of light clusters are further capable of illuminating at least two of the sub-sections with different illumination characteristics based on the at least one processor determining specific, different illumination characteristics for each of the at least two sub-sections.*”

192. Claim 40 depends from claim 37 and requires “*wherein the light distribution pattern defines illumination for at least the first and the one or more second sub-sections of the field of view.*”

193. Claim 41 depends from claim 37 and requires “*wherein the light distribution patterns defines illumination for the first subsection designed to result in an illuminance below the predefined threshold value, and defines illumination for the one or more second subsections designed to result in an illuminance above the predefined threshold value.*”

(2) All Sub-Grounds

194. Petitioner relies on Beam’s blanking disclosure for satisfying these limitations. (Petition, 66-71.) As explained for claim 1, Beam teaches a binary system – in which emitters are blanked to become inactive and active emitters output “maximum intensity” emission “at all times.” (Ex.1005, 5:13-16; 4:36-57; 2:60-62; 6:23-27.)

195. Blanked light is the absence of light, *i.e.*, not illumination. Therefore Beam does not teach determining/defining different “*illumination*” at multiple locations.

196. The Beam+Thominet+Stam Combinations do not teach all claim limitations, and claims 39, 40, 41 are non-obvious over the combination.

197. Intentionally left blank.

c. Claims 42, 58 – The Beam+Thominet+Stam Combination does not teach controllable “*light modifying elements*” or “*reflectors, refractors, or lenses usable to alter emitted light . . . as part of the instructed operation.*”

198. Claim 42 depends from claim 37 and requires “control of the light sources and light modifying elements results in a specified emitted light-source light characteristic.”

199. Petitioner references its claim 2 analysis for satisfying these limitations, respectively. (Petition, 71.)

200. Claim 58 depends from claim 37 and requires “*wherein at least one of the one or more headlamps further includes at least one of reflectors, refractors, or lenses usable to alter emitted light from at least one of the light clusters as part of the instructed operation.*” A POSA would have understood that reflectors, refractors, and lenses that alter emitted light as part of the instructed operation are controllable or active lenses.

201. Petitioner references its claim 19 analysis in which it relies on Beams LEDs, Thominet semiconductor light sources and disclosure of mixing color in paragraphs 26-29 for satisfying this limitation. (Petition, 74, 43-44.)

**(3) Grounds 2B (BeamLEDs+Stam)
and 2E (Beam+Thominet Curved
Substrate+Stam)**

202. Beam does not disclose that its LED embodiment includes an SLM or any controllable optics, e.g., “*light modifying elements,*” or “*reflectors, refractors, or lenses usable to alter emitted light from at least one of the light clusters as part of the instructed operation.*”

**(4) Ground 2D
(Beam+ThominetHW+Stam)**

203. Thominet’s discloses passive optical element 43 and passive lenses 46. (Ex.1006, [0029]-[0030], Figs. 5,6.) Thominet does not teach controllable optics, e.g., “*light modifying elements,*” or “*reflectors, refractors, or lenses usable*

to alter emitted light from at least one of the light clusters as part of the instructed operation.”

204. The above combinations do not teach all claim limitations.

205. Intentionally left blank.

d. Claim 45 – The Beam+Thominet+Stam Combinations do not teach “*each light source having a spectral power distribution characteristic alterable . . . resulting in a color change to projected light.*”

206. Claim 45 depends from claim 37 and requires “*a plurality of light sources, wherein one or more light sources of the plurality of light sources comprise at least one of light-emitting-diodes (LEDs) or organic light-emitting-diodes, each light source having a spectral power distribution characteristic alterable, at least responsive to instructions from at least one of the at least one processors, by modifying power to the one or more light sources of the plurality of light sources, resulting in a color change to projected light from the at least one light-cluster illuminating at least one sub-section of the field-of-view..”*

207. Petitioner references its analysis of claim 5 in which it relied on Beam’s LEDs, Thominet’s semiconductor light sources and disclosure of mixing color in paragraphs 26-29 for satisfying the claim limitation. (Petition, 71, 43-44.)

(1) Grounds 2A-2B (Beam+Stam)

208. Beam does not disclose that its lamp or LEDs provide multi-color

light. Accordingly, Beam does not teach “*a color change to projected light.*”

**(2) Ground 2C,2E
(Beam+ThominetSW/Substrate)**

209. Since Beam does not teach different color lamps or LEDs, a POSA would have understood that Thominet’s software would not have been able to control Beam’s single color light source to provide “*a color change to projected light.*”

**(3) Ground 2D
(Beam+ThominetHW+Stam)**

210. Since Beam does not teach the control of different color LEDs, Beam’s software would not be able to control Thominet’s LEDs to provide “*a color change.*”

211. The above combinations do not teach all claim limitations.

212. Intentionally left blank.

C. Ground 3 – Beam, Thominet, and Kobayashi

1. Dependent Claims:

- e. Claims 15 and 17 – The Beam+Thominet+Kobayashi Combinations Do Not Teach “increasing illumination in a direction of the road curvature.”**

(1) All Sub-Grounds

213. Claim 15 depends from claim 1 and requires “*wherein the logical*

controller is further configured to determine at least a road curvature, indicated by the sensor data, ahead of the vehicle and wherein the required illumination includes increasing illumination in a direction of the road curvature.”

214. Claim 17 depends from claim 1 and requires “*wherein the logical controller is further configured to determine at least a planned upcoming turn, indicated by the sensor data, and wherein the required illumination includes increasing illumination illuminating the turn.”*

215. Petitioner relies on Beam’s disclosure at 6:14-27 for satisfying this limitation. (Petition, 81.) Beam discloses “AABH headlights [that] will operate at **maximum intensity at all times**.” (Ex.1005, 6:11-12.) Beam further discloses “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.” (*Id.*, 6:14-19.)

216. Beam further 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.) Beam further discloses that “[t]he resulting beam is at full intensity except in areas that would dazzle a driver ahead.” (*Id.*, 4:57-59.) Petitioner admitted, in a related proceeding, that this disclosure teaches providing a “Full Intensity” beam outside

of the anti-glare region. (Ex. 2008 at 36; Ex. 2009, ¶¶145-146.) Similar to the European approach to adaptive driving beam (ADB) technology, Beam uses the high-beam at all times and includes anti-glare strategies, to avoid blinding oncoming traffic when needed. (Ex. 2007 at 69, 71.)

