

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Mercedes-Benz USA, LLC,
Petitioner,

v.

Yechezkal Evan Spero,
Patent Owner.

Case [To be assigned]
Patent 11,208,029

**DECLARATION OF DR. NIKOLAOS PAPANIKOLOPOULOS
IN SUPPORT OF MERCEDES' PETITION FOR *INTER PARTES* REVIEW
OF CLAIMS 1-33 OF U.S. PATENT NO. 11,208,029**

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I, Dr. Nikolaos Papanikolopoulos, declare:

I. INTRODUCTION

A. Engagement

1. I have been retained on behalf of Mercedes-Benz USA, LLC (“**Mercedes**”) to offer technical opinions relating to U.S. Patent No. 11,208,029 (EX1001) (the “**029 Patent**”) and prior art references relating to its subject matter.¹

2. I have no financial interest in either party or in the outcome of this proceeding. I am being compensated for my work as an expert on an hourly basis at my standard consulting rate of \$450 per hour. My compensation is not dependent on the outcome of these proceedings or the content of my opinions.

B. Background and Qualification

3. I am the McKnight Presidential Endowed Professor and Distinguished McKnight University Professor in the Department of Computer Science and Engineering of the University of Minnesota in Minneapolis, Minnesota. I am also the Director for the Minnesota Robotics Institute.

¹ For brevity, when providing citations herein, I will generally refer to the name of the reference, rather than the exhibit number. The exhibit numbers associated with each reference can be found in Appendix A.

4. I have been a professor at the University of Minnesota (originally as an assistant professor, and then as an associate professor) since the Fall of 1992. Between Fall 2001 and Spring 2004, and between Fall 2010 and Spring 2013, I was the Director of Undergraduate Studies of the College of Science and Engineering.

5. In 1992, I received my Ph.D. in Electrical and Computer Engineering from Carnegie Mellon University. My thesis was entitled “Controlled Active Vision” and focused on using computer vision in a controlled fashion to detect, track, and manipulate objects in the environment. In 1988, I received my M.S. in Electrical and Computer Engineering from Carnegie Mellon University. My B.S. in Electrical Engineering was received in 1987 from the National Technical University in Athens, Greece.

6. For over thirty years, my research and teaching work has focused on image processing, computer vision, intelligent transportation systems, and robotics. This research has included detection and tracking of humans and objects such as vehicles using information from stationary or moving cameras. It has also included object detection and recognition including work with artificial intelligence and pattern recognition systems for surveillance applications.

7. I currently teach three courses relating to object detection and tracking: (i) CSci 5561 Computer Vision, (ii) CSci 5511 Artificial Intelligence, and

(iii) CSci 5551 Introduction to Intelligent Robotic Systems. I have been teaching the class in Computer Vision since 1992. Many of the assignments in the class include segmentation and tracking of objects in real-world settings.

8. I am currently serving as a Senior Editor in the IEEE Transactions on Intelligent Transportation Systems with responsibility in the area of imaging. I was Associate Editor in the same journal for twelve years.

9. I have received research grants for various projects involving computer vision and sensing as applied to the transportation industry, including vehicle tracking, assessing truck parking, detection of pedestrians, and obstacle avoidance. My industry experience includes founding a robotics company in 2005 named ReconRobotics Inc. that develops different robotic platforms. I have also been a consultant since 1997 for numerous companies and provided technical expertise in developing computer vision algorithms for vehicle tracking, camera calibration, inspection, precision agriculture, human tracking, object recognition, and fingerprint recognition. In one of my consulting assignments, I had to develop computer vision algorithms for inspection of industrial parts by using different illumination sources (Banner Engineering). I have licensed my algorithms to several companies, with the most recent one being Sentra Inc., which is using computer vision for precision agriculture.

10. My research has produced more than 380 journal and conference publications. More than 90 publications are in refereed journals. Many of my publications and research grants relate to vehicle and human detection and tracking systems. Some examples include:

Cook, D., Morris, T., Morellas, V., and Papanikolopoulos, N., "An Automated System for Persistent Real-Time Truck Parking Detection and Information Dissemination", *Proceedings of the 2014 IEEE Int. Conference on Robotics and Automation*, Hong Kong, China, May 31 – June 7, 2014, PP. 3989-3994.

Somasundaram, G., Sivalingam, R., Morellas, V., and Papanikolopoulos, N.P., "Classification and Counting of Composite Objects in Traffic Scenes Using Global and Local Image Analysis", *IEEE Trans. on Intelligent Transportation Systems*, Volume 14, No. 1, March 2013, PP. 69-81.

Atev, S., Miller, G., and Papanikolopoulos, N.P., "Clustering of Vehicle Trajectories", *IEEE Trans. on Intelligent Transportation Systems*, Volume 11, No. 3, September 2010, PP. 647-657.

Atev, S., Arumugam, H., Masoud, O., Janardan, R., and Papanikolopoulos, N.P., "A Vision-Based Approach to Collision Prediction at Traffic Intersections", *IEEE Trans. on Intelligent Transportation Systems*, Volume 6, No. 4, December 2005, PP. 416-423.

Masoud, O., and Papanikolopoulos, N.P., "A Novel Method for Tracking and Counting Pedestrians in Real-time Using a Single Camera", *IEEE Trans. on Vehicular Technology*, Volume 50, No. 5, September 2001, PP. 1267-1278.

Du, Y., and Papanikolopoulos, N.P., "Real-time Vehicle Following Through a Novel Symmetry-Based Approach", *Proceedings of the 1997 IEEE Int. Conf. on Robotics and Automation*, PP. 3160-3165, Albuquerque, NM, April 20-25, 1997.

11. My work in vehicle detection and tracking has focused on using image and video processing techniques, including object detection, tracking, and recognition, to accurately track vehicles in real-time. These algorithms have been applied to different scenarios, such as urban traffic monitoring and surveillance. Moreover, machine learning techniques have helped in the improvement of these methodologies.

12. I have done extensive work in sensor fusion and data integration as part of intelligent transportation systems. In particular, my research includes contributions in integrating data from multiple sensors to enhance vehicle tracking accuracy. By combining information from cameras, GPS systems, radar, LiDAR, and other sensors, my research has aimed to create a comprehensive tracking system that can handle various environmental conditions and challenges.

13. My work in intelligent transportation systems includes the use of control algorithms and sensing methodologies to control light systems in the context of transportation applications. For example, I have developed a system that detects and tracks pedestrians as they cross the street in order to eventually extend the “Walk” signal. The images below are from a system deployment in the Twin Cities (the “Flashing” Red signal indicates the presence of pedestrians in the crossing) in the late 1990s. The images below are from a system deployment in the Twin Cities (the “Flashing” Red signal indicates the presence of pedestrians in the

crossing) in the late 1990s. The images are from a final project report #2000-28 published by Minnesota Department of Transportation, titled “Pedestrian Control at Intersections: Phase IV” which was prepared by me and Osama Masoud.

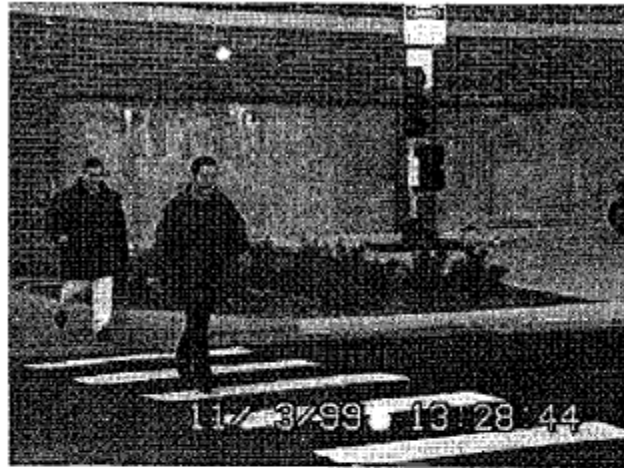


Figure 6.3 The traffic light is flashing red when there are pedestrians at the intersection.



Figure 6.4 Another view of the intersection.

14. My work has been extended to tracking autonomous vehicles. My interests include developing tracking algorithms and systems that can handle the complexities of autonomous vehicles, including predicting their future movements

and understanding their intentions. The work has been extended to monitor the intentions of pedestrians.

15. These vehicle tracking systems enable continuous monitoring and tracking of vehicles, providing valuable information for traffic management, law enforcement, and security purposes.

16. My paper “Detection and Classification of Vehicles,” published in the IEEE Transactions on Intelligent Transportation Systems in March 2002, is one of the most cited papers in the history of this journal (more than a thousand citations). The paper, among other contributions, shows how to use detected headlights and taillights to extract vehicles from videos and images in low-light conditions. One should note that the majority of my papers in the broader area of intelligent vehicle systems dealt with the detection of vehicles, pedestrians, trucks, etc., by using a variety of techniques which were mainly based on computer vision. I also have nine patents in pertinent areas.

17. My research work has been funded by several government agencies. For example, I have received funding from the Department of Homeland Security to monitor threats at Mass Transit Sites, like the 30th Street Station in Philadelphia, PA, and the Light Rail Station in the Minneapolis-Saint Paul International Airport. Monitoring parked vehicles was an essential task for which we developed a variety of computer vision algorithms and tools.

18. 18. For more than a decade, I have been developing computer vision-based systems to assess truck parking availability at truck rest areas. The funding came from Federal Highway Administration (FHWA), Minnesota Dept. of Transportation (MnDOT), Wisconsin Dept. of Transportation (WiscDOT), and Kansas Dept. of Transportation (KansasDOT). The approach uses multiple cameras to detect trucks and other vehicles and determine empty spaces. The system operates in all weather conditions around the clock.

