

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MERCEDES-BENZ USA, LLC
Petitioner,

v.

YECHEZKAL EVAN SPERO
Patent Owner.

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

IPR Case No.: IPR2023-01034

DECLARATION OF MATTHEW A. TURK, Ph.D.

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List of Exhibits

Exhibit No.	Description	Identifier
2001	Declaration of Matthew A. Turk, Ph.D.	Turk Decl
2002	Curriculum Vitae of Matthew A. Turk, Ph.D.	Turk CV
2003	Intentionally left blank	
2004	Intentionally left blank	
2005	Intentionally left blank	
2006	U.S. Published Patent Application US2003/0137849A1 to Alden, Prosecution History in the U.S. Patent and Trademark Office	Alden Prosecution History

1. I, Matthew A. Turk, hereby declare as follows:
2. I am making this declaration at the request of Yechezkal Evan Spero in the matter of *Inter Partes* Review of U.S. Patent No. 11,208,029 (“the ’029 Patent”) to Yechezkal Evan Spero.
3. I am being compensated for my work in this matter at a rate of \$490/hour for time spent reviewing materials and performing my analysis of the technical issues relevant to this matter. My compensation in no way depends on the outcome of this proceeding.
4. In preparation of this declaration, I have studied the exhibits as listed in the Exhibit List shown above in my report.
5. 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

6. 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.

7. 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.

8. 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).

9. 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.

10. 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.

11. In 2000, I joined the faculty of the University of California, Santa Barbara, as an Associate Professor. In 2005, I was promoted to Full Professor and served as the Chair of the Media Arts and Technology Graduate Program from 2005 to 2010. In 2017, I was appointed as Chair of the Department of Computer Science. At UCSB, I taught graduate and undergraduate courses related to computer vision, computer imaging, human computer interaction, probabilistic models and methods, artificial intelligence, computer graphics, machine learning, and other areas. My graduate Computer Imaging course covered the fundamentals of imaging systems, including the capture, storage, display, retrieval, and processing of images, as well as the nature of light, color, optics, human vision, non-visible (UV and IR) and multispectral imaging, sensors, cameras, and illumination.

12. 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.

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

14. 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.

15. 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.”

16. 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).

17. 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.

18. 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.

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

II. Relevant Legal Standards

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

21. 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.

22. 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. Overview of the '029 Patent

23. The '029 Patent is directed to “a novel multi-light source approach to the design and construction of solid-state lighting fixtures ... (vs. solid state lamps), which is termed a ‘Digital Lighting Fixture’, due to the control of individual lighting element ‘digits’ to provide the ‘correct’ lighting solution for the situation at hand.” (Ex. 1001, 11:8-13.) The '029 Patent further explains that “[t]he terminology ‘digital’ as used herein refers to the discrete nature of the multiple LED lamps provided in the luminaire, whereby, ‘digital’ control results from the individual control of the discrete, i.e., ‘digital’ lighting elements, the LEDs, in the luminaire.” (*Id.*, 2:67-3:5.)

24. The '029 Patent also describes the deficiencies of prior art lighting systems that replace conventional lights with solid-state LED light sources “with some minor adjustments” but do not utilize the full “digital” control of the LEDs. (Ex. 1001, 9:60-63.)