217. 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. Accordingly, the Beam/Thominet/Kobayashi Combination Does Not Teach “*increasing illumination in a direction of the road curvature*” as claimed.

218. The above combinations do not teach all claim limitations.

219. Intentionally left blank.

2. A Person of Ordinary Skill in the Art Would Not Have Been Motivated to Combine Beam+Thominet with Kobayashi

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

220. Petitioner states that “A POSA would have been further motivated to modify Beam-Thominet to adjust light based on sensed data, such as map data from a GPS sensor (including road curvature/planned upcoming turns), as in Kobayashi, to further control Beam’s system to illuminate curves/turns.” (Petition, 74-75.)

221. 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 but for selective blanking relative to other vehicles, 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) as a result, would not accomplish Petitioner's proffered purpose of "improving driver safety."

**(1) Petitioner's Rationale Undermines
the Crux of Beam's Illumination Strategy**

222. Beam is clear, beginning with the title and extending throughout the detailed description and claims, that it is an anti-blinding system that 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.

223. 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.

**(2) Petitioner Reads Beam in a Manner
that Results in a Non-functional Device**

224. Moreover, Beam's AABH system is incapable of operating as Petitioner contends. Because Beam's blanking of selected microbeams forming the output beam is controlled in response to incoming light, and specifically the location of incoming light relative to the corresponding microbeams generated by the LED array, Beam maps the angular position of incoming light with each LED in the X-Y matrix to facilitate selective blanking, not to control or change the angular position of each LED, as Petitioner contends. (*Id.*, ¶119; Ex.1005, 4:62-5:1; 3:16-27, 4:45-48.)

225. Additionally, Beam's AABH embodiments provide alternative fixed, non-movable components controllable to blank illumination of individual microbeams in response to detecting incoming light sources such as headlights/taillights. The SLM embodiment is not capable of pointing or otherwise changing direction of microbeams exiting the headlamp. (Ex.1005, 5:65-66.) Similarly, the LED embodiment has no controllable elements capable of changing the position or otherwise pointing or steering the associated microbeams illuminating the road.

226. 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) at all times without the use of moving components.

227. 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 α (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. And, it has no need to control the direction of emitted light, as it already illuminates the field-of view (FOV) of the headlights (and FOV of the aligned, bore-sighted sensor) at “maximum intensity.”

228. Intentionally left blank.

D. Ground 4 – Beam, Thominet, Stam, and Kobayashi

1. Dependent Claims

**b. Claims 54, 56 – The
Beam+Thominet+Stam/Kobayashi Combination Does
Not Teach “*increased illumination in a direction of the
road curvature.*”**

229. Claim 54 depends from claim 37 and requires “*wherein at least one of the at least one processors is further configured to determine at least a road curvature, indicated by the sensor data, ahead of the first vehicle and to determine*

a second illumination pattern defining increased illumination in a direction of the road curvature.”

230. Claim 56 depends from claim 37 and requires “*wherein at least one of the at least one processors is further configured to determine at least a planned upcoming turn, indicated by the sensor data, and to determine a third illumination pattern defining increased illumination illuminating the turn.*”

231. Petitioner cites its claim 15-17 analysis in which it relies on, Beam’s disclosure at 6:14-27 for satisfying this limitation. (Petition, 81.)

(1) All Sub-Grounds

232. As explained regarding claims 15-17, Beam discloses “AABH headlights [that] will operate at maximum intensity at all times.” (Ex.1005, 6:11-12.) 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.

233. The above combinations do not teach all claim limitations.

234. Intentionally left blank.

2. A Person of Ordinary Skill in the Art Would Not Have Been Motivated to Combine Beam, Thominet, Stam, and Kobayashi

235. Petitioner references its rationale to combine the Ground 3 references. (Petition, 87.) Accordingly, a POSA would not have been motivated to combine

Beam, Thominet, Stam, and Kobayashi for at least the same reasons given for Ground 3. (¶¶219-226.)

236. Intentionally left blank.

E. Ground 5 – Beam, Thominet, and Braun

1. Dependent Claims

a. Claim 6

237. Claim 6 depends from claim 1 and requires “*wherein the headlight beam further comprises light in at least one of infra-red (IR) or ultra-violet (UV) wavelengths.*”

2. A POSA Would Not Have Been Motivated to Combine Beam, Thominet, and Braun

b. Petitioner Does Not Explain How a POSA Would Have Combined Beam, Thominet and Braun

238. Petitioner states that the combination “would have been combining prior-art elements or a simple substitution of one known element for another (Beam’s/Braun’s respective arrays) according to known methods to yield predictable results (improved visibility and safety).” “This would have been combining prior-art elements or a simple substitution of one known element for another (Beam’s/Braun’s respective arrays) according to known methods to yield predictable results (improved visibility and safety).” Or “modifying Beam’s LEDs with Braun’s colored LEDs to provide colored light sources with IR/UV

wavelengths for different functions.” (Petition, 90.)

**(1) Grounds 5A (Beam
Lamp+SLM+Braun), 5D
(Beam+ThominetHW+Braun)**

239. Petitioner does not provide any explanation for how and why a POSA would have combined or substituted Beam’s lamp/SLM or Thominet’s LEDs with Braun’s luxels. (Petition, 90.)

**(2) Grounds 5B (Beam LEDs), and 5C
(Beam+ThominetSW+Braun)**

240. Petitioner does not explain how Beam’s LED arrays and Braun’s luxels would have been combined, or what additional changes would be needed to combine or substitute the light sources. 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 and tradeoffs involving complex and interrelated optics, heat management, white LED lumen output, packaging and cost issues.

241. Intentionally left blank.

F. Ground 6 – Beam, Thominet, Stam and Braun

**1. A Person of Ordinary Skill in the Art Would Not
Have Been Motivated to Combine Beam, Thominet,
Stam, and Braun**

242. Claim 46 requires “*wherein the light output from at least one*

headlamp further comprises at least one of infrared or ultraviolet wavelengths.”

243. Petitioner relies on Braun’s luxels for satisfying this limitation. (Petition, 91.) Petitioner references its claim 6 analysis for claim 46. (Petition, 93.)

244. A POSA would not have combined Beam, Thominet, Stam and Braun for at least the same reasons given for claim 6 in Ground 5. (Supra, ¶¶237-239.)