19. I have received numerous honors and awards for my research and contributions. I have been a Distinguished McKnight University Professor at the University of Minnesota since 2007 and have been a McKnight Presidential Endowed Professor in Computer Science since 2016. Also in 2007, I was nominated and became an IEEE Fellow. In 2016, I received the IEEE RAS George Saridis Leadership Award in Robotics and Automation as well as the Center for Transportation Studies Research Partnership Award. I have also received the IEEE VTS 2001 Best Land Transportation Paper Award for the paper “A Novel Method for Tracking and Counting Pedestrians in Real-Time Using a Single Camera” (with Osama Masoud).

20. The figures below show the detection and tracking of a vehicle by a camera mounted in a car that follows a target vehicle. These figures are from a paper that I had published in 1997: Du, Y., and Papanikolopoulos, N.P., “Real-time

Vehicle Following Through a Novel Symmetry-Based Approach,” *Proceedings of the 1997 IEEE Int. Conf. on Robotics and Automation*, PP 3160-3165, Albuquerque, NM, April 20-25, 1997.

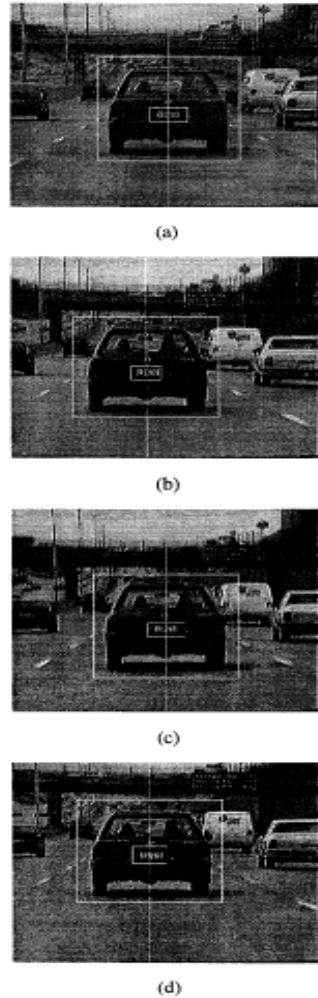


Fig. 2 A sequence of images processed by the symmetry-based scheme in real-time

21. I have also worked in the use of sensors to monitor driver fatigue. I developed a computer vision-based system that analyzes facial features and eye movements to detect signs of drowsiness and driver fatigue. By monitoring factors such as eye closure, head pose, and blink patterns, the system can alert drivers

when they show signs of fatigue and suggest appropriate actions (this research took place in the late 90s). The proposed algorithms and systems considered the continuously evolving light conditions that vehicular systems operate within.

22. As a result of my work and research, I am familiar with the design, operation, and functionality of systems described in the '029 Patent.

23. Further details regarding my employment and academic history are included in my *curriculum vitae*, attached as EX1004.

C. Information Considered

24. I have reviewed the '029 Patent and its prosecution history, as well as the other materials referenced in Appendix A. Counsel has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the '029 Patent, at the time of the earliest purported priority date of the '029 Patent, and I have done so during my review of these materials. I have been asked to assume, for purposes of this Declaration, that the '029 Patent has a priority date of July 12, 2002 (the “**Critical Date**”).

25. My analyses are based on my years of education, research, and work experience, as well as my investigation and study of relevant materials. In my analyses, I have considered the materials that I identify in this Declaration and those listed in Appendix A.

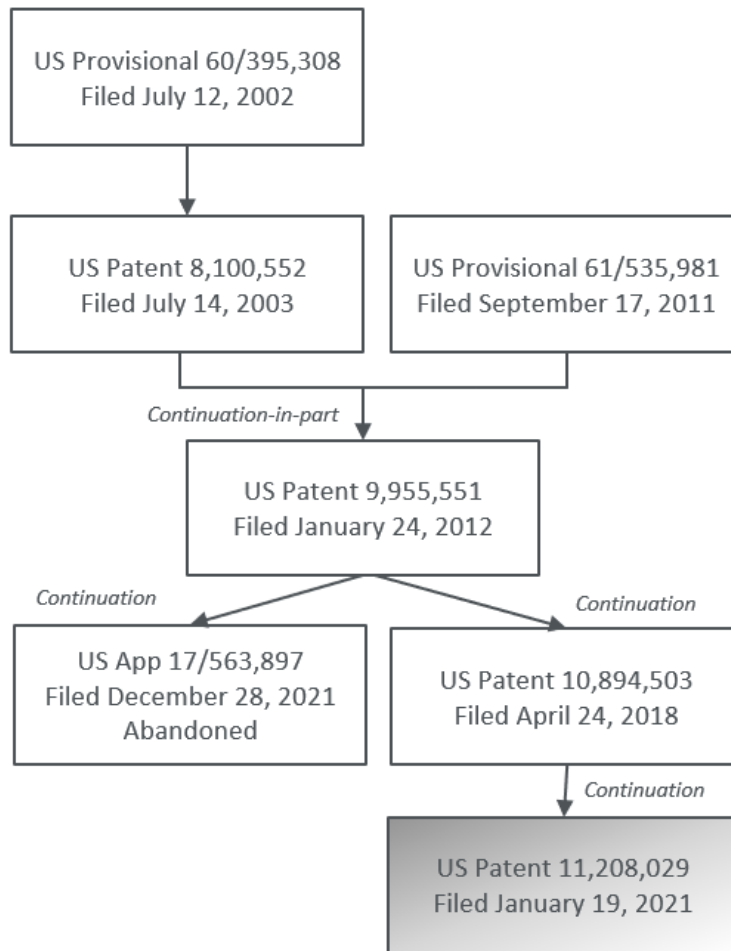
26. I may rely on these and additional materials to respond to arguments raised by the Patent Owner. I may also consider additional documents and information in further analyses—including documents that may not yet have been provided to me.

27. My review and assessment of the materials provided in this proceeding is ongoing, and I will continue to consider any new material as it is provided. I reserve the right to review, supplement, and amend my analyses based on new information and on my continuing review of the materials already provided.

II. BACKGROUND OF THE '029 PATENT

A. The '029 Patent

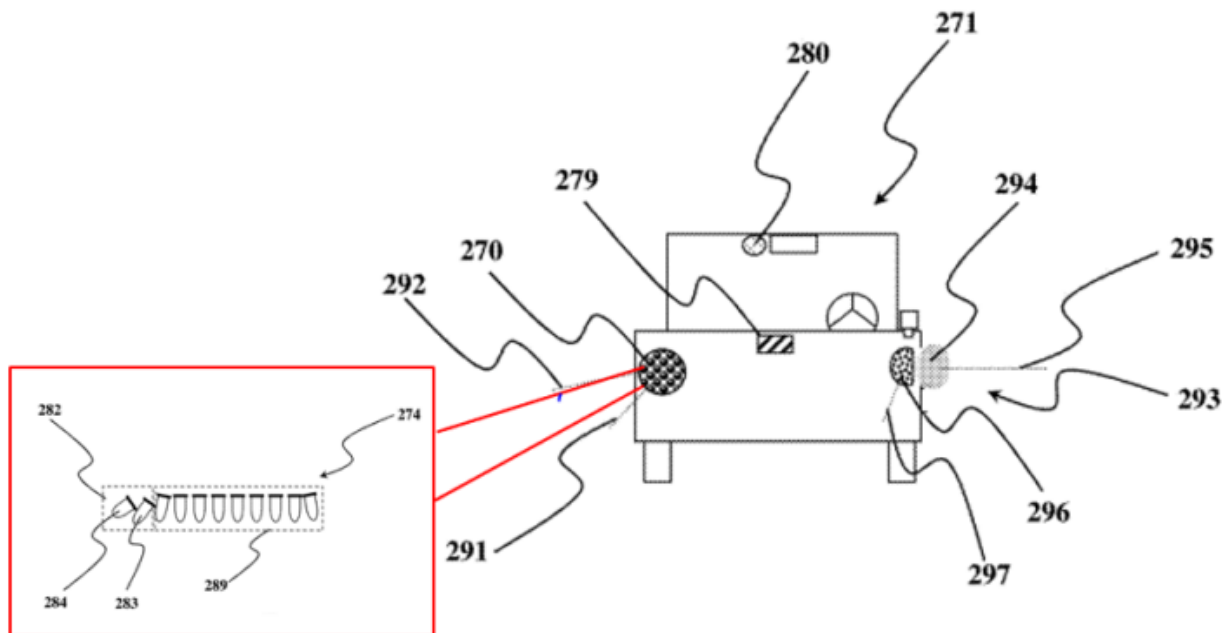
28. I understand the '029 Patent was filed on January 19, 2021, and issued on December 28, 2021. I also understand that the '029 Patent is part of the following patent family:



29. I have assumed, for purpose of this declaration, that the '029 Patent is entitled to this Critical Date of July 12, 2002.

30. The '029 Patent alleges that in the “prior art,” lighting fixtures were often single, large lights that were “generic” and “universal.” ('029 Patent, 5:35-59.) These lights were allegedly not tailored to individual applications, were “inexact and wasteful,” produced light in more places than needed, and required reflectors and refractors to re-direct light. (*Id.*) The '029 Patent claims it came up with a new approach it called a “Digital Lighting Fixture” that can “provide the

‘correct’ lighting solution for the situation at hand.” (*Id.*, 10:63-11:14.) The ’029 purports to accomplish this through “controllability offered by breaking the total light output up into discrete (‘digital’) specifically aimable and dimmable elements which can be addressed by control electronics.” (*Id.*, 11:56-65.)



output from the individual lights to increase light in the direction of the curvature.

(See, e.g., *id.*)

III. CLAIM CONSTRUCTION AND POSITA DEFINITION

A. Claim Construction

32. I understand that in an *inter partes* review, claims must be given their ordinary and customary meaning, as understood by one of ordinary skill in the art in light of the specification and prosecution history. I apply that standard in my analysis below to the words and phrases in the claims of the '029 Patent.