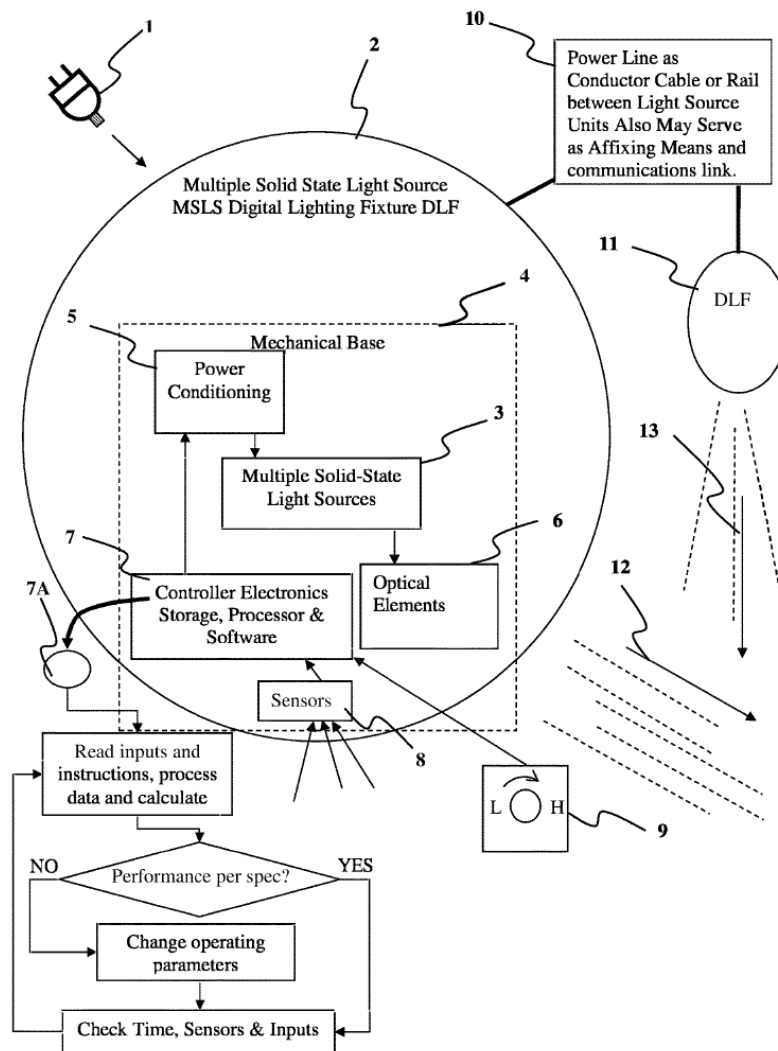


FIG. 1

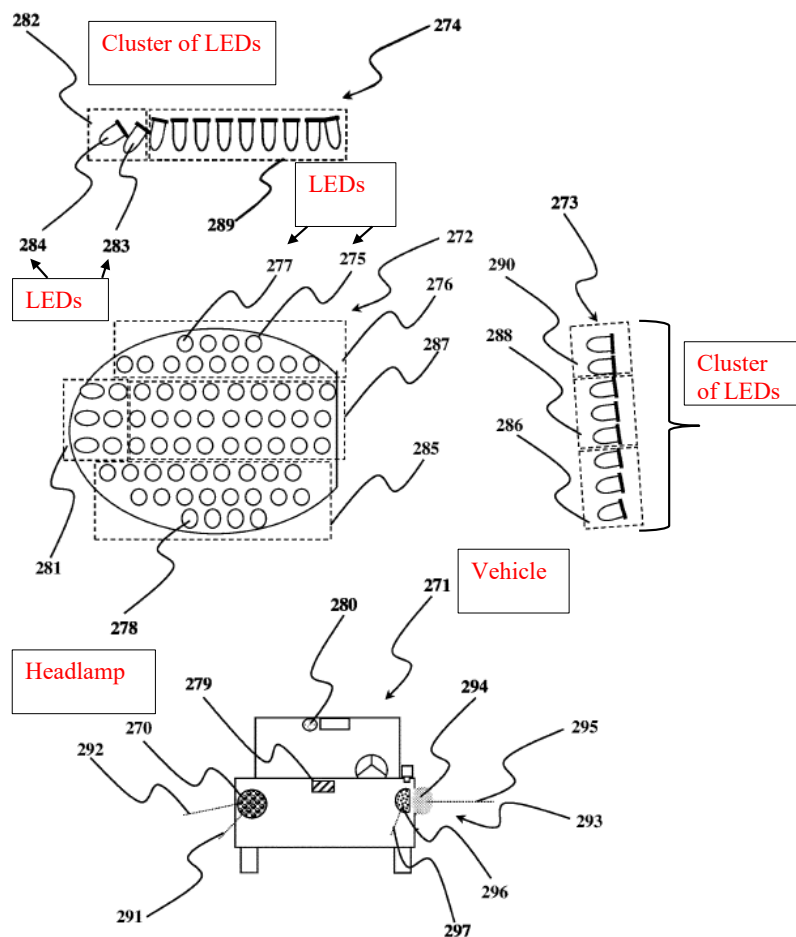
(Ex. 1001, Fig. 1)

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

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

26. The '029 Patent describes “a different approach which is to provide the end user with the most correct lighting solution not a new technology lamp to replace the old one.” (Ex. 1001, 11:5-8.) “In contrast to a prior art, single large, lamp replacement like light source, the present invention provides multiple, small sized sources of differing characteristics such that the effect of the whole is greater than the sum of the individual parts.” (*Id.*, 11:45-49.) “The added controllability offered by breaking the total light output up into **discrete (‘digital’) specifically aimable and dimmable elements**¹ which can be addressed by control electronics to effect intensity, spectrum and spatial distribution of intensity and spectrum, yields a lighting fixture (vs. lamp) of unparalleled performance.” (*Id.*, 11:56-62.) “The invention embraces LED-illuminating devices covering a wide scope of applications,” including transportation. (*Id.*, 11:14-21, 4:18-20, 50:49-50.)

¹ Emphasis added unless indicated otherwise.



(Ex. 1001, FIG. 15, Annotated)

27. The claimed invention of the '029 Patent, titled "Adaptive Headlight System," is directed to multi-LED headlight systems that provide predictive curve illumination with the receipt of map data indicating a road curvature upcoming along a road on which the motor vehicle is traveling. The '029 claimed invention solves the problem of how to provide a digital lighting solution that can "provide the optimal lighting solution in real-time" to predictively illuminate an upcoming road curvature. (Ex. 1001, 57:43-49.) The '029 Patent describes using a digital

light fixture (DLF) to provide multiple functions, for example “[i]n a DLF it is possible to combine a task light having a very narrow ‘spot’ beam at the correct aiming with a general area lighting ‘flood’ beam into one fixture.” (*Id.*, 22:26-28.) Similarly, an adaptive headlight system may utilize this dual functionality to aim a light beam at a curve ahead of the vehicle while maintaining forward lighting. (Ex. 1001, 50:61-67; 51:54-67.)

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

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

more processors to:

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

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

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

Predictive
Illumination
Determination
Limitation

Control
Limitation

(Ex. 1001, claim 1.)

29. The '029 Patent describes various techniques for predicting and illuminating an upcoming curve in the road. For example, Adaptive Frontal-lighting Systems are provided that “aid in seeing around curves and other features in the road.” (Ex. 1001, 51:54-56.) These systems predict upcoming curves in the road based on “instantaneous road conditions” and map data. (*Id.*, 51:56-67.) “A

GPS system on the car may also let the headlamps system know of curves up ahead, one-way traffic and others factors such [that] the headlamp may be operated in the optimal mode at that instantaneous location.” (*Id.*) The ’029 Patent also describes adjusting “the intensity, spectrum and beam pattern of the headlamp” based on “instantaneous road conditions” and map data indicative of an upcoming curve. (*Id.*)

IV. The Challenged Claims

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

V. Qualifications of One of Ordinary Skill in the Art

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

VI. Proposed Claim Construction

32. To properly evaluate these claims, I understand that the terms of the claims must first be construed. In my opinion, the claims of the ’029 Patent do not include any terms that require specific construction. Instead, each of the claims includes terms that an ordinary artisan would understand according to their plain and ordinary meaning.

VII. Overview of the Prior Art

A. Alden

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

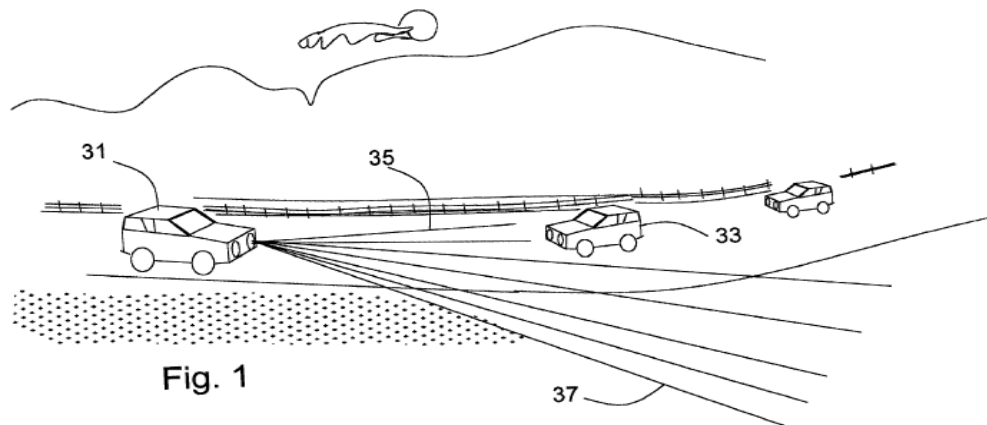


Fig. 1

(Ex. 1005, FIGURE 1)