245. Intentionally left blank.

G. Ground 7 – Karlsson and Harbers

1. Independent Claims

- a. Claims 1/37 - The Karlsson/Harbers Combinations do not teach “*determin[ing] an illumination . . . to reduce glare*” or “*substantially illuminat[ing] a first subsection of the field-of-view including at least a portion of the second vehicle.*”**

246. Claim 1 requires “*wherein the processor is configured to process the one or more algorithms and the sensor data to determine an illumination for at least two of the sub-sections, that reduces illumination to reduce glare.*”

247. Claim 37 requires “at least one processor configured to: . . . process the sensor data to determine a light distribution pattern for an adaptive headlight beam, such that a headlight beam adapted to the pattern substantially illuminates a first subsection of the field-of-view including at least a portion of the second vehicle with an illuminance below a predefined threshold value.”

248. The plain meaning of illuminate is “to supply or brighten with light”

or “to make luminous or shining.” (www.merriam-webster.com/dictionary/illuminate.)

249. This plain meaning is consistent with the ‘503 Patent specification which teaches three different operating states for the light emitting elements: 1) operating at full power; 2) operating at a fraction of full power for reduced intensity and 3) not operating. (Ex.1001, 19:30-37.) Per the ‘503 Patent, shutting off a light element is distinct from reducing intensity. (Ex.1001, 65:37-41.)

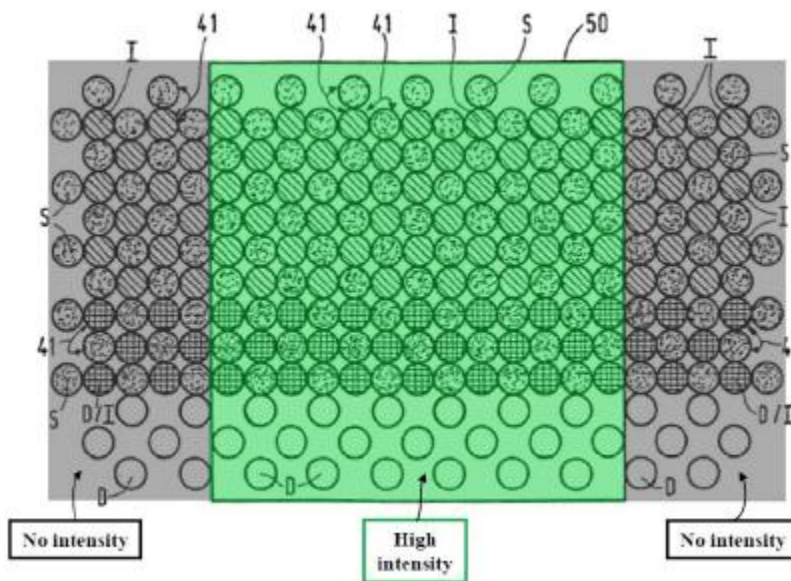
250. Petitioner relies on, *inter alia*, Karlsson’s disclosure at 9:9-17 for satisfying these limitations. (Petition, at 116, 120, 123-124.)

(1) All Sub-Grounds

251. Karlsson discloses that “the lighting means 2, 3 are intermittently controlled by control means 14 . . . so as to control the lighting means 2, 3 in such a manner that a light beam 7 having a desired pattern and a desired intensity is emitted.” (Ex.1010, 9-17.) Karlsson further 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.)

252. Petitioner explains Karlsson’s disclosure as teaching a shaded area of “no intensity” and a non-shaded area of “high intensity”: “Thus, Karlsson’s processor processes the data, and uses memory (with algorithms) to “determine an

illumination for at least two of the subsections” (shaded area of **no intensity**/non-shaded area of high intensity).” (Petition, 116.) Petitioner annotated Karlsson’s Figure 14 to identify the areas of “No intensity” and “High intensity” illumination:



(Petition, 117,119,122,124; Ex.1010, Fig. 14, Annotated by Petitioner)

253. Karlsson teaches providing illumination depending on the function (dipped beam LEDs (D), combination LEDs (D/I), and high-intensity/driving beam LEDs (I) in the alleged “high intensity” region, other than LEDs where incoming light is detected by an associated sensor (S). To the extent that any “No intensity” regions (that do not correspond to LEDs associated with light detected by sensors (S)) exist, Karlsson does not teach determining illumination for either of the alleged shaded areas of no intensity. Accordingly, Karlsson does not teach “adapt[ing] the light emitted . . . that provides the determined illumination” or “substantially illuminat[ing] a first subsection of the field-of-view including at

least a portion of the second vehicle.” as claimed.

254. The Karlsson/Harbers Combinations do not teach all claim limitations.

255. Intentionally left blank.

256. Intentionally left blank.

b. Claims 1/37 – The Karlsson/Harbers Combinations do not teach “*the subsections determined in response to sensor data.*”

257. Claim 1 requires “*a plurality of light clusters. . . capable of projecting light so as to illuminate a plurality of sub-sections of a field-of-view with different illumination characteristics, [1.4] the subsections determined in response to sensor data.*”

258. Claim [37.4] requires “*wherein at least two of the light clusters operate to create a headlight beam.*”

259. Petitioner analyzes claim [1.4] and [37.4] together and relies on Karlsson’s disclosure at 2:2-4 for satisfying these limitations. (Petition, 108.)

(2) All Sub-Grounds

260. Petitioner merges Karlsson’s description of a prior art sensor at 2:2-4 with Karlsson’s disclosure of its control means 14 at 9:9-17 for satisfying this limitation. (Petition, 108.) Petitioner states that:

Karlsson's "light-sensitive sensor...detects the distribution and the intensity of light in the area ahead of a vehicle" and "control means 14...control the lighting means 2, 3...[so] light beam 7 having a desired pattern and a desired intensity is emitted."

(Petition, 108.)

261. Karlsson is not describing its own light-sensitive sensor at 9:9-1, instead it is describing the prior art:

The **prior art** lighting device comprises a light sensitive sensor, which detects the distribution and the intensity of light in the area ahead of a vehicle.

(Ex.1010, 2:2-4.)