B. Definition of a Person of Ordinary Skill in the Art

33. A person of ordinary skill in the art (“**POSITA**”) in the field of the '029 Patent would have had an undergraduate degree in mechanical engineering, electrical engineering, automotive engineering, optical engineering, applied physics, computer science, or similar disciplines, along with two years of experience working with intelligent vehicle systems, automotive control systems, or lighting control systems. The more education one has, the less experience needed to attain an ordinary level of skill. Similarly, more experience in the field may serve as a substitute for formal education.

IV. UNDERSTANDING OF LEGAL STANDARDS

A. Anticipation

34. I understand that a patent claim is invalid when the invention that it claims is not new. To establish that a claimed invention is not new (i.e., “not

novel”), I understand that one may establish that a single publication, or other reference in the prior art discloses (explicitly or inherently) every element required in a patent claim (*i.e.*, all features or “limitations” recited in the patent claim). I understand that a reference in the prior art “anticipates” a claimed invention if that reference discloses, either explicitly or inherently, every element of the claim.

35. I understand that “prior art” and “prior art reference” are legal terms of art referring to, for example, devices, methods, and publications that predate the earliest effective filing date of the claimed invention.

36. I understand that a prior art reference that anticipates a claim may disclose an element or limitation of a patent claim expressly or inherently. A prior art reference discloses an element or limitation of a patent claim inherently when the prior art’s disclosure necessarily requires or implies that the claimed element or limitation be present in the process, machine, manufacture, or composition disclosed. I understand there is still considered to be an inherent disclosure even if the author of the reference did not describe or understand the underlying inherent principle. I understand that one may establish that a prior art reference inherently discloses a claimed element or limitation through the use of other reference material or through testing.

37. I understand that the description in a written reference does not have to be in the same words as the claim, but all of the requirements of the claim must be

there, either stated or necessarily implied, so that a POSITA looking at that one reference would be able to make and use the claimed invention.

38. I understand that any prior art reference that can be considered for purposes of determining whether it anticipates a patent claim may also be used to determine whether the reference renders that claim obvious, as discussed below.

B. Obviousness

39. I understand that, even if a claim is not fully disclosed in a single prior art reference, the patent claim is invalid if the invention would have been obvious to a POSITA at the time of the invention. In particular, I understand that a patent claim is normally invalid as obvious if it would have been an “ordinary innovation” within the relevant field to create the claimed product or method at the time of the invention.

40. I understand that the relevant portion of pre-AIA Section 103, subsection (a) of the Patent Act states:

“A patent may not be obtained through the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.”

41. I understand that, by way of example only, a claimed invention is obvious if:

it combines prior art elements according to known methods to yield predictable results;

it simply substitutes one known element for another to obtain predictable results;

it uses a known technique to improve similar devices (methods, or products) in the same way;

it applies a known technique to a known device (method, or product) ready for improvement to yield predictable results;

it was “obvious to try” in that the inventor chose from a finite number of identified, predictable solutions, with a reasonable expectation of success;

known work in one field of endeavor prompted variations of it for use in either the same field or a different one based on design incentives or other market forces and those variations were predictable to one of ordinary skill in the art; or

some teaching, suggestion, or motivation in the prior art led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

42. When considering obviousness, I understand that I am to: (i) decide the level of ordinary skill in the field that someone would have had at the time the alleged invention was made; (ii) determine the scope and content of the prior art; (iii) determine what differences, if any, existed between the prior art and the Asserted Claims; and (iv) consider objective evidence of non-obviousness (also known as secondary considerations). Further, when considering obviousness, I understand that it is not necessary to seek out precise teachings, and it is permissible to consider the inferences, common sense, and creative steps that a POSITA (who is considered to have an ordinary level of creativity and is not an automaton) would employ.

43. I understand that objective evidence relevant to the issue of obviousness may also be considered. This type of evidence is sometimes referred to as “secondary considerations,” and may include evidence of commercial success, long-felt but unsolved needs, failure of others, and unexpected results. I understand that any secondary evidence must have a nexus to the relevant claims. For example, I understand that commercial success must have a nexus to features of the alleged invention not disclosed in the prior art, and in particular the prior art references which support an obviousness theory. In other words, I understand that commercial success is material only if it comes from the merits of the claimed invention beyond what the prior art disclosed. With respect to secondary

considerations, I understand that Patent Owner bears the burden of proof, and I have seen no evidence to date that any secondary considerations would establish non-obviousness.

V. THE ELEMENTS IN CLAIMS 1-33 OF THE '029 PATENT ARE ANTICIPATED AND RENDERED OBVIOUS BY THE PRIOR ART

44. I have been asked to provide an analysis as to whether the elements of Claims 1-33 of the '029 Patent (the “**Challenged Claims**”) are disclosed in the primary prior art reference: U.S. Patent Application Publication No. 2003/0137849 (“**Alden**”) (EX1005). I was also asked to consider this reference in view of certain additional prior art for some of the limitations of the Challenged Claims, including U.S. Patent No. 6,049,749 to Kobayashi (“**Kobayashi**”) (EX1009) and U.S. Patent No. 6,144,158 to Beam (“**Beam**”) (EX1008).

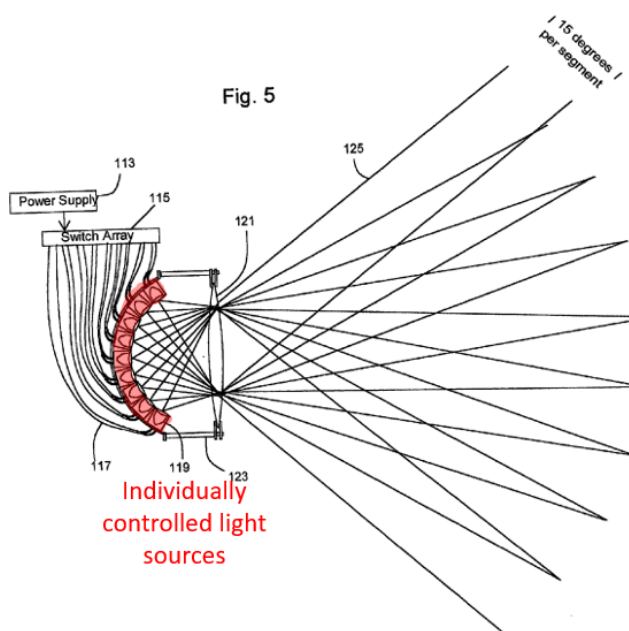
45. My analysis of these prior art references relative to the elements of the Challenged Claims—specifically, how and where the prior art references disclose the limitations of the challenged claims—is provided below. The citations that I have included are not intended to provide an exhaustive list, but rather provide examples of how the references disclose or teach the elements of these claims.

46. I have reviewed Alden. Alden is directed to a headlight system with individually-controllable LEDs such that different areas in the field-of-view of the vehicle can be illuminated in different ways, *e.g.*, high beam and low beam areas can be created concurrently. Alden was filed on January 22, 2002, and published

on July 24, 2003. I understand Alden is prior art under at least pre-AIA 35 U.S.C. § 102(e).

47. My review of the '029 Patent file history shows that Alden was not considered during prosecution of the '029 Patent.

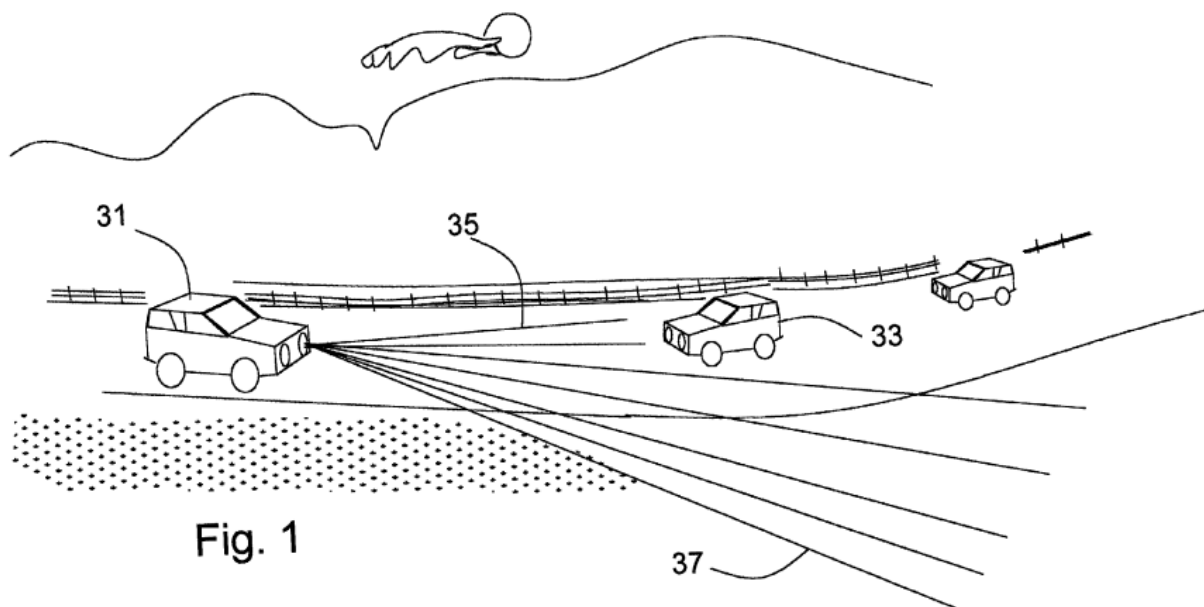
48. Alden discloses a headlight system where the headlights can “segment” the illumination “into sectors of the light distribution area.” (Alden, [0008].) Alden discloses that lighting elements which correspond to the individual illumination sectors can be individually and automatically controlled as to intensity and direction. (*Id.*) For example, in Alden, the individual lighting elements (119) may be LEDs that are positioned along a curve inside of a headlight:



(*Id.*, Fig. 5, [0029].) Alongside this, the Alden system includes (a) a “sensor unit” for detecting objects, such as other vehicles along the road in the area of the

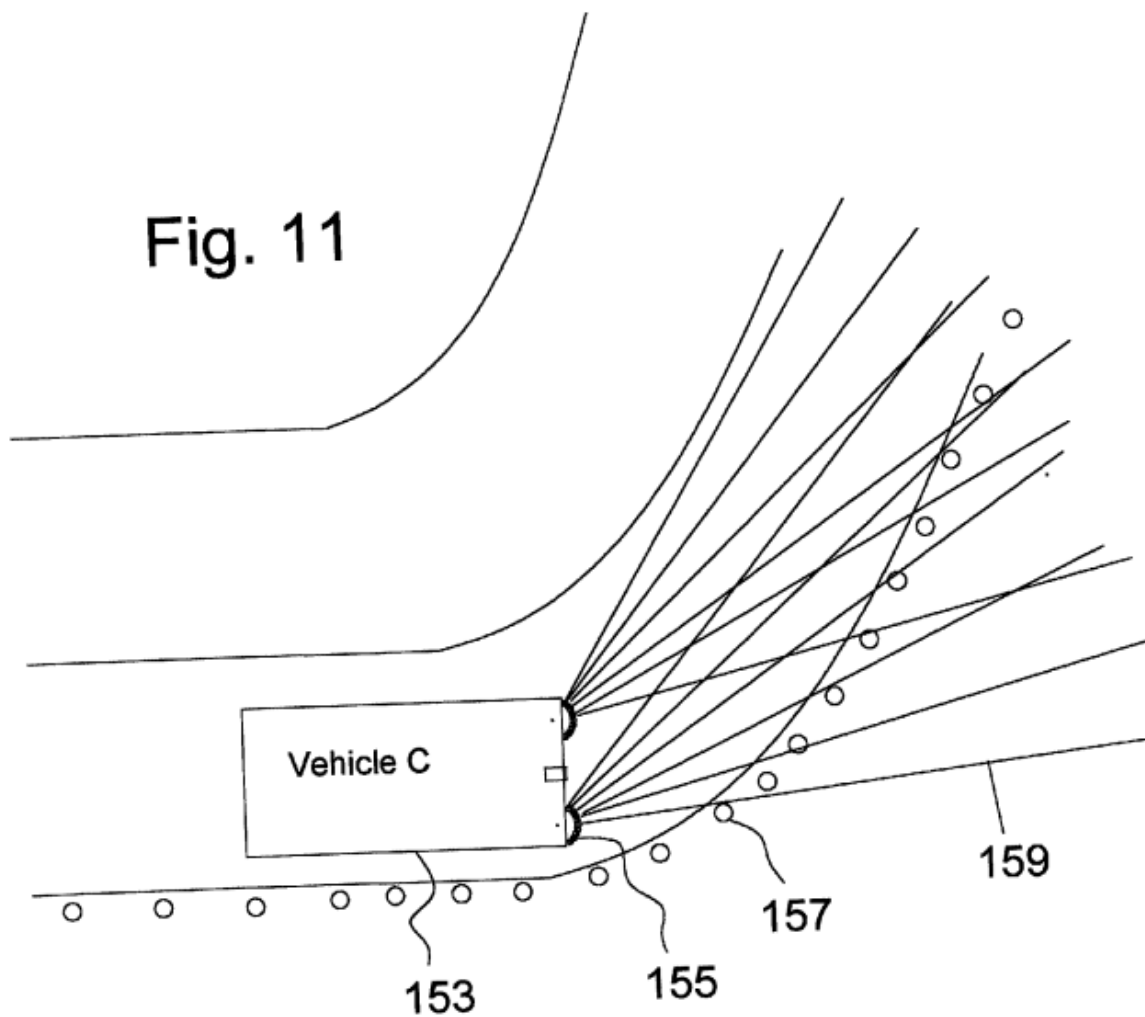
vehicle equipped with Alden's headlight system and (b) a "light control circuit" with a "CPU" to adjust the individual LEDs based on sensor data. (*Id.*, Figs. 2-3, [0026]-[0027].)

49. Alden teaches that, with its system of individually-controllable LEDs, a vehicle can "emit[] a low beam illumination 35 in a first headlight distribution sector while concurrently emitting a high beam, illumination 37 in a second highlight distribution sector," with "[t]he low beam illumination being emitted in response to the detection of an oncoming vehicle 33" to reduce "glare":



(*Id.*, Fig. 1, [0004], [0025].) For example, looking at the figure above, Alden's system directs dimmed low beam light in the segments of the light distribution area that contain detected vehicle 33. Other sectors where no other vehicles are detected would have high beam light. Alden discloses that this is achieved by providing

sensor data to a processor, determining the location of other vehicles from the sensor data, and then determining which headlight sectors or segments should be switched to dim, low beam light and which should be switched to high beam light. (*Id.*, [0027]-0029], Fig. 4.) Alden's system can also be used to "concentrate light" to "look around corners," "look up a hill," and "look down a hill," all "in response to road conditions." (*Id.*, Figs. 11-13, [0036]-[0038].)

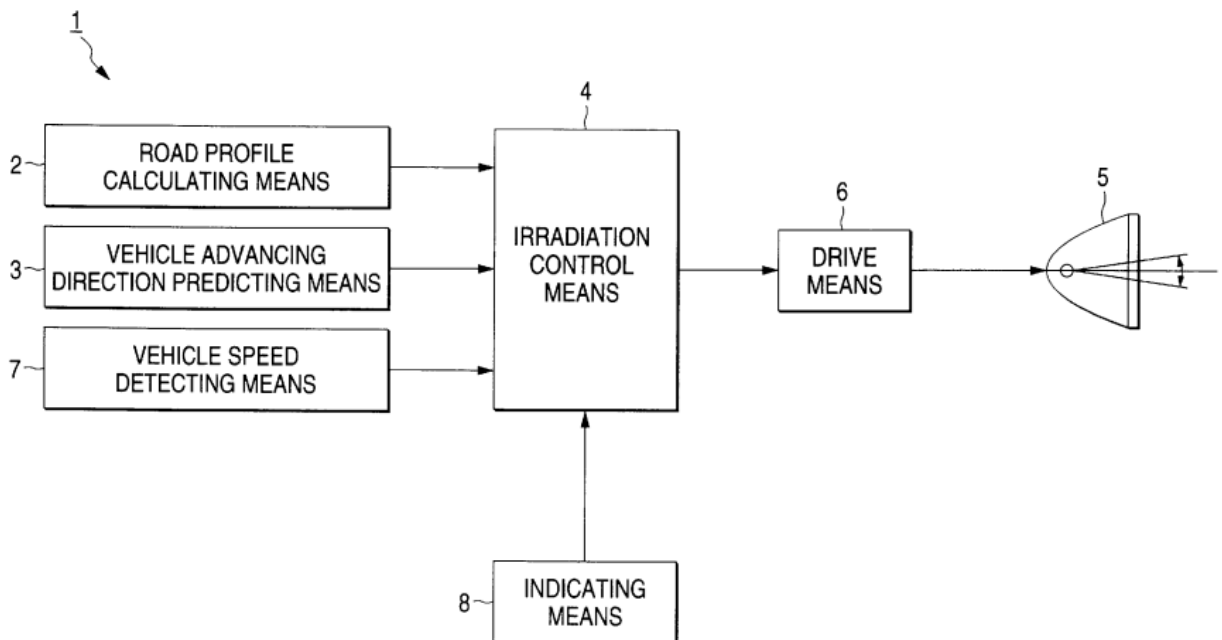


(*Id.*, Fig. 11.)

50. I have also reviewed Kobayashi. Kobayashi is titled “Lighting device for a vehicle” and, like Alden, is directed to improvements in vehicle headlamp systems including detection of positioning along a road. (Kobayashi, Abstract.) Kobayashi was filed on December 12, 1997 and issued on April 11, 2000. I understand that Kobayashi is prior art under § 102(b).

51. My review of the '029 Patent file history shows that Kobayashi was not considered during prosecution of the '029 Patent.

52. Similar to Alden, Kobayashi’s headlamp system includes various inputs, a controller, and a headlamp:



(Kobayashi, Fig. 1, 3:9-5:28; see also Fig. 12, 17:3-67.) Kobayashi discloses that its controller (“irradiation control means 4”) receives “road map information” from “road profile calculating means 2,” along with other sensor data, and use these inputs to automatically adjust the illumination of headlamp 5. (*Id.*; see also 2:4-39.)

53. Kobayashi discloses that a “GPS navigation device 29 sends information about the road profile and the present vehicle position to ECU 10.” (*Id.*, 17:39-40.) Kobayashi further discloses that “when the vehicle advances along a scheduled course, irradiation control of the lamp is conducted in accordance with the course concerned.” (*Id.*, 17:59-61.)