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

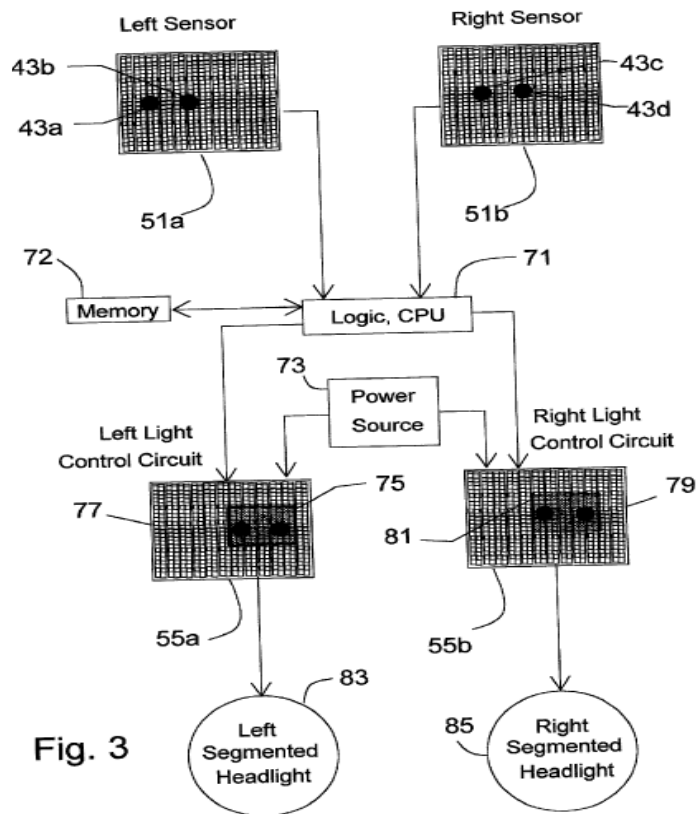
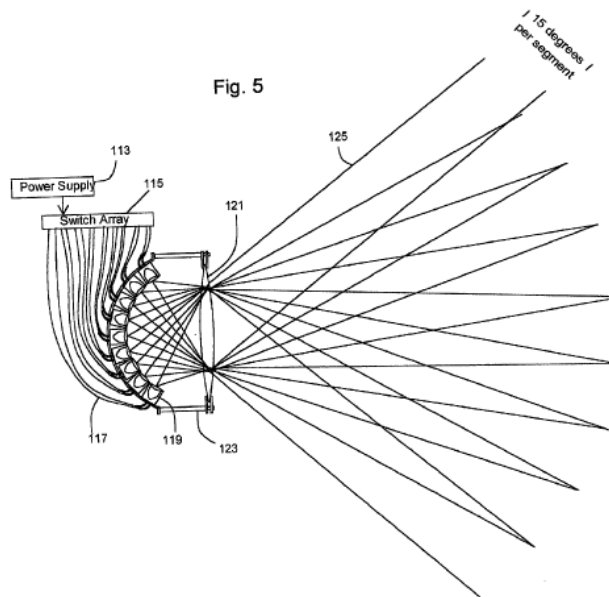


Fig. 3

(Ex. 1005, FIGURE 3)

35. In one of the two types of embodiments described, illustrated in Figures 1, 2, and 5-7, the headlight system dims the intensity of those beam segments produced by the headlight of an equipped vehicle that are incident on a sector or sectors in the distribution area. In one example of this type of embodiment, shown in Figure 5, a headlight 123 employs a one-dimensional array of light emitting diode (LED) elements 119 and a convex lens 121 for directing the beam segment produced by each LED element 119 that illuminate different sectors of the distribution area. (Ex. 1005, ¶¶[0025, 0026, 0029].) In another example of this type of embodiment, shown in Figures 6 and 7, electro-optical dimming means

are employed. (*Id.*, ¶¶[0025, 0026, 0029].)



(Ex. 1005, FIGURE 5)

36. The CPU 71 determines the sector or sectors of the sensors 51a, 51b receiving incoming light from the distribution area that have a detected threshold intensity. In response, the CPU 71 controls the headlight 123 to dim those beam segments or segments produced by the individual LED elements 119 that illuminate the distribution area sector or sectors associated with any such sensor sectors. (Ex. 1005, ¶¶[0026-0029].)

37. In the other of the two types of embodiments described, illustrated in Figures 8-15, the headlight system changes the direction of light produced by the headlights of an equipped vehicle. For example, light produced by the equipped vehicle headlights may be re-directed from a forward direction to a leftward or rightward direction to illuminate a turn in the road, or from a forward direction to

an upward or downward direction to illuminate an incline or decline in the road. In these embodiments, the headlight system employs a single point light source 129, a collimating reflector 131, electro-optical refractive elements 127, and a concave lens 133 to produce multiple light beam segments. (Ex. 1005, ¶¶[0032-0040].)

Fig. 8

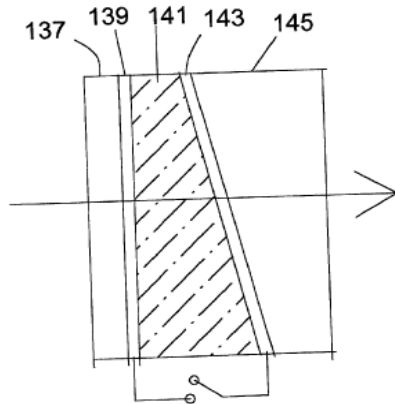
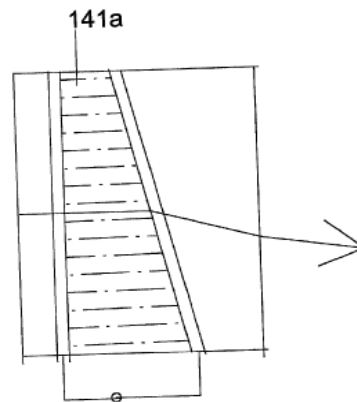
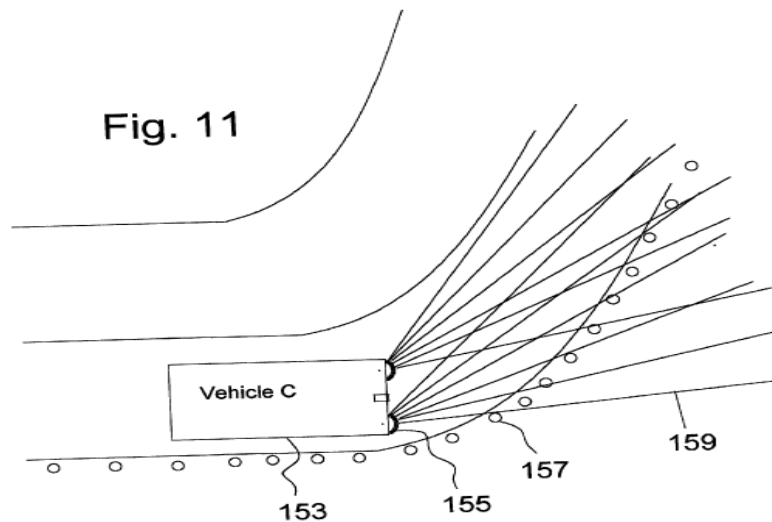


Fig. 9



(Ex. 1005, FIGURES 8, 9)

38. In one example of this second type of embodiment, the CPU 71 determines the sector or sectors of the sensors 51a, 51b receiving incoming light from the distribution area that have a detected threshold intensity. In response, the CPU 71 controls the electro-optical refractive elements 127 of the headlight to change the direction of the beam segments produced thereby to illuminate a turn in the road. (Ex. 1005, ¶¶[0036], Figure 11.)