262. Karlsson also discloses, with reference to its own invention, "light-sensitive sensors 9 and 23 [that] are preferably designed to be capable of precisely determining the direction and the intensity of the detected light 11." (Ex.1010, 12:19-22.) Karlsson discloses light-sensitive sensors 9/23 that determine light direction; Karlsson does not disclose that its light-sensitive sensors determine light distribution or sub-sections. Determining light subsections provides a higher level of specificity than just determining direction.

263. The Karlsson/Harbers Combinations do not teach "*the subsections determined in response to sensor data*" as claimed.

2. Dependent Claims

**a. Claims 2, 42, 58 – The Karlsson/Harbers
Combination Does Not Teach controllable “*light
modifying elements*”**

264. Claim 2 depends from claim 1 and requires “*one or more light modifying elements provided in the path of light . . . further controlling the light-source characteristics; wherein the structure combined with control of the light sources and light modifying elements.*”

265. Claim 42 depends from claim 37 and requires “*control of the light sources and light modifying elements results in a specified emitted light-source light characteristic.*”

266. Claim 58 depends from claim 37 and requires “*wherein at least one of the one or more headlamps further includes at least one of reflectors, refractors, or lenses usable to alter emitted light from at least one of the light clusters as part of the instructed operation.*” A POSA would have understood that reflectors, refractors, and lenses that alter emitted light as part of the instructed operation are controllable or active lenses.

267. Petitioner relies on Karlsson’s light modulator means 3 for satisfying these limitations. (Petition, 130, 133-134, 148.)

**(1) Grounds 7B (Karlsson LEDs), 7D
(Karlsson LEDs + Harbers SW)**

268. Karlsson discloses a passive (not controllable) lens 6 that may be

included in the LED embodiments (e.g., Fig. 14) and in the SLM embodiments (e.g., Figs. 1, 3.). Without the SLM, Grounds 7B and 7D do not teach controllable “*light modifying elements*” or “*lenses usable to alter emitted light from at least one of the light clusters as part of the instructed operation.*”

269. The above combinations do not teach all claim limitations.

270. Intentionally left blank.

b. Claims 7, 8, 11, 47, 48, 50 - The Karlsson/Harbers Combinations Do Not Teach “*determin[ing] a position of the oncoming[preceding] vehicle*” or “*identifying entities.*”

271. Claim 7 depends from claim 1 and requires “*wherein at least one of the sensors is a camera-sensor configured to image at least lights indicative of oncoming vehicles having a driver whose vision could be disturbed by the headlight beam, and wherein the logical controller upon receiving data, indicating a position of the lights, from the camera-sensor, is configured to use one or more of the algorithms to determine a position of the oncoming vehicle, based on the position of the lights as indicated by the data, relative to the vehicle headlight system and responsively adapt the headlight beam to decrease at least one vision-disturbing characteristic to the oncoming vehicle driver.*”

272. Claim 8 depends from claim 1 and requires “*wherein at least one of the sensors is a camera-sensor configured to image at least lights indicative of*

preceding vehicles having a driver whose vision could be disturbed by the headlight beam reflected in a mirror, and where the logical controller upon receiving data, indicating a position of the lights, from the camera-sensor, is configured to use one or more of the algorithms to determine a position of the preceding vehicle, based on the position of the lights as indicated by the data, relative to the vehicle headlight system and responsively adapt the headlight beam to decrease at least one vision-disturbing characteristic to the driver of the preceding vehicle.”

273. Claim 11 depends from claim 1 and requires “a computer vision processing unit configured to use the sensor data and one or more of the algorithms to identify entities including at least one of beings, vehicles, roadway, or street signs and wherein the logical controller is further configured to modify the headlight beam to change illumination of the identified entity.”

274. Claim 47 depends from claim 37 and requires “wherein at least one of the sensors is a camera-sensor configured to image at least lights indicative of an oncoming vehicle.”

275. Claim 48 depends from claim 37 and requires “wherein at least one of the sensors is a camera-sensor configured to image at least lights indicative of a preceding vehicle.”

276. Claim 50 depends from claim 37 and requires “a computer vision

processing unit configured to use the sensor data to identify entities including at least one of beings, vehicles, roadway, or street signs, and wherein the processor is further configured to determine modification of the headlight beam to change illumination of the identified entity.”

277. Petitioner relies on Karlsson’s disclosure at 2:2-4, Abstract, 12:19-24, FIGS. 3, 14, 3:17-20, 5:16-32, 3:27-31 for satisfying these limitations. (Petition at 138, 141.)

(2) All Sub-Grounds

278. Karlsson discloses “light-sensitive sensors 9 and 23 [that] are preferably designed to be capable of precisely determining the direction and the intensity of the detected light 11.” (Ex.1010, 12:19-22.) Karlsson does not disclose determining a position of a vehicle associated with the detected light, identifying the vehicle, or detecting the vehicle. On the contrary, with reference to Figure 14, Karlsson discloses an arrangement in which each sensor (S) of an array of spotlight sensors is electrically connected to an adjacent spotlight source to provide a switch to control the LEDs:

The spotlight sources and the spotlight sensors, ... may also be formed by LEDs and photosensitive transistors, respectively. Arrow 41 schematically indicates an electric connection between the spotlight sensors and spotlight sources D, I and D/I, which, for

example, may consist of transistors or the like... Integration of LEDs and phototransistors on one carrier, for example, is also possible.

(Ex.1010, 19:34-20:5.)

279. With reference to the Figure 14 embodiment, Karlsson does not disclose a controller or storage means connected between the sensors (S) and the sources to determine a vehicle position. Instead, if each sensor is functioning as a switch for the adjacent LED(s) to which it is electrically connected, then light detected by the sensor would cause a change to the electrical current to the LED and cause it to change state.

280. The Karlsson/Harbers Combinations Do Not Teach “*determin[ing] a position of the oncoming [preceding] vehicle*” or “*identify[ing] entities*” as claimed.

281. Intentionally left blank.

**c. Claims 14, 53 - The Karlsson/Harbers Combinations
Do Not Teach a “camera”**

282. Claim 14 depends from claim 1 and requires “*wherein the one or more sensors further includes at least one of a camera, a microphone, an ultrasonic transducer and receiver, or an electromagnetic radiation source and detector including any of IR, UV, laser, or light.*”

283. Claim 53 depends from claim 37 and requires “*wherein the one or more sensors further includes at least one of a camera, a microphone, an*

ultrasonic transducer and receiver, or an electromagnetic radiation source and detector including any of IR, UV, laser, or light.”