A. Ground 1 – Alden in View of Kobayashi Renders Obvious Claims 1-8, 10-19, 21-30, and 32-33.

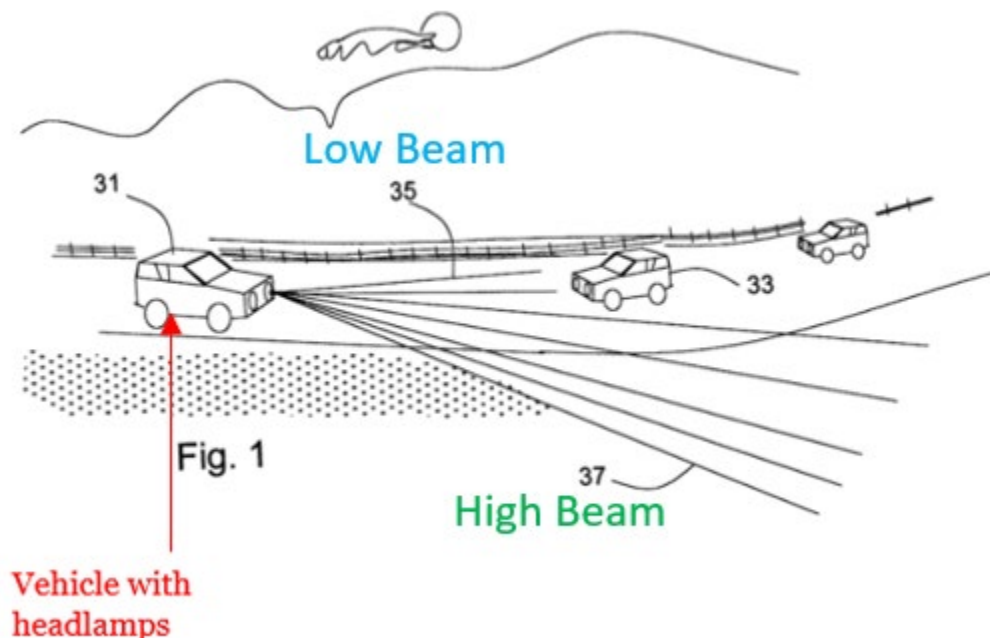
1. Independent Claim 1

54. As viewed by a POSITA, Alden in view of Kobayashi renders obvious Claim 1.

1[Pre]: *A system, for a motor vehicle, comprising:*

55. Alden discloses Claim 1[Pre] to the extent the preamble limits the scope of the claim. As I describe above, Alden’s headlight system is “for automatically *controlling the distribution of a headlight* in response to environmental conditions.” (*Id.*, [0006]; *see also* Abstract.) In Alden, a “first vehicle 31” includes an “automatic segmented illumination” headlight system, allowing the vehicle to emit different light illuminations in different areas in its

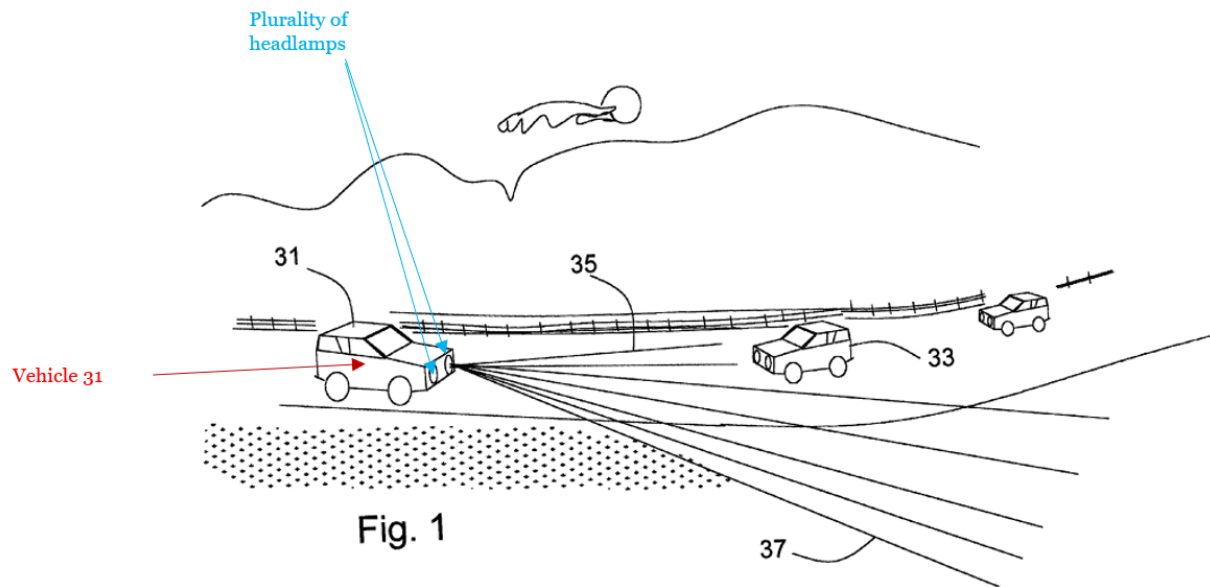
field-of-view. (*Id.*, [0025], Fig. 1 (annotated); *see also* [0026], [0029].) That is, the segmented headlight system can provide different lighting illumination to different sectors of the headlight distribution area in front of the vehicle. The illumination in each sector can be controlled as to intensity and direction based on sensed information about the environment around the vehicle. For example, Alden discloses that the system can emit “a low beam illumination 35 in a first headlight distribution sector while concurrently emitting a high beam, illumination 37 in a second headlight distribution sector”:



(*Id.*, [0025], Fig. 1 (annotated); *see also* [0026]-[0029].) Similarly, the system can be used to “concentrate light” in sectors to “look around corners,” “look up a hill,” and “look down a hill,” all “in response to road conditions.” (*Id.*, Figs. 11-13, [0036]-[0038].)

1[A]: a plurality of headlamps, each comprising a plurality of LED light sources;

56. Alden discloses Claim 1[A]. Alden discloses that its system is for a vehicle with “one or more headlamps,” or headlights (*i.e.*, a plurality of headlamps):

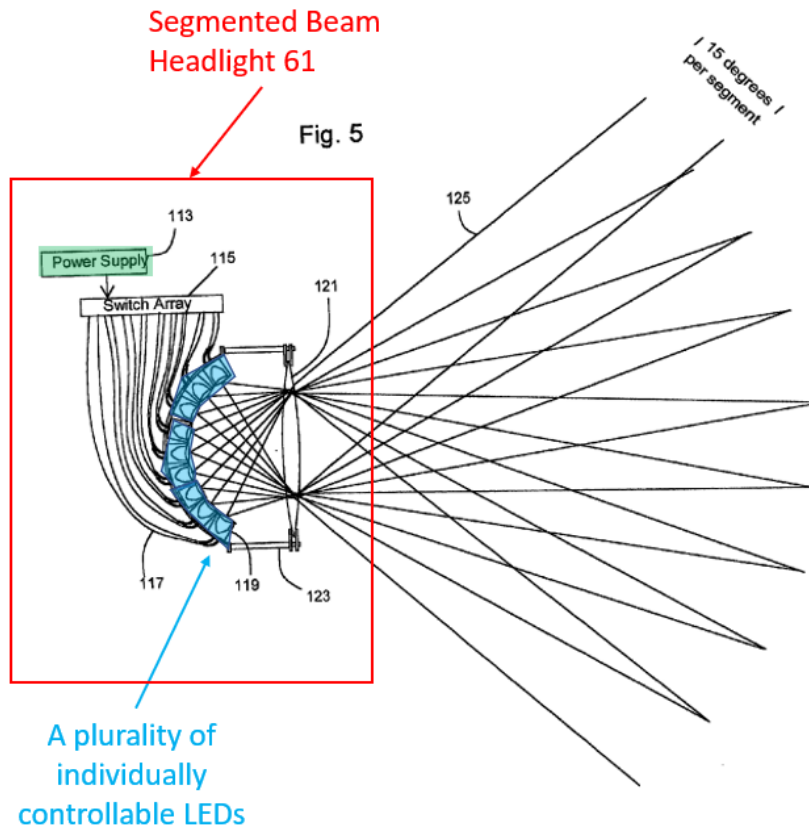


(Alden, Fig. 1 (annotated), [0025], [0027]-[0028]; *see also* Fig. 11, [0036].) As shown, the vehicle includes both a left “segmented beam headlight” and a right “segmented beam headlight.” (*Id.*, [0025]-[0026], *see also* Figs. 2, 11.) Alden notes that the “left headlight” and “right headlight” are controlled to emit different light in different sectors of the headlight distribution area, so that, for example, drivers of other vehicles have “minimum glare while the driver of the equipped vehicle has maximum light.” (*Id.*, [0027].) Alden’s segmented headlamps can similarly be controlled to “concentrate light” in sectors to look around corners and

up and down hills. (*Id.*, Figs. 11, [0054] (disclosing that “directing of light” around corner can be achieved with “the segmented elements described herein”); see also Figs. 12-13, [0037]-[0038].)

57. For example, Figure 1 of Alden discloses a “first vehicle 31 [that] emits a *low beam illumination 35* in a first headlight distribution sector while concurrently emitting a *high beam, illumination [sic] 37* in a second headlight distribution sector.” (*Id.*, [0025].) These low and high “beams” are the light emitted from the “one or more headlamps” of the vehicle. Alden discloses that the vehicle 31 headlight system also includes components for sensing locations of other vehicles (*e.g.*, vehicle 33) and for providing independent sector illumination control. (*Id.*, [0025]-[0027], [0042-0043].) Alden’s lighting system implemented in the headlights of a vehicle can also be seen with reference to Figure 11, where the Alden system is implemented in the two headlights of a vehicle to control illumination around curves of a road. (*Id.*, Fig. 11.)