(Ex. 1005, FIGURE 11)

39. Notably, each of the two types of embodiments disclosed by Alden is discrete and includes features that are incompatible with the other type of embodiment. For example, the headlight system embodiment described in connection with Figures 8-15 having electro-optical refractive elements 127 for changing the direction of headlight beam segments is designed to work with collimated light produced by single point light source 129, collimating reflector 131, and concave lens 133. However, the LED elements 119 of the headlight system embodiment described in connection with Figure 5 produce non-collimated light. Non-collimated light cannot be directed in any meaningful fashion by the electro-optical refractive elements 127 of the headlight system embodiment described in connection with Figures 8-15. Rather, non-collimated light would blend and have different incident angles on those electro-optical refractive

elements 127 thereby preventing any meaningful control of individual sectors as well as redirecting much of the non-collimated light they receive away from the desired segments of the distribution area. Any combination of these different types of Alden's headlight system embodiments would therefore be incapable of meeting the basic requirements of a headlight, *i.e.*, effectively illuminating the area ahead of the equipped vehicle, let alone directing its emitted light in any meaningful fashion. Rather than suggesting combinations of various features of its different headlight system embodiments, Alden only states generally that each of its two types of headlight system embodiments may employ the sensing elements 51a, 51b discussed in connection with Figures 3 and 4. (Ex. 1005, ¶¶[0036-0038].)

40. Alden is a theoretical reference that fails to enable much of its disclosure and is ambiguous in critical respects. The disclosure in Alden is directed to certain features of headlamp systems and general benefits such features and systems could provide but lacks detailed explanations as to how those features and systems are practically implemented or how those benefits are realized thereby. For example, while Alden depicts control circuit switch array switches in Figure 3 for dimming certain headlight beam segments while leaving other beam segments on high intensity, it does not clearly describe or specifically demonstrate how such operations are accomplished using the one-dimensional array of LED elements 119 of headlight 123 illustrated in Figure 5. In connection with Figure 4

Alden describes progressing through the sectors of sensors 51a, 51b of Figure 3 to detect incoming light, but it does not explain how those sensor sectors are mapped to either the one-dimensional array of LED elements 119 shown in Figure 5, the switches 115 for that array, or the distribution area sectors depicted therein. In fact, Alden specifically states that the switch arrays of the light control circuits 55a, 55b shown in Figure 3 are merely for illustrative purposes. (Ex. 1005, ¶[0027].)

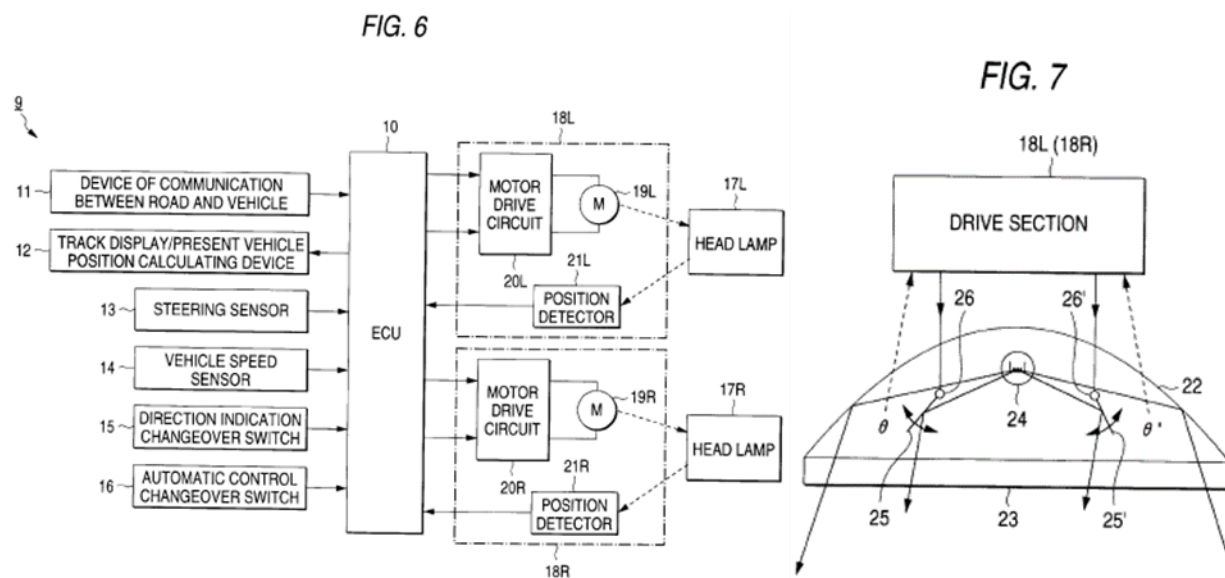
41. Relatedly, Alden contacted Gentex Corporation, an automotive industry supplier, regarding his segmented headlight system and was informed that Gentex's technical staff had determined the system to be "futuristic" and likely "years away from any practical use." (Ex. 2006 at 39.)

B. Kobayashi

42. Kobayashi is directed to a mechanical headlight control system that changes direction or range of a non-LED headlight beam using map information unless a predicted vehicle travel direction as indicated by a turn indicator, steering angle, vehicle speed/acceleration differs from the map data, i.e., "[w]hen the vehicle advancing direction at which the driver aims does not coincide with the profile of the road." (Ex. 1006, 2:34-36.) More specifically, Kobayashi discloses a headlamp system with moveable components to control irradiation (illumination) direction and range in accordance with a road profile when the vehicle travels along a scheduled course, or in accordance with a steering angle and vehicle speed

when the predicted advancing direction of the vehicle deviates from the scheduled course. (Ex. 1006, 6:4-10, 17:59-67.)

43. Kobayashi changes irradiation direction using a motor to either rotate the entire lighting device about its axis, or to change relative position among internal lighting device components, such as a reflecting mirror, lens, light source, or shielding member. (Ex. 1006, 6:11-39.) Irradiation range is controlled by either combining different lighting devices with each other (such as a fog lamp, head lamp, and cornering lamp), or by controlling a motor to change position of the internal components (such as reflecting mirrors lenses, or shades) relative to one another. (Ex. 1006, 6:40-7:14.) Irradiation range may be changed responsive to a branch (intersection) ahead on a road by moving the internal lighting device components to change a horizontal irradiating angle α . (Ex. 1006, 8:1-32.)