284. Petitioner relies on Karlsson’s disclosure at 12:19-24 for satisfying this limitation. (Petition, 147.)

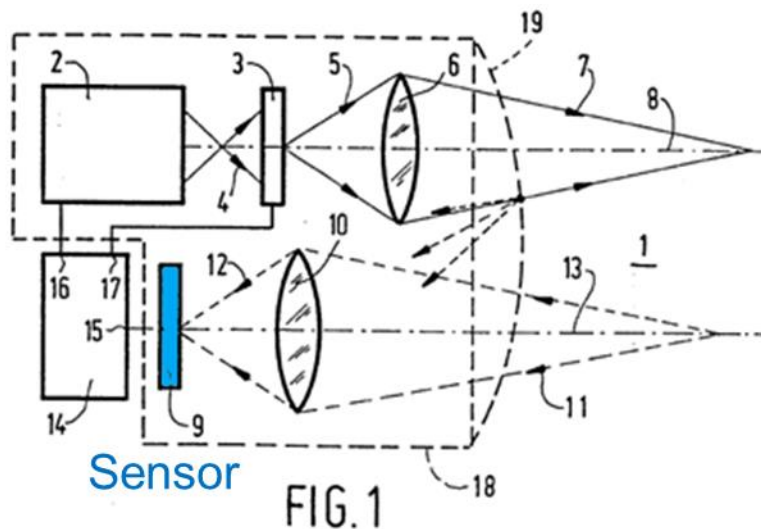
(1) All Sub-Grounds

285. Karlsson discloses light-sensitive sensors 9, 23, that may be comprised of: a matrix of photo-diodes, like the spotlight sensors (S) described with reference to Figure 14, **or, alternatively**, a photo-sensitive plate as used in modern video cameras:

In the preferred embodiment of the invention, the light-sensitive sensors 9 and 23 are preferably designed to be capable of precisely determining the direction and the intensity of the detected light 11. They may for example be comprised of a **matrix** of photo diodes **or** in the case of a light-sensitive sensor 23, a photo-sensitive plate as used in modern video **cameras**.

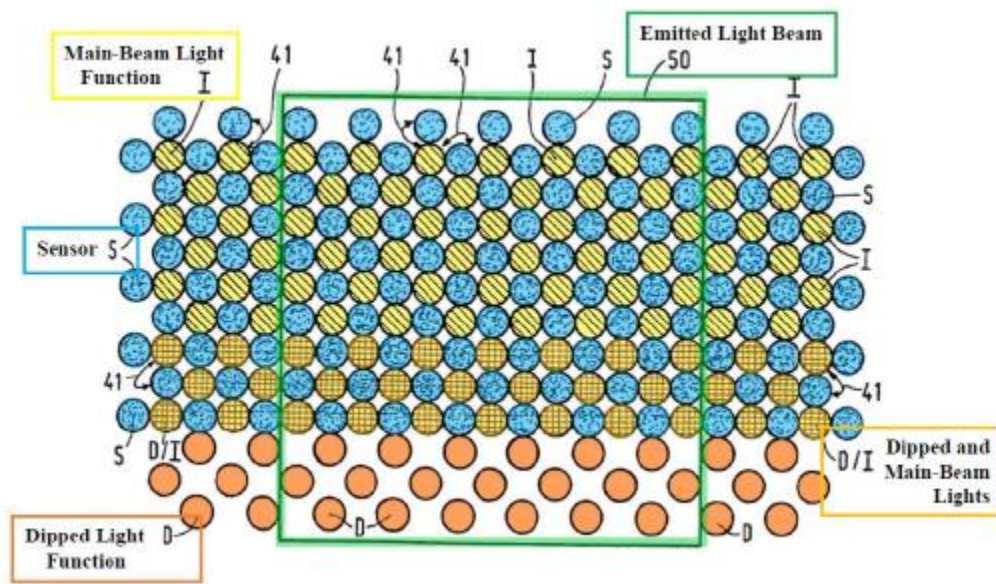
(Ex.1010, 12:22-24.)

286. With reference to Figure 1, Karlsson discloses a lighting device 1 with “sensor means consisting of a light-sensitive sensor 9 and a further lens 10 disposed on the side of sensor 9 that is exposed to the incident light, such that incident light 11 on the lens 10 is formed into an incident light beam 12 on light-sensitive sensor 9.” (Ex.1010, 8:19-23.)



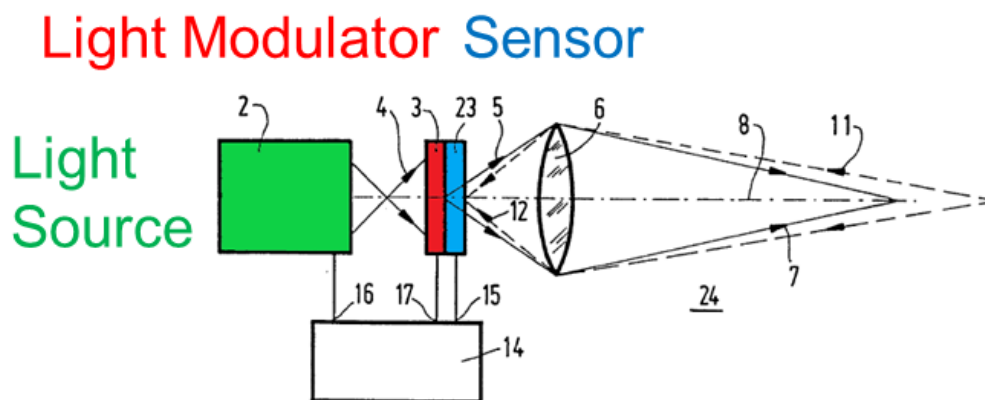
(Ex.1010, Fig. 1, Annotated)

287. With reference to Figure 14, Karlsson discloses spotlight sensors (S) that may be formed by “photosensitive transistors.” (Ex.1010, 19:34-35.) Karlsson further discloses that “a preferred embodiment of the invention comprises spotlight sensors in the form of, for example, photosensitive diodes, photo transistors or other light- sensitive semiconductor components, which are spatially distributed in a predetermined manner or at random so as to be capable of detecting light from desired directions or from all directions.” (*Id.*, 5:18-23.) Karlsson also discloses that “the term spotlight sensor used herein is understood to indicate a light-sensitive sensor of limited, physically light-sensitive dimensions, which generally detects light from a specific direction.” (*Id.*, 5:25-27.)