58. Each of Alden’s segmented headlights 61 can include an “array of individual lighting elements,” with each lighting element being a “white **LED** (or alternate lighting mechanism)” light source:

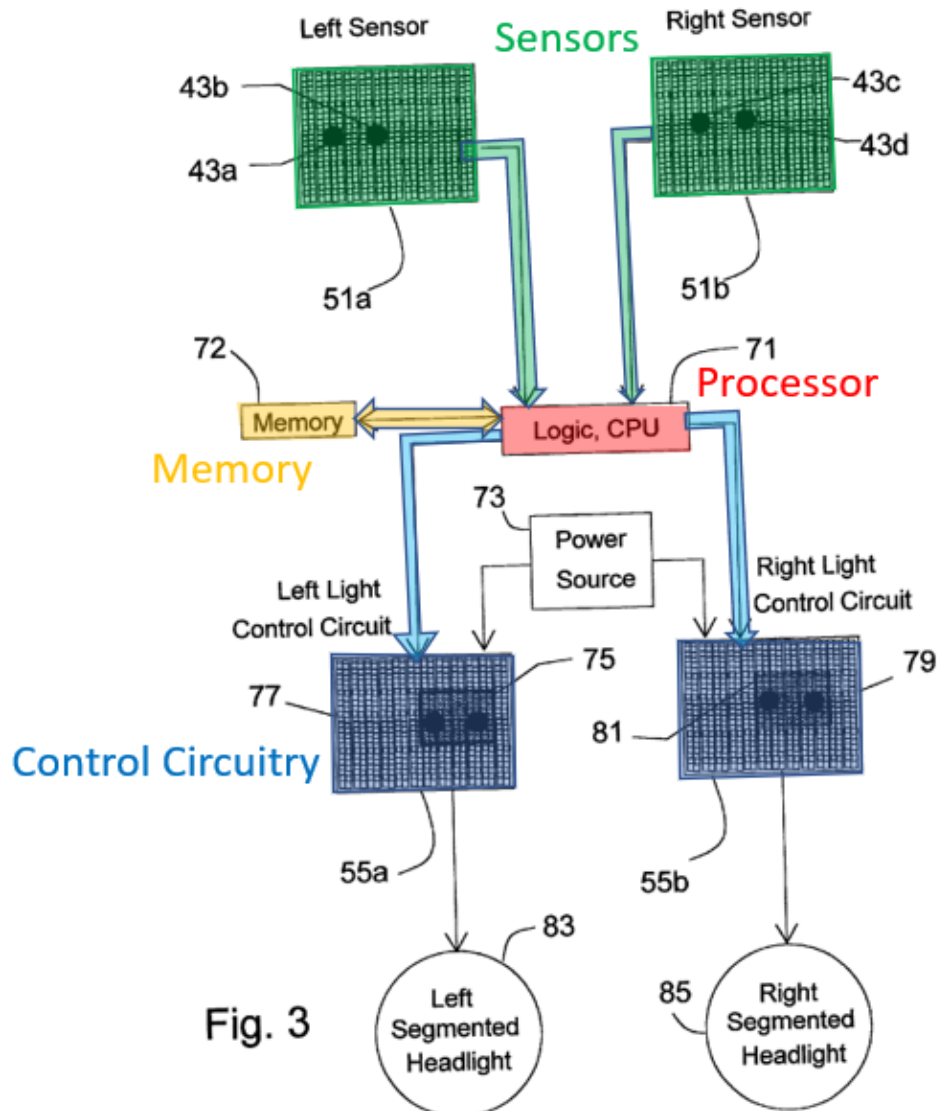


(*Id.*, Fig. 5 (annotated), [0029].) Thus, this “array” of LEDs are a plurality of LED light sources. As seen above in Figure 5, these LEDs are “on a curve along the focal point of a headlight lens 121, such that the light from each lighting element goes into a specified portion (or portions) of the headlight distribution area.” (*Id.*) Each LED is “independently controllable as to intensity and direction.” (Alden, [0008]; *see also* Abstract, [0026]-[0029], Figs. 2-4.) To adjust intensity, for example, the power to each lighting element (i.e., light source) is CPU-controlled, such that “the light sent to the area of 41 [an oncoming vehicle] is dimmed using a headlight with segmented lighting means.” (*Id.*, [0029]; *see also* [0026]-[0028], [0061].) Alden discloses using optical elements to adjust the direction of the beams emitted by the LEDs, such as

lens 121 or variable refractive elements. (*Id.*, [0029], Fig. 5, [0033]-[0035], Figs. 8-10.) For example, as noted above, the lens 121 causes the light from the LEDs to “go into a specified portion (or portions) of the headlight distribution area.” (*Id.*, [0029].) And, Alden explains, for example, how a liquid crystal (variable refraction element) can be used to selectively “bend” light in certain output sectors by changing the refractive index of the liquid crystal through opening or closing a switch. (*Id.*, [0033]-[0035], Figs. 8-10.)

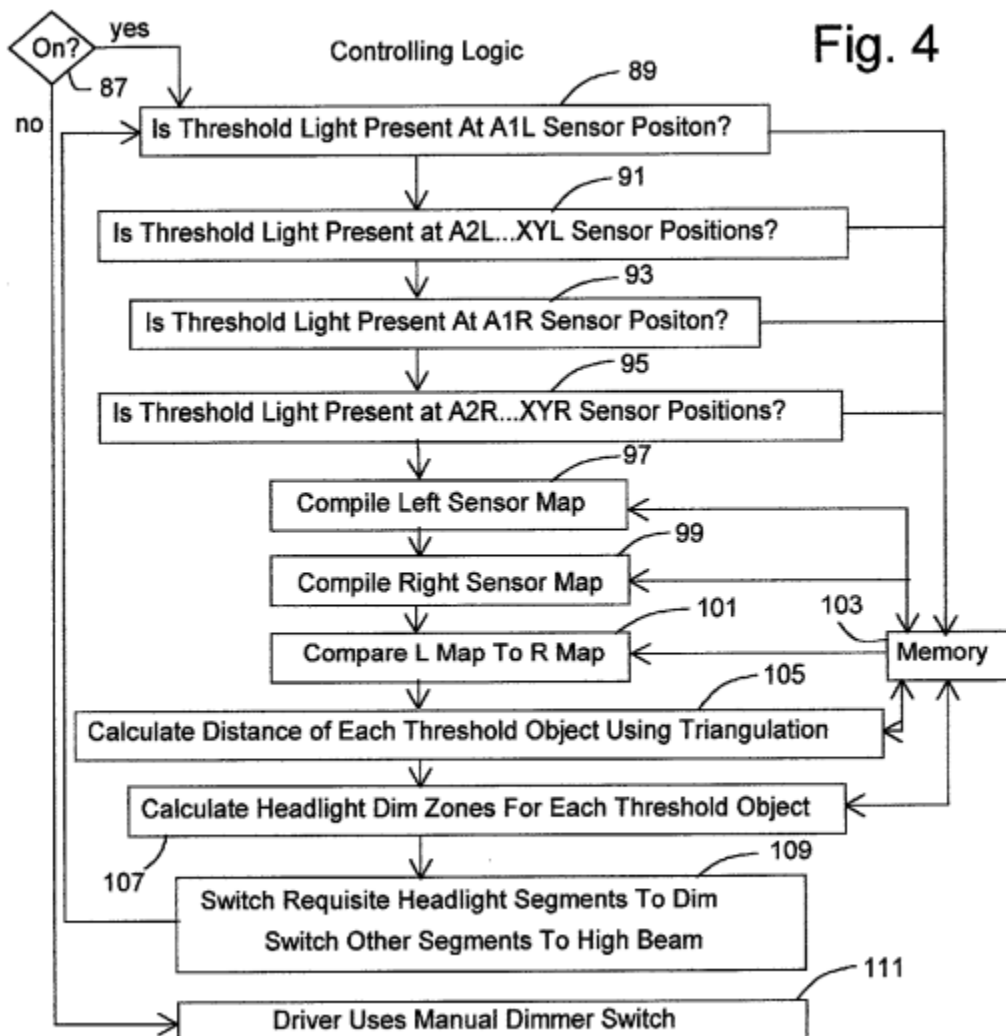
1[B]: one or more processors; and a memory storing instructions that, when executed by one or more of the one or more processors, enable the one or more processors to:

59. Alden discloses Claim 1[B]. First, Alden discloses a “logical controller including a processor” that is in communication with “memory,” “sensors,” and “control circuitry” to detect objects and determine whether to adjust lighting elements:



(Alden, Fig. 3 (annotated), [0027]-[0028] (describing logic used and data being “stored in a memory 72”); see also Fig. 2, [0026].) As shown in Figure 3 above, left and right sensors 51a-51b are connected to processor CPU 71 comprising logic. (*Id.*, [0027].) The CPU is connected to memory 72, and “[i]nformation from the [memory] 72 and [CPU] 71 is sent to control the power flow from a power source 73 via a left light control circuit 55a and a right light control circuit 55b.” (*Id.*)

60. Alden further discloses that its processor (logic CPU 71) is configured to execute logic (*i.e.*, “instructions”) that are stored in memory. (*Id.*, [0027]-[0029], Fig. 4.) In particular, Figure 4 of Alden discloses the “controlling logic” that the CPU 71 may execute, which would be stored in the memory, to process sensor data and control each LED within the headlights:



(*Id.*, Fig. 4.) As shown in Figure 4, the logic process used by the CPU can include: processing sensor data (steps 89, 91, 93, 95); compiling sensor maps (steps 97, 99); determining the “distance and intensity of each object sensed in a calculating process 101”; and calculating distances to objects using a “triangulation process 105.” (*Id.*, Fig. 4, [0028]; see also Fig. 3, [0026]-[0027].) For example, if the system of Alden detects light from roadside “reflectors” indicating a curve, then it can determine the distance to those reflectors. (*Id.*, Fig. 11, [0054].) The system in Alden could detect these reflectors using the same process as outlined in Figures 3 and 4 for detecting the lights of an oncoming vehicle. However, instead of setting a “threshold” for the value of light received at each sensor sector based on a process for detecting vehicle headlight, a POSITA would have known that different thresholds could be used that would correspond to the intensity and spatial distribution of light from the series of roadside reflectors. In addition, just like how the system looks for “two dots” (from lights of the two headlights) when executing the process to determine the presence and location of an oncoming vehicle, the system could instead look for a series of smaller dots representing the light reflectors along the road when executing the process to detect such reflectors. A POSITA would understand that the system could also look at the spatial-temporal data representing light received from the reflectors, as it does for the vehicle headlights (checking intensity and distance) (*Id.*, [0028].) The light from the

reflectors would get stronger the closer you get, and so checking the spatial-temporal aspects of the received, as Alden discloses its system can do, would again be a way for the process to determine the presence and location of such reflectors.