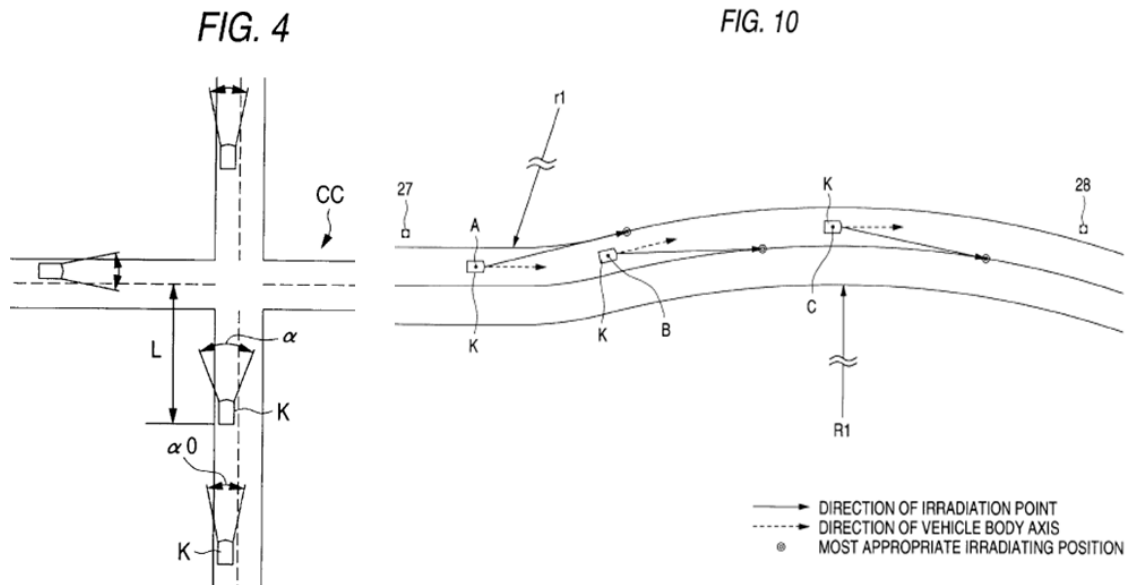


(Ex. 1006, FIGs. 6, 7)

44. Kobayashi's ECU 10 receives signals from communication device 11 (conducting communication between a road and vehicle), track display/present vehicle position calculating device 12, steering sensor 13, vehicle speed sensor 14, direction indicating switch 15, and automatic control change-over switch 16. ECU 10 generates signals for drive sections 18L, 18R of head lamps 17L, 17R arranged on the left and right front portion of a vehicle. (Ex. 1006, 10:1-17.) Drive sections 18L, 18R include associated motor drive circuits 20L, 20R to drive associated motors 19L, 19R with position detectors 21L, 21R to detect the posture of the head lamps 17L, 17R or their composing members (internal components). (Ex. 1006, 10:66-11:4.)

45. Figure 7 illustrates a headlamp with moveable composing members to control the direction and range of irradiation. Light source 24 and movable reflecting mirrors 25, 25' are positioned between stationary reflecting mirror 22 and front lens 23. Movable reflecting mirrors 25, 25' are rotated about respective rotating axes 26, 26' by a link mechanism to a rotation angle (θ , θ') to provide partial direction control of irradiating light. (Ex. 1006, 11:5-14.)

46. Figures 4 and 10 illustrate operation of the moveable composing members of the headlamps to control irradiation range and direction while approaching an intersection and running on a curved road, respectively. (Ex. 1006, 2:48-49, 2:65-67.)



(Ex. 1006, FIGs. 4, 10)

47. As shown in Figure 4, Kobayashi's headlamp motors are operated to increase horizontal irradiating angle α to $\alpha > \alpha_0$ based on a distance L from intersection CC and vehicle speed. (Ex. 1006, 8:14-25.) In Figure 10, the headlamp motors are operated according to road profile information and vehicle speed to change the irradiating direction toward a determined irradiating position for the driver's line of sight at each position of the vehicle. (Ex. 1006, 14:53-15:28.) When the vehicle turns to the left at point A , the left shoulder is irradiated. When the vehicle turns to right, 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. 1006, 14:53-15:39.)

VIII. Grounds for Challenge

A. Ground 1: Petitioner's Combination of Alden and Kobayashi Fails to Teach All of the Elements of Independent Claims 1, 12, and 23

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

1. Petitioner's Combination of Alden and Kobayashi Fails to Teach the Independent Claim 1 Predictive Illumination Determination and Control Limitations

49. It is my understanding that Petitioner must explain how and why a POSA would have modified or combined the prior art and that there must be an articulated reasoning with a rational underpinning to support a legal conclusion of obviousness. It is also my understanding that, if a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. It is still further my understanding that, if a proposed modification or combination of prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are insufficient to render a claim obvious. Petitioner fails to address these issues.

50. Independent claim 1 includes predictive illumination determination

elements recited as “determine a light change, the change adapting a light pattern of the headlamps in at least one of color, intensity or spatial distribution to increase light in a direction of the road curvature ahead of the motor vehicle and shaping light based at least in part on the road curvature.” (Ex. 1001, Claim 1.) Independent claim 1 also includes control elements recited as “control at least a first plurality of the LED light sources to provide light based at least in part on the determined light change and prior to the motor vehicle reaching the road curvature.” (*Id.*)

51. Petitioner’s obviousness contentions rely in part on a combination of the headlight system embodiment discussed in connection with Figure 5 of Alden with that of the headlight system embodiment discussed in connection with Figures 8-15 of Alden. (Petition at 25-27.) In that regard, Petitioner cites the headlight system embodiment of Figures 8-15 to allegedly satisfy the independent claim 1 elements of “determine a light change, the change adapting a light pattern of the headlamps . . . to increase light in a direction of the road curvature ahead of the motor vehicle.” (*Id.*) At the same time, Petitioner cites the headlight system embodiment of Figure 5 to allegedly satisfy the independent claim 1 elements of “control at least a first plurality of the LED light sources to provide light based on the determined light change.” (*Id.* at 28-29.) Petitioner does not cite Kobayashi in connection with the independent claim 1 elements relating to increasing light or

LED light sources, instead relying solely on Alden in connection with these claim feature. Petitioner cites Kobayashi only in connection with the independent claim 1 elements relating to shaping light. (*Id.* at 25-28.)