(Petition, 107;Ex.1010, Fig. 14 Annotated)

288. With reference to Figure 3, Karlsson discloses “a light-sensitive sensor 23 and light modulator means 3 are arranged between the light source 2 and the lens 6.” (Ex.1010, 11:10-11.) Notably, Karlsson does not disclose that the light source 2 described with reference to Figure 3 embodiment includes a plurality of LEDs. (Ex.1010, 11:7-36.)

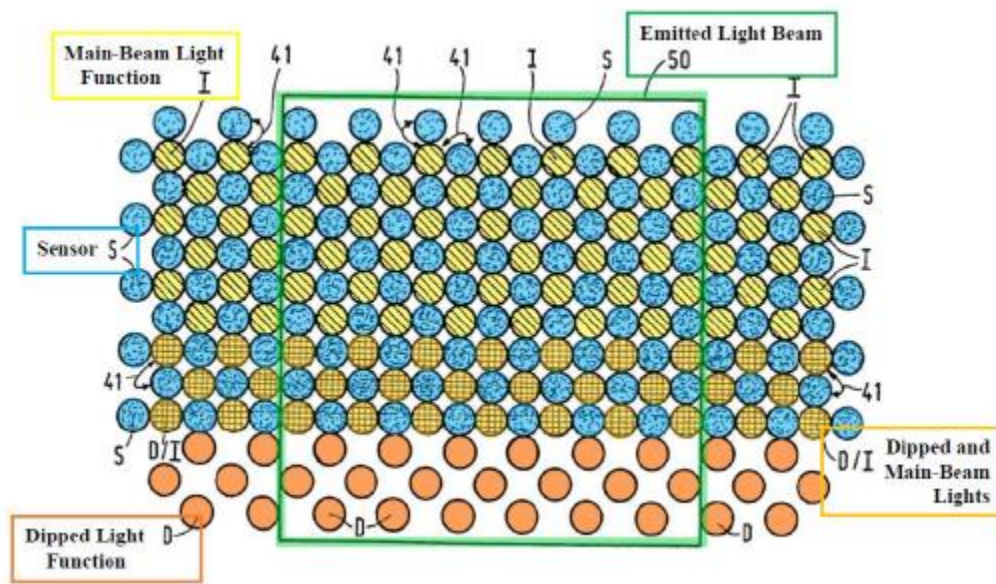


(Ex.1010, Fig. 3; Petition, 67, Annotated)

289. Petitioner relies on Karlsson's matrix of photo diodes as illustrated in Figure 14 for satisfying various control limitations. (Petition, 107, 109, 111, 113, 115, 117, 119, 121, 124, 126, 146, 158.)

290. A matrix of photo diodes alone is not a camera. A camera also requires a lens to focus the received light, and to be able to deliver the sensed array for processing and imaging. A POSA would have known that a modern video camera in the early 2000s would have required many thousands of photosensors.

291. Further, a camera would not have included photosensors interspersed with emitters because this would have resulted in low resolution data that could not be formatted into an image. Further, the lack of sensors in the lower region of the array results in no data in this region and Karlsson does not disclose image processing, at all, so it is clear that the spotlight sensors are limited to sensing light.



(Petition, 107, 109, 111, 113, 115, 117, 119, 121, 124, 126, 146, 158; Ex.1010, Fig. 14, Annotated by Petitioner)

292. The Karlsson-Harbers combinations do not teach “*wherein the one or more sensors further includes at least one of a camera*” as claimed.

293. Intentionally left blank.

3. A POSA Would Not Have Been Motivated to Combine Karlsson and Harbers

a. Petitioner Fails to Explain Why a POSA Would Have Combined the Ground 7 Embodiments/References Absent Hindsight

**(1) Ground 7A-7B (Karlsson):
Combining Karlsson’s Embodiments
Results in an Unsuitable Headlamp**

294. Although Petitioner did not frame the obviousness ground as based on Karlsson alone, Petitioner argues that Karlsson alone teaches the limitations of claims 1 and 37: “[i]f Patent Owner argues, incorrectly, [that] Karlsson does not

disclose [1.2]/[37.2], it would have been obvious in view of Harbers.” (Petition, 104.) Additionally, the Board instituted on Karlsson alone without considering the rationale to combine with Harbers. (DI, 13.)

295. As detailed for claims 14, 53, Petitioner’s proposed combination of Karlsson and Harbers combines incompatible features from Karlsson’s alternative embodiments — Karlsson’s LED array with the light-sensitive sensor 23, which may include “a photo-sensitive plate as used in modern video cameras,” from the light modulator embodiment, without explaining why a POSA would do so. (Petition, 147.)

296. As I explained in the state of the art section, a POSA would have understood that a light modulator is not needed with an array of LEDs because the LEDs themselves can be controlled or modulated and therefore a light modulator is redundant, and further unsuitable with an LED array as it decreases optical efficiency and adds expense and packaging challenges. (¶¶35-39.) A POSA would thus not have been motivated to combine Karlsson’s teachings of the LED array and light modulator embodiments.

297. Further, such an inefficient and cost-prohibitive combination would be unsuitable, especially in the extremely cost-conscious automotive industry.

298. Intentionally left blank.

(2) Ground 7C (Karlsson+HarbersSW)

299. Petitioner argues that “including an additional control technique (software implementation) for Karlsson—Harbers’s known technique of using multiple directional beam segments for different functions—would have added different functions to Karlsson for different situations.” (Petition, 96-97.) Petitioner further states that “Multiple beam segments (clusters) as in Harbers, implemented with Karlsson’s control means 14/spotlight beams 34, would have provided Karlsson with different spatial distributions for different situations beyond reducing glare for drivers.” (Petition, 98.)

300. Karlsson discloses a headlight having spotlight beams and sensors to . . . automatically control a lighting pattern to reduce blinding of oncoming traffic” and different illumination patterns/functions “produced by spotlight sources D (dipped light), I (main-beam light), and D/I (dipped and main-beam lights). (Ex.1010, 19:22-30.) Karlsson also discloses “further sensor means, such as inclination sensors, and direction sensors for controlling the light beams . . . dependent on the inclination of a vehicle and/or its change of direction.” (Ex.1010, 15:7-10.) As such, Karlsson already provides “different spatial distributions for different driving situations” such that there would be no increased/improved driver safety or visibility, and therefore no motivation for a POSA to look to Harbers to provide these features as advanced by Petitioner. (Petition, 98.)