61. In Alden, the distance data is then used to “determine the intensity of light that will be produced by the 61 [headlight] in the corresponding headlight sectors,” as shown in step 107, where CPU 71 determines “which zones of each headlight need to be dimmed.” (*Id.*, Fig. 4, [0027]-[0028]; *see also* Fig. 3, [0026]-[0027].) Moreover, Alden discloses that the processor executes the logic instructions to individually control each LED. (*Id.*, [0029] (“Each lighting element being independently controlled by a corresponding switch in an array of switches 115. Each switch is controlled by the CPU and logic previously described.”), Figs. 11-15, [0036]-[0038] (describing changing the projection of light in areas in front of vehicle based on road conditions such as corners and hills), [0054], [0057]-[0058].)

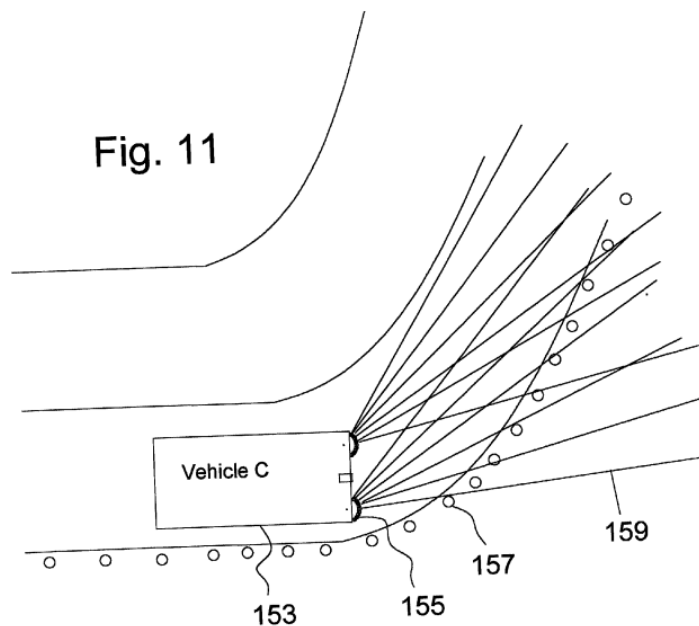
62. Alden further explains that this is a real-time process that is continuously repeated. (*Id.*, [0028] (stating that the “process then begins again so as to be responsive to changing environmental conditions in real time.”).) Thus, if environmental conditions, such as the area around the vehicle, change, the determined light distribution pattern for the headlights will also change. This is because the sensors are constantly receiving new data based on such changing

conditions and feeding that data to the processor for use as an input for Alden's "controlling logic."

63. For the processor to execute the logic shown in Figure 4, that logic would have to be stored and accessible to the processor, CPU 71. In Alden's system, this logic would be stored in memory, which the processor communicates with. Particularly, Alden discloses that this is a real time process executed by the processor (Alden, [0028], Fig. 4 (illustrating the iterative nature of the process), and thus a POSITA would have understood that the memory element next to the processor (CPU 71, Figure 3) is used among other things to store compiled instructions that could be executed by the CPU continuously in real time. During "real-time" execution, the CPU fetches the program's instructions from memory, decodes them, and executes them in the appropriate sequence.

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

64. Alden in view of Kobayashi discloses Claim 1[C]. Alden discloses that "the present invention," namely its segmented headlight system, can be used to "concentrate light to look around corners in response to road conditions":



(Alden, [0036], Fig. 11.) As shown, Alden discloses that a vehicle with the “segmented sensing elements and segmented light distribution elements described herein” can “*sense[] that the road turns*” by receiving light from reflectors such as a reflector 157.” (*Id.*, [0036].) That is, Alden identifies an upcoming road curve by receiving and detecting light (“first data”) reflectors positioned along the curve. (*Id.*) Alden’s “sensing elements” include left and right sensors to detect such light and a CPU to process this data and instruct the control circuitry and LEDs accordingly. (Alden, Figs. 3-5, [0027]-[0029].) This data is, in particular, used by the CPU and control circuitry to adjust the LEDs “responding headlights 155” (such as, for example, those shown in Figure 5 pointed in the direction of the reflectors) so that they “direct light into the corner to maximize the driver’s ability to see there.” (*Id.*, [0036], [0026]-[0029].)

65. A POSITA would understand from Alden that its process to detect traffic objects of interest based on sensed light is not limited to headlights of oncoming vehicle. A POSITA would realize the process detailed in Figure 4, including sensing light above a threshold a plurality of sensor sector positions, compiling and comparing sensor maps, and using a triangulation process to determine location and distance of an object such as oncoming vehicle could be used to determine locations and distances of many other types of objects around the road that would emit light towards the detectors on vehicles equipped with Alden's system, like reflective traffic signs and other reflective elements along the road. (*Id.*, Figs. 3-4, [0027]-[0028].) And, as shown in Figure 11, one other type of object Alden contemplates detecting are roadside reflectors that reflect light which would be received by the sensors. (*Id.*, Fig. 11, [0036].) With information on the location and distances of the reflectors obtained by implementing the process of Figure 4, Alden's processor can determine the curve of the road, as the reflector locations would outline this curve. Alden itself uses this terminology, describing data it receives from camera sensors as a "map of sensed light." (Alden, Fig. 3, [0027].)

66. Alden is also about the refinement of the results, as it also describes using a steering wheel sensor to detect road curve. (Alden, [0039]-[0040].) This teaches a POSITA that Alden suggests not to rely on one piece of data about an

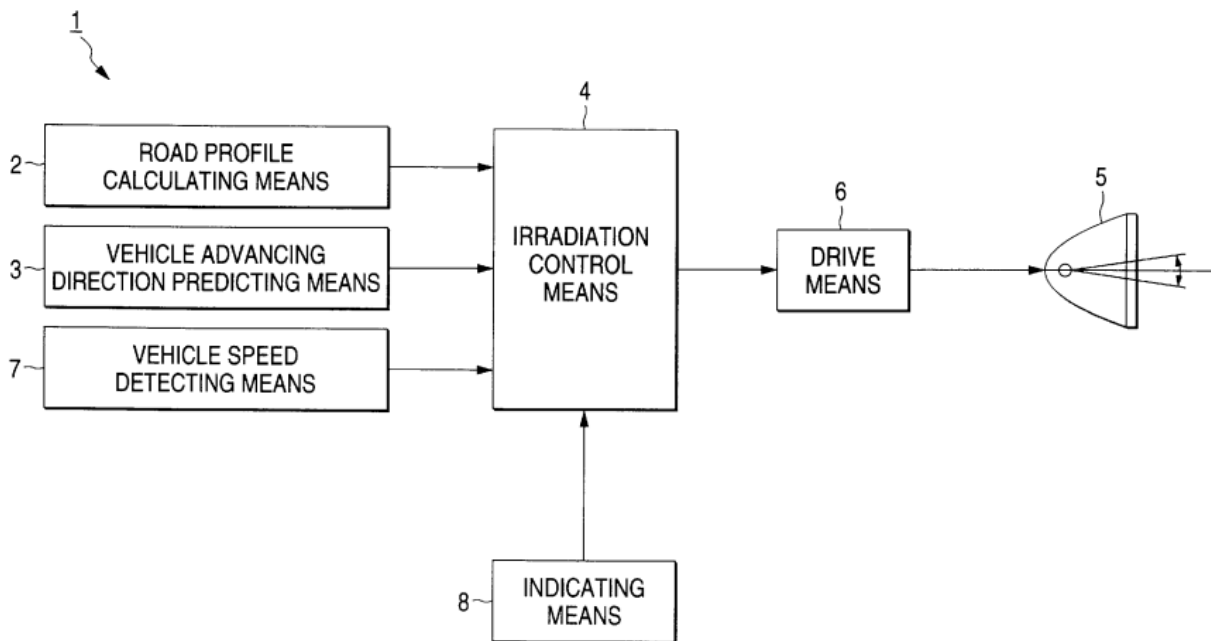
environment, and instead to use multiple sources of data to refine information on the position of objects of interest and the environment around the vehicle.

Therefore, Alden teaches a POSITA to go and look for multiple sources of data, and using these multiple sources to refine its results before using the processor to control the LEDs.

67. Additionally, Alden discloses that its system can include a “rotation sensor” in the steering wheel that can further detect when a vehicle is approaching an upcoming turn (*i.e.*, the rotation sensor provides “first data” regarding the angle of the steering wheel). (Alden, [0039]-[0040], Figs. 14-15.) As the steering wheel “rotates ‘x’ degrees,” the system calculates the new planned direction of the vehicle and “changes the direction of the headlight output 197 a corresponding ‘f(x)’ degrees.” (*Id.*) Thus, when a driver turns her steering wheel before moving, in anticipation of an upcoming curve where the vehicle will have to turn, Alden’s system adapts the light output so that it increases illumination illuminating the turn. (*Id.*, [0054].) I should note that one example of this would be when a driver is at a stoplight or a stop sign. As a POSITA would have known, often times the driver would turn their wheel before giving the vehicle gas, so as to be ready to turn after oncoming traffic has passed. In this example, the system of Alden would anticipate the upcoming turn and increase illumination in the anticipated new direction of the

vehicle, so that that area will be illuminated before the driver makes the turn and heads in that direction.