52. However, each of the embodiments disclosed by Alden is distinct and includes features that are incompatible with the other embodiment. The headlight system embodiment discussed in Alden in connection with Figure 5 is directed to a headlight having a one-dimensional array of individually controlled LED elements 119 and a convex lens 121 for providing selective dimming and a fixed direction (*i.e.*, forward) of non-collimated light produced by the LED elements 119. (Ex. 1005, ¶¶[0025-0026, 0029], Figure 5.) In contrast, the headlight system embodiment discussed in Alden in connection with Figures 8-15 is directed to a headlight having a single point light source 129, a collimating reflector 131, electro-optical refractive elements 127, and a concave lens 133 for changing the direction (*i.e.*, forward, left, right, up, down) of multiple beams of collimated light produced by the single point light source 129 and collimating reflector 131. (*Id.*, ¶¶[0032-0040].)

53. Alden's non-collimated light producing LED elements 119 and convex lens 121 are incompatible with Alden's electro-optical refractive elements 127 and concave lens 133, which are designed to work with collimated light and, indeed, are inoperable with non-collimated light. Non-collimated light cannot be

directed in any meaningful fashion by the electro-optical refractive elements 127 of the headlight system embodiment described in connection with Figures 8-15 of Alden. Rather, non-collimated light would blend and have different incident angles on those electro-optical refractive elements 127 thereby preventing any meaningful control of individual sectors as well as redirecting much of the non-collimated light they receive away from the desired segments of the distribution area. The result of any combination thereof would therefore be incapable of meeting the basic requirements of a headlight, *i.e.*, effectively illuminating the area ahead of the equipped vehicle, let alone directing its emitted light in any meaningful fashion.

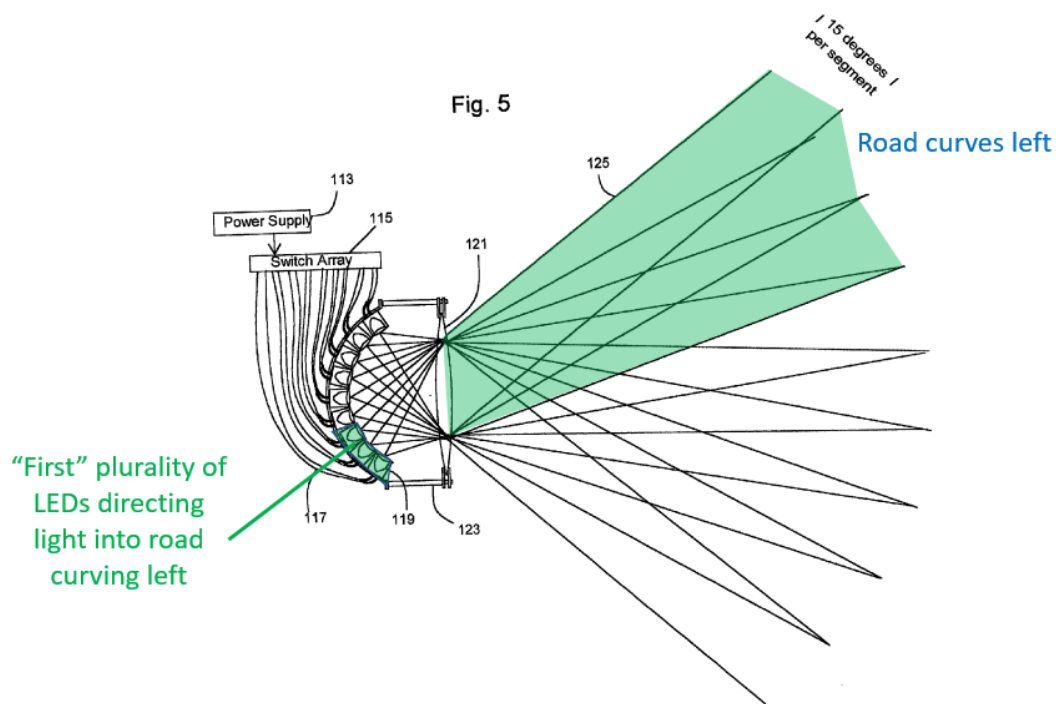
54. It is my understanding that Petitioner cannot simply treat the various features of Alden's embodiments as interchangeable. Instead, it is my understanding that Alden's disclosure must support any contention of interchangeability. It is also my understanding that extrinsic evidence, such as an expert declaration, on what Alden's different embodiments could include or would accommodate are not the same as what Alden specifically discloses.

55. It is further my understanding that Petitioner must provide a sufficient rationale to combine Alden's different embodiments. In that regard, rather than suggesting combinations of various features of its different headlight system embodiments, Alden does nothing more than state generally that each of its two

different types of headlight system embodiments may employ the sensing elements discussed in connection with Figures 3 and 4. (Ex. 1005, ¶¶[0036-0038].)

56. Having failed to explain *why* a POSA would have found it obvious to combine those embodiments, any contentions by Petitioner of obviousness based thereon fail. Moreover, the features of the headlight system embodiments of Alden being incompatible, Petitioner's combination of Alden's embodiments would therefore render the resulting headlight system inoperable or unsatisfactory for its intended purpose and change its principle of operation -- making it an unsuitable option. As a result, one of ordinary skill would not be motivated to combine Alden and Kobayashi as Petitioner contends and, indeed, the teachings of Alden and Kobayashi are insufficient to render the claimed invention obvious.

57. Additionally, to support its contention that Alden allegedly teaches the independent claim 1 elements of "control at least a first plurality of the LED light sources to provide light based on the determined light change [to increase light in a direction of the road curvature ahead of the motor vehicle]," Petitioner cites its annotated version of Figure 5 of Alden. (Petition at 29.) Petitioner's annotated version of Figure 5 is reproduced immediately below:



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

58. Unlike elsewhere in its Petition, Petitioner did not annotate Figure 5 to simply highlight elements of Alden's headlight system. Instead, with these annotations of Figure 5, Petitioner purports to show how headlight 123 operates in a specific scenario. However, the operation of headlight 123 purportedly shown by Petitioner's annotations of Figure 5 is not disclosed in Alden. Petitioner's annotations are therefore mere speculation, *i.e.*, extrinsic evidence that I understand cannot be used to fill gaps in Alden.

59. More specifically, Petitioner has annotated Figure 5 of Alden to show a scenario where only a select "first plurality" LED elements 119 are activated and configured to illuminate sectors on the left of the distribution area ahead of the

equipped vehicle, while showing as deactivated the remaining LED elements 119 configured to illuminate sectors in the center and on the right of that distribution area. (Petition at 28-29.) However, Petitioner's annotation of Figure 5 is inaccurate.