301. Rather than providing articulated reasoning with rational underpinnings for culling building blocks from Harbers and combining them with Karlsson, Petitioner relies on the catch-all goals of “improved visibility” and “increasing safety.” (Petition, 96.) The Petition fails to articulate why the inclusion of the multiple directional beam segments “software or hardware” from Harbers provides “different functions” when combined with Karlsson, resulting in “increase[ed] safety.” (Petition, 96-99.) A POSA would have understood that Karlsson and Harbers disclosed fundamentally different approaches that do not benefit from the combinations Petitioner proffers.

**(3) Grounds 7E
(Karlsson+HarbersHW)**

302. Petitioner also argues that “a POSA would have sought to incorporate known components (hardware implementation) of Harbers’s opto-electronic elements 11-14 on a “curved substrate” (with differently aimed opto-electronic elements 11-14 . . .) into Karlsson.” (Petition, 99.) “This, too, would have provided different spatial distributions for different situations.” (*Id.*)

303. Petitioner thus relies on Harbers’ curved substrate to provide different spatial distributions, However, Harbers describes the curved substrate as an optional feature. See Ex.1011, 7:27–29 (“The array of optoelectronic elements . . . does not have to be provided on a flat substrate, it may alternatively be provided on

a curved substrate.”). Since Harbers’ curved substrate is optional, a POSA would have understood that it is not needed to provide Harbers’s different spatial distributions – therefore a POSA would not have been motivated to combine Karlsson with Harbers’ unnecessary hardware. Additionally, adding a curved substrate would negatively impact packaging limitations, further discouraging a POSA from making Petitioner proposed modification.

**b. The Proposed Karlsson-Harbers (Software)
Combination Renders Karlsson Inoperable and
Defeating its High-Intensity Illumination Purpose**

**(4) Grounds 7C-7F
(Karlsson+HarbersSW/HW)**

304. Petitioner’s proposed modification of controlling Karlsson’s LED array with Harbers’ software and controlling Harbers’ light sources with Karlsson’s software would be inoperable because the software would need to be modified to accommodate different light sources. As explained by Petitioner’s expert, software is used to control changes in light direction and intensity:

Q. . . . [T]o achieve the control, specifically intensity and direction, in Thominet, that requires software controls?

A It is always software control the light direction and intensity change, both Beam and Thominet.

(Ex. 2025, 65:13-19.)

305. Intentionally left blank.

c. Petitioner Does Not Explain How a POSA Would Have Combined Embodiments/References

306. Petitioner fails to recognize a conflict in the implementation of the Karlsson and Harbers strategies. Karlsson modifies high-intensity main-beam illumination in regions where that illumination might glare, e.g., when it uses such illumination for the full scene to provide “optimum illumination for the driver.” (Ex.1010, 2:2-9.) Harbers, on the other hand, selectively chooses illumination for different situations, such as selectively engaging or disengaging different beam segments based on velocity (Ex. 1011, 9:1-6, 7:13-15.)

307. As with Beam’s high-intensity microbeams, Karlsson’s high-intensity illumination is designed to provide optimum forward illumination with some of the “spotlight beams” that correspond to detected light deactivated. Similar to Thominet, Harbers does not contemplate dimming any portion of a chosen beam segment (subset). When combining the systems, the conflicting solutions create similar issues as described with respect to the Beam/Thominet combination such that there would have been no motivation for a POSA to have combined the systems as proposed, and no reasonable expectation of success for the combined system.

308. Petitioner makes at least three combinations using different Harbers components. The software combination uses both Harbers’ and Karlsson’s

software and Karlsson's LED + SLM (see Petition, 96-98.) The hardware combinations use either Harbers' LED array substituted for Karlsson's array with Karlsson's software (selective control), or a "modification" of Karlsson's flat substrate of lighting means 2, 3 with a "curved substrate" from Harbers. (*Id.*, 98-99.)

(5) Petitioner never explains how to merge conflicting functionality of Harbers and Karlsson software

309. Harbers does provide for some form of apparent automatic control, based on velocity and steering (Ex.1011, 3:27-4:14.) In low speed situations, wide light of decreased intensity is used. (*Id.*, 3:30-34.) As vehicle speed increases, fewer, but brighter, LEDs are used (*Id.*) When a steering-wheel is turned, the main beam is dimmed (*Id.*, 4:5-14.) Karlsson, on the other hand, discloses optimum illumination and will utilize its full array when possible.

310. Petitioner does not explain how Harbers' selective functions will not conflict with the "maximal illumination" disclosed in Karlsson. For example, if Harbers control were interposed on a Petitioner-example cited above, as would occur in the combination, and the emitting vehicle slowed, a conflict would arise. Harbers software would attempt to widen the beam and decrease central forward illumination (use the passing and side beam segments) at the same time as Karlsson would attempt to maintain dimming of the sides that Harbers is

attempting to illuminate as well as maintain intense forward illumination that Harbers is attempting to dim.

311. Because both control functions are present in the software combinations, such conflicts would arise, and they are neither noted nor addressed by Petitioner. Without solutions to these conflicts, a POSA would not have been motivated to utilize both sets of software as proposed by Petitioner.

(6) Petitioner does not explain how any segmentation would occur in the absence of Harbers' software

312. Petitioner contends that including Harbers hardware (as an **alternative to software**) into Karlsson's system would "have provided different spatial distributions for different driving situations." (Petition, 99-100.)

313. Petitioner's argument that "elements 11-14... provide beam segments - 6-6'-6"-6"', 7-7'-7"-7"', without having Harbers' software, is completely unfounded in the teachings of Harbers. (See Petition, 99.) All of Harbers' described control functions are related to software controls (Ex.1011, 3:27-4:14). While the system would have included differently **colored** LEDs, it would not have segmented the beams as Harbers suggests because it would not have known how to handle colored LEDs.

314. Intentionally left blank.

H. Ground 8 – Karlsson, Harbers, and Gotou

1. Dependent Claims

d. Claims 15, 17, 54, 56 – The Karlsson/Harbers/Gotou Combination Does Not Teach “*increas[ing] illumination in a direction of the road curvature.*”

315. Claim 15 depends from claim 1 and requires “*wherein the logical controller is further configured to determine at least a road curvature, indicated by the sensor data, ahead of the vehicle and wherein the required illumination includes increasing illumination in a direction of the road curvature.*”

316. Claim 17 depends from claim 1 and requires “*wherein the logical controller is further configured to determine at least a planned upcoming turn, indicated by the sensor data, and wherein the required illumination includes increasing illumination illuminating the turn.*”

317. Claim 54 depends from claim 37 and requires “*wherein at least one of the at least one processors is further configured to determine at least a road curvature, indicated by the sensor data, ahead of the first vehicle and to determine a second illumination pattern defining increased illumination in a direction of the road curvature.*”

318. Claim 56 depends from claim 37 and requires “*wherein at least one of the at least one processors is further configured to determine at least a planned upcoming turn, indicated by the sensor data, and to determine a third illumination pattern defining increased illumination illuminating the turn.*”

319. Petitioner relies on Gotou’s disclosure of adjusting light based on GPS data including road curvature for satisfying the sensor data limitations, and relies on Karlsson/Harbers for satisfying the hardware and software limitations. (Petition, 159-163, 164, 166.)

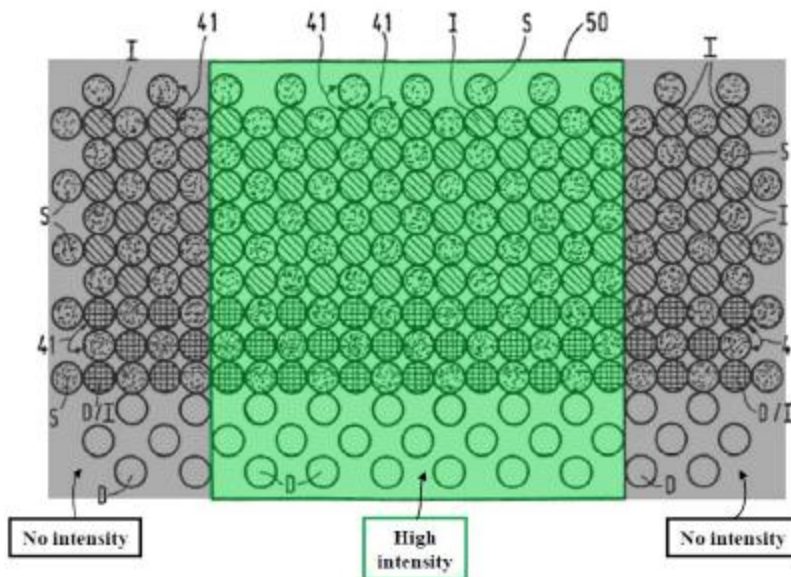
(1) All Sub-Grounds

320. 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 also 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.) Karlsson seeks the **retention** of “optimum” light anywhere glare is not being accommodated. (Ex.1010, 2:7-10, 9:23-26.)

321. Karlsson discloses that “the lighting means 2, 3 are intermittently controlled by control means 14 . . . so as to control the lighting means 2, 3 in such a manner that a light beam 7 having a desired pattern and a desired intensity is emitted.” (Ex.1010, 9-17.) Karlsson further 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.)

322. Petitioner explains Karlsson as teaching a shaded area of “no intensity” and a non-shaded area of “high intensity”: “Thus, Karlsson’s processor processes the data, and uses memory (with algorithms) to “determine an illumination for at least two of the subsections” (shaded area of no intensity/non-shaded area of high intensity).” (Petition, 116.) Petitioner annotated Karlsson’s Figure 14 to identify the areas of “No intensity” and “High intensity” illumination:



(Petition at 117,119,122,124; Ex.1010, Fig. 14, Annotated by Petitioner)

323. Petitioner admitted, in IPR2023-00318, that Karlsson’s 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.)

324. “The greatest extent possible” that “surrounds” a reduced illumination area, is, of course, use of the full LED array, to provide the driving beam 7. As Petitioner explains, this would also “maximize the area that is fully illuminated” to achieve “optimum lighting effect for the driver.” (Ex. 2008 at 67.) 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.

325. 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, nor would there be remaining unlit LEDs with which to achieve the increase. Accordingly, the Karlsson/Harbers/Gotou combination does not teach “*increas[ing] illumination in a direction of the road curvature*” as claimed.

I. Ground 9 – Karlsson, Harbers, and Braun (claims 6, 46)

1. Dependent Claims

e. Claim 6

326. Claim 6 depends from claim 1 and requires “*wherein the headlight beam further comprises light in at least one of infra-red (IR) or ultra-violet (UV) wavelengths.*”

2. A POSA Would Not Have Been Motivated to Combine Karlsson, Harbers, and Braun

a. Petitioner Does Not Explain How a POSA Would Have Combined Karlsson, Harbers, and Braun

327. Claim 6 is representative of claim 46 and requires “*wherein the headlight beam further comprises light in at least one of infra-red (IR) or ultra-violet (UV) wavelengths.*” The Petitioner relies on Braun’s luxels for satisfying this limitation. (Petition, 172.)

328. Petitioner states that combination “would have been combining prior-art elements **or** a simple substitution of one known element for another (Karlsson’s/Braun’s respective arrays) according to known methods to yield

predictable results (improved visibility and safety).” This would include “modifying Karlsson’s LEDs with Braun’s colored LEDs to provide colored light sources with IR/UV wavelengths for different functions.” (Petition, 170.)

**(1) Grounds 9A (Beam Lamp +
SLM+Stam/Braun) 9D
(Beam+ThominetHW+Stam/Braun)**

329. Petitioner does not provide any explanation for how and why a POSA would have combined or substituted Karlsson’s lamp/SLM or Harbers’s LEDs with Braun’s luxels. (Petition, 170.)

**(1) Grounds 9B (Karlsson LEDs), and
9C-9D (Karlson + HarbersSW)**

330. Petitioner does not explain how Karlsson’s LED arrays and Braun’s luxels would have been combined, or what additional changes would be needed to combine or substitute the light sources. 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 and tradeoffs involving complex and interrelated optics, heat management, white LED lumen output, packaging and cost issues.

331. Intentionally left blank.

X. Conclusion

332. 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.

333. 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: 10/12/2023

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

Matthew A. Turk PhD