60. Contrary to Petitioner's annotations, nowhere in Alden lacks any mention of deactivating selected LED elements 119 of headlight 123. As previously demonstrated, in the headlight system embodiment described in Alden in connection with Figure 5, the headlight 123 includes LED elements 119 that are individually controlled to provide selective dimming. (Ex. 1005, ¶¶[0025-0026, 0029].) That is, all the LED elements 119 are activated and initially emit high intensity beam segments (*i.e.*, high beam) to illuminate a distribution area ahead of the equipped vehicle, and then the high intensity of selected LED elements 119 is reduced so that those selected LED elements 119 subsequently emit low intensity beam segments (*e.g.*, low beam). Thus, none of the LED elements 119 are ever deactivated. (*Id.*, ¶¶[0025-0026, 0029].)

61. Moreover, even assuming that Petitioner's annotation of Figure 5 is accurate (which is not conceded), that annotation fails to demonstrate increasing light in a direction of a road curvature. Once again, as previously demonstrated, all the LED elements 119 of headlight 123 are activated and initially emit high intensity beam segments (*i.e.*, high beam). Therefore, Petitioner's annotation

showing as deactivated those LED elements 119 that illuminate the center and right distribution area sectors ahead of the equipped vehicle while showing as activated only those LED elements 119 that illuminate the left distribution area sectors ahead of the vehicle does nothing to increase the light from LED elements 119 illuminating those left distribution area sectors. This is true even if all the LED elements 119 of headlight 123 are activated (i.e., none are selectively deactivated), because the intensity of the light emitted by those LED elements 119 illuminating the left distribution area sectors (indeed, the intensity of the light emitted by any LED element 119 illuminating any sector of the distribution area) is never increased beyond the (high) intensity emitted when they are initially activated. Furthermore, as also previously demonstrated, the light produced by headlight 123 of the headlight system embodiment of Figure 5 of Alden has a fixed, forward direction toward the distribution area ahead of the equipped vehicle, which direction is never changed. (Ex. 1005, ¶¶[0025-0026, 0029].)

62. It is only by mischaracterizing the operation of the headlight system embodiment of Figure 5 of Alden that Petitioner can assert that headlight system embodiment “teaches” the independent claim 1 elements of “determine a light change . . . to increase light in a direction of the road curvature ahead of the motor vehicle.” Once again, Petitioner does not cite Kobayashi in connection with the independent claim 1 elements relating to increasing light, instead relying solely on

Alden in connection with those claim elements. (Petition at 25-28.) Because Alden does not teach such independent claim 1 elements, Petitioner's obviousness contention fails.

63. Still further, neither Alden nor Kobayashi teaches the independent claim 1 elements directed to shaping light. As previously demonstrated, the headlight system embodiment discussed in connection with Figure 5 of Alden only dims selected LED elements 119 of headlight 123; it does not even change the direction of the beam segments emitted by the LED elements 119, let alone shape those beam segments. As also previously demonstrated, the headlight system embodiment discussed in connection with Figures 8-15 of Alden merely changes the direction of light emitted by the headlight having a single point light source 129 and collimating reflector 131 from a forward direction to a left, right, up, or down direction, but does not shape the light emitted. (Ex. 1005, ¶¶0029-0040].)

64. Thus, in each of the two types of headlight system embodiments of Alden, the overall shape of the light emitted by the headlight remains unchanged before, during, and after dimming (according to the embodiment of Figures 1, 2, and 5-7 of Alden) or re-direction (according to the embodiment of Figures 8-15 of Alden). The concept of shaping light emitted by its headlight system embodiments is never discussed in Alden and, indeed, the words "shape," "shaped," or "shaping" never appear in Alden's disclosure. As a result, Petitioner simply equates Alden's

discussions relating to “directing” and “concentrate[ing]” light with shaping light – offering only its expert’s declaration in support (Petition at 26-27), which I understand is insufficient.

65. Petitioner does the same regarding Kobayashi. (Petition at 27.) However, in the context of road curves, Kobayashi discloses only changing the direction of light produced by vehicle headlights, and never discloses shaping light. In that regard, Kobayashi’s disclosure of controlling the (lateral) range of light emitted by vehicle headlights relates only to road intersections (also referred to as branches), which Kobayashi distinguishes from road curves. (Kobayashi, 14:53-16:56, Figure 11.)

66. It is only by conflating the concept of directing light with that of shaping light that Petitioner can assert that Alden and/or Kobayashi disclose(s) the independent claim 1 elements of “determining a light change, the change . . . shaping light based at least in part on the road curvature.” (Petition at 25-27.) Because neither Alden nor Kobayashi teaches these independent claim 1 elements, any combination of those references would fail to result in the claimed invention recited therein. Petitioner’s obviousness contentions therefore fail.

67. Also, neither Alden nor Kobayashi teaches the independent claim 1 elements relating to a processor to control a first plurality of LED light sources to provide light based on a determined light change prior to the equipped vehicle

reaching a road curvature. Petitioner contends that Alden teaches these independent claim 1 elements because it allegedly discusses the detection of an upcoming road turn in connection with the headlight system embodiment of Figure 11 thereof. (Petition at 29-30.) However, in connection with Figure 11, Alden merely states that “an equipped vehicle 153 senses that the road turns by receiving light from reflectors, such as reflector 157” and does not teach that such sensing occurs prior to the equipped vehicle entering the turn. (Ex. 1005, ¶[0036].) Similarly, Alden’s statement that “[t]he responding headlights 155 direct light into the corner to maximize the driver’s ability to see there” also is not a teaching that such re-direction of light occurs prior to the equipped vehicle entering the turn. Even assuming that Alden discusses detection of an upcoming curve (which is not conceded), the mere detection of an upcoming curve is obviously neither the same as nor a teaching of re-directing the light produced by the headlight of that embodiment, let alone re-directing that light prior to the equipped vehicle entering that turn.

68. Indeed, Alden does not discuss the timing of the re-direction of the light emitted by headlights 155 in connection with Figure 11. (Ex. 1005, ¶[0036].) Rather, the only discussion of the timing of the re-direction of light occurs in connection with Figures 14 and 15, where Alden states “[a]s the steering wheel 191 rotates “x” degrees, rotation sensor 193 detects the rotation” and “[t]he system

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

69. Kobayashi also fails to teach these independent claim 1 elements. In connection with the discussion of Figure 10 depicting a vehicle K traversing a curved road, Kobayashi expressly states: “[w]hen the vehicle turns to the left, the left shoulder is illuminated” and “[w]hen the vehicle turns to the right, the right shoulder is illuminated.” (Ex. 1006, 15:21-23; *Id.*, Figure 10.) Thus, as in Alden, re-direction of the light emitted by the headlights of Kobayashi’s vehicle K does not occur until the vehicle has entered the curve. As a result, like Alden, Kobayashi likewise fails to teach the independent claim 1 elements of “control at least a first plurality of the LED light sources to provide light based at least in part on the determined light change and prior to the motor vehicle reaching the road curvature.” Once again, Kobayashi’s discussion of controlling the (lateral) range of light emitted by vehicle headlights relates only to road intersections (also referred

to as branches), which Kobayashi distinguishes from road curves. (Ex. 1006, 14:53-16:56, Figure 11.) Here again, because neither Alden nor Kobayashi teaches these independent claim 1 elements, any combination of those references would fail to result in the claimed invention recited therein. Petitioner's obviousness contentions therefore again fail.

2. Petitioner's Combination of Alden and Kobayashi Fails to Teach the Independent Claim 12 Predictive Illumination Determination and Control Limitations

70. Similar to independent claim 1, independent claim 12 includes predictive illumination determination elements recited as “determine a light change, the change adapting a light pattern of the headlamps in at least one of color, intensity or spatial distribution to increase light in a direction of the road curvature ahead of the motor vehicle and shaping light based at least in part on the road curvature.” (Ex. 1001, Claim 12.) Also similar to independent claim 1, independent claim 12 also includes control elements recited as “control at least a first plurality of the LED light sources to provide light based at least in part on the determined light change and prior to the motor vehicle reaching the road curvature.” (*Id.*)

71. Petitioner's obviousness contentions relating to independent claim 12 are the same as those relating to independent claim 1. That is, Petitioner relies on a combination of Alden and Kobayashi, including a combination of incompatible

features from the different headlight system embodiments discussed in Alden. (Petition at 31-32.) Petitioner's obviousness contentions relating to independent claim 12 therefore fail for the same reasons as those set forth above in connection with independent claim 1.

72. In that regard, having failed to explain *why* a POSA would have found it obvious to combine those embodiments, any contentions by Petitioner of obviousness based thereon fail. Additionally, because the features from the different headlight system embodiments of Alden are incompatible, Petitioner's combination of Alden's embodiments would render any resulting headlight system inoperable or unsatisfactory for its intended purpose and change its principle of operation -- making it an unsuitable option. As a result, one of ordinary skill would not be motivated to combine Alden and Kobayashi as Petitioner contends and, indeed, the teachings of Alden and Kobayashi are insufficient to render the claimed invention obvious.

73. Moreover, despite Petitioner's inaccurate annotation of Figure 5, Alden fails to teach the independent claim 12 elements relating to increasing light in a direction of a road curvature. Petitioner's obviousness contentions therefore fail.

74. Alden and Kobayashi also both fail to teach the independent claim 12 elements directed to shaping light, nor instructions that enable a processor to

control LED light sources to provide a determined light change prior to the equipped vehicle reaching a road curvature. Because neither Alden nor Kobayashi teaches these independent claim 12 elements, any combination of those references would fail to result in the claimed invention recited therein. Petitioner's obviousness contentions therefore again fail.

3. Petitioner's Combination of Alden and Kobayashi Fails to Teach the Independent Claim 23 Predictive Illumination Determination and Control Limitations

75. Similar to independent claim 1, independent claim 23 includes predictive illumination determination elements recited as “determining a light output, the output adapting a light pattern of the headlamps in at least one of color, intensity or spatial distribution to increase light in a direction associated with the [road] shape change ahead of the motor vehicle and shaping light based on the [road] shape change.” (Ex. 1001, Claim 23.) Also similar to independent claim 1, independent claim 23 also includes control elements recited as “prior to reaching the road shape change, causing at least a first plurality of the LED light sources to provide light based at least in part on the determined light output.” (*Id.*)

76. Petitioner's obviousness contentions relating to independent claim 23 are the same as those relating to independent claim 1. That is, Petitioner relies on a combination of Alden and Kobayashi, including a combination of incompatible features from the different headlight system embodiments discussed in Alden.

(Petition at 32-33.) Petitioner's obviousness contentions relating to independent claim 23 therefore fail for the same reasons as those set forth above in connection with independent claim 1.

77. In that regard, having failed to explain *why* a POSA would have found it obvious to combine those embodiments, any contentions by Petitioner of obviousness based thereon fail. Additionally, because the features from the different headlight system embodiments of Alden are incompatible, Petitioner's combination of Alden's embodiments would render any resulting headlight system inoperable or unsatisfactory for its intended purpose and change its principle of operation -- making it an unsuitable option. As a result, one of ordinary skill would not be motivated to combine Alden and Kobayashi as Petitioner contends and, indeed, the teachings of Alden and Kobayashi are insufficient to render the claimed invention obvious.

78. Moreover, despite Petitioner's inaccurate annotation of Figure 5, Alden fails to teach the independent claim 23 elements relating to increasing light in a direction associated with a road shape change. Petitioner's obviousness contentions therefore fail.

79. Alden and Kobayashi also both fail teach the independent claim 23 elements directed to shaping light, nor causing LED light sources to provide a determined light change prior to the equipped vehicle reaching a road shape

change. Because neither Alden nor Kobayashi teaches these independent claim 23 elements, any combination of those references would fail to result in the claimed invention recited therein. Petitioner's obviousness contentions therefore again fail.

B. Ground 2: Petitioner's Combination of Alden, Kobayashi and Beam Fails to Teach All of the Limitations of Claims 9, 20 and 31

80. For the reasons detailed in Section VIII(A) *supra*, the combination of Alden and Kobayashi fails to teach the Predictive Illumination Determination and Control Limitations of independent claims 1, 12 and 23. The Petition's optional inclusion of the Beam reference —“Alden (alone or with Beam) in view of Kobayashi” — fails to satisfy the missing claim limitations in dependent claims 9, 20 and 31. (Petition at 5.)

81. Among other reasons, the combination of Alden, Kobayashi and Beam does not teach “one or more processors to: “determine a light change ... to **increase light** in a direction of the road curvature **ahead** of the motor vehicle” as required in claims 9, 20 and 31. Beam discloses a headlamp that provides “the equivalent of **high beam headlights or brighter on at all times**, greatly enhancing the ability to see at night” except for areas where incoming light is detected. (Ex. 1007, 6:53-56.) Beam further discloses that “[t]he resulting beam is at **full intensity** except in areas that would dazzle a driver ahead.” (Ex. 1007, 4:57-59.) 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 Beam system. The Ground 2 combination also fails to establish obviousness of claims 9, 20 and 31.

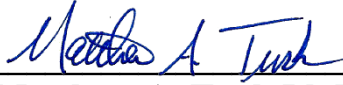
IX. Conclusion

82. 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.

83. 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: 10/24/2023



Matthew A. Turk Ph.D.