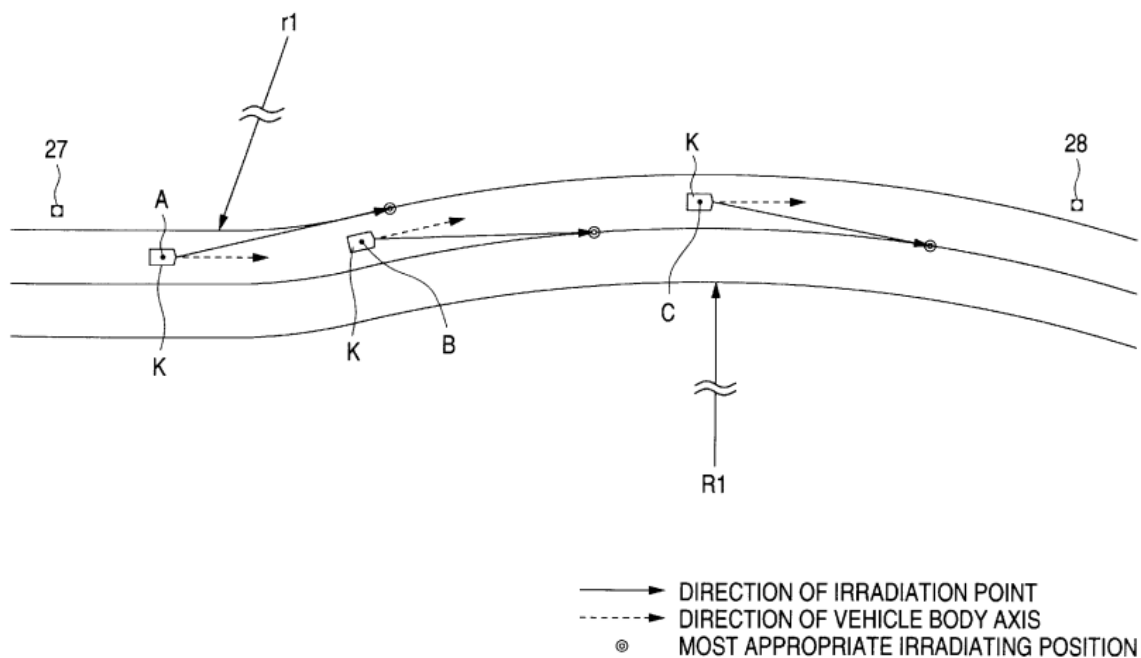
68. Kobayashi, in the same field as Alden, discloses performing similar control of headlight systems to illuminate road curves based on road map data. Similar to Alden, Kobayashi's headlamp system includes various inputs, a controller, and a headlamp:



(Kobayashi, Fig. 1, 3:9-5:28; *see also* Fig. 12, 17:3-67.) Specifically, Kobayashi discloses that its controller (“irradiation control means 4”) receives “road map information” from “road profile calculating means 2,” along with other sensor data, and use these inputs to automatically adjust the illumination of headlamp 5. (*Id.*; *see also* 2:4-39.) The “road profile calculating means” can also be included as part

of a GPS sensor that outputs “map information.” (*Id.*, Fig. 12, 17:3-61, 2:28-50.) Kobayashi further discloses that as a vehicle moves along the road, the “irradiation control means 4” can “conduct[] irradiation control of the lighting device in accordance with the road profile.” (*Id.*, 4:5-13.) As a result, “when the vehicle turns to left, the left shoulder is irradiated,” and “[w]hen the vehicle turns to right, the right shoulder is irradiated”:

FIG. 10



(*Id.*, Fig. 10, 15:6-28, 17:41-67; *see also* Fig. 9, 11:34-14:52.) Stated differently, “when the vehicle advances along a scheduled course, irradiation control of the lamp is conducted in accordance with the course concerned.” (*Id.*, 17:39-61.) In this sense, Kobayashi discloses a lighting device that identifies road curvatures

and adapts the light direction of headlamps accordingly based at least in part on map data. (Kobayashi, 1:5-8, 2:4-14, 3:9-14, 5:2-13, 15:6-28.)

69. It would have been obvious to a POSITA to apply these teachings to Alden to additionally—or through simple substitution—use map data to identify road curvature when adapting the LEDs of Alden to “direct light into the corner.” (Alden, [0036].) Both Alden and Kobayashi are directed to vehicle headlamp systems that focus on controlled vehicle lighting systems based on multiple data streams. Moreover, both can re-direct light based on detecting an upcoming road curve, and both can use data from various sensors to do so (with Alden using light sensors to detect roadside reflectors as well as steering wheel sensors, and Kobayashi using map data, along with other sensor data). Further, Alden already discloses that road curvature can be detected and light correspondingly adjusted using numerous means, including roadside reflectors and steering wheel sensors, and Kobayashi simply discloses an additional known means to detect road curvature: map data. A POSITA would have thus understood the systems to be complementary and/or substitutable, as both Alden and Kobayashi disclose sensor data fed to a controller, which then controls lighting. And, a POSITA would have had predictable results and a reasonable expectation of success, as Alden’s controller can already successfully synthesize multiple sources of information (e.g., roadside reflectors, steering sensors, oncoming vehicles) and the map data of

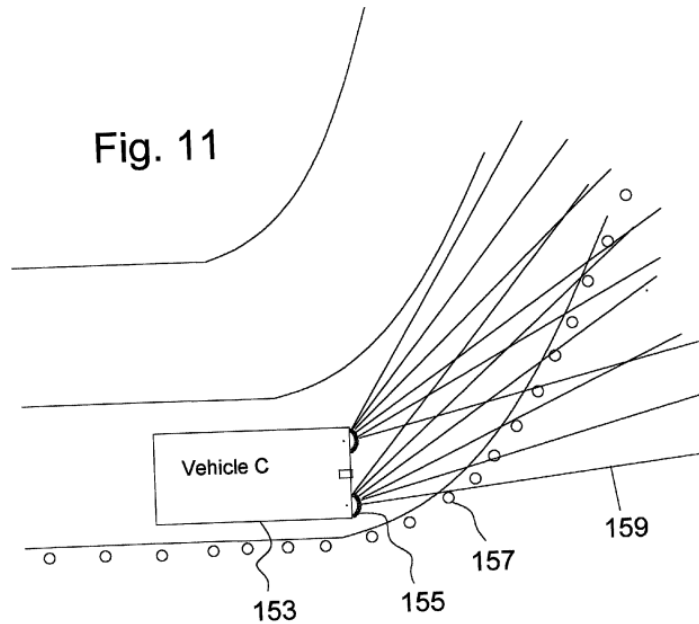
Kobayashi could be similarly synthesized or substituted for one or more of Alden's sources of information. Doing so would be a suitable option to replace or supplement Alden's sources of information because Kobayashi's GPS-derived map data would be expected to be as reliable as such sources, depending on the context.

70. Further, a POSITA would have been motivated to combine the teachings of Alden and Kobayashi. Alden details how an LED lighting system can be configured to alter a light beam based on the detection of road curvature using various approaches in combination, including light sensors and reflectors and steering wheel sensors. (Alden, Fig. 11, [0036], Fig. 14, [0039].) Kobayashi makes clear that map data can be included as an additional approach in controlling the direction of the vehicle headlights. (Kobayashi, Fig. 1, 2:4-50, 3:9-50, Fig. 12, 17:3-47, Fig. 10, 15:6-28, Fig. 9, 11:34-14:52.) A POSITA would have thus been motivated to combine the techniques of detecting a road curvature to maximize successful detection in different environments. For example, where a road lacks the reflectors contemplated in Alden, relying on map data would be preferred. Installing such road reflectors along all roads would be expensive, and it could be impractical in some areas, like urban environments, where there may not be a place for such reflectors to be installed such that they could be recognized. And in an environment where map data may be less reliable, light or steering wheel sensors may be preferred. Alden suggests that combining multiple sources of information

about road curvature is beneficial, so a POSITA would naturally be motivated to incorporate additional sources of road curvature information, such as Kobayashi's functionality of using map data to determine road curvature.

1[D]: 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

71. Alden discloses Claim 1[D]. As I discuss above, Alden's system, including the processor executing stored instructions, determines a light change adapting a light pattern of the headlamps in "intensity" and "spatial distribution" in a direction of road curvature ahead of the equipped vehicle. *See supra* ¶¶59-70 (Claims 1[B]-1[C]). In particular, Alden discloses that its system, including the processor executing stored instructions, accommodates road curvature ahead of the equipped vehicle by adapting the light pattern in intensity and spatial distribution to "concentrate light to look around corners in response to road conditions":



(Alden, [0036], Fig. 11.) Alden discloses that this “directing of light can be achieved with the segmented elements described herein.” (*Id.*) Alden does this by adapting the pattern of light from the lighting element in the segmented headlights (such as, for example, the LEDs shown in the “segmented headlight” of Figure 5) to “direct light into the corner to maximize the driver’s ability to see there.” (*Id.*, [0036], [0026]-[0029], Fig. 11 *see also* [0039]-[0040] (discussing controlling direction of the headlight beam based on the sensed steering wheel angle). That is, based on the sensor data indicating that the road ahead curves, Alden’s system determines changes to the light distribution from the headlights to “shape” the light so that it is concentrated (or directed) into the curve, thereby increasing the illumination intensity in the area of the curve. (*Id.*) For example, as can be seen in Figure 11 above, Alden’s systems adapts the shape of the light pattern from the

headlights to shift light to the left, in the direction of the curve, so that the curve is illuminated with greater intensity and distribution of light.

72. In addition, as noted above, Kobayashi similarly includes a controller that determines a changed shaping of light when map data indicates an upcoming curve or change in road shape. *See supra* ¶¶64-71 (Claim 1[C]). For example, where map data indicates that a road curves left and then right, Kobayashi's controller can use this to concentrate or direct light in advance of the curves to the left and then to the right. Again, as I discussed above, it would have been obvious to modify Alden in view of Kobayashi to determine the required changed shaping of light to accommodate upcoming road turns based on map data. *Id.* Alden would continue to perform the same determination of changed light patterns to accommodate upcoming curves or changes in road shape, only now it would make the determination based on the additional or substituted received map data indicating the road curvature.

1[E]: [1] 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 [2] prior to the motor vehicle reaching the road curvature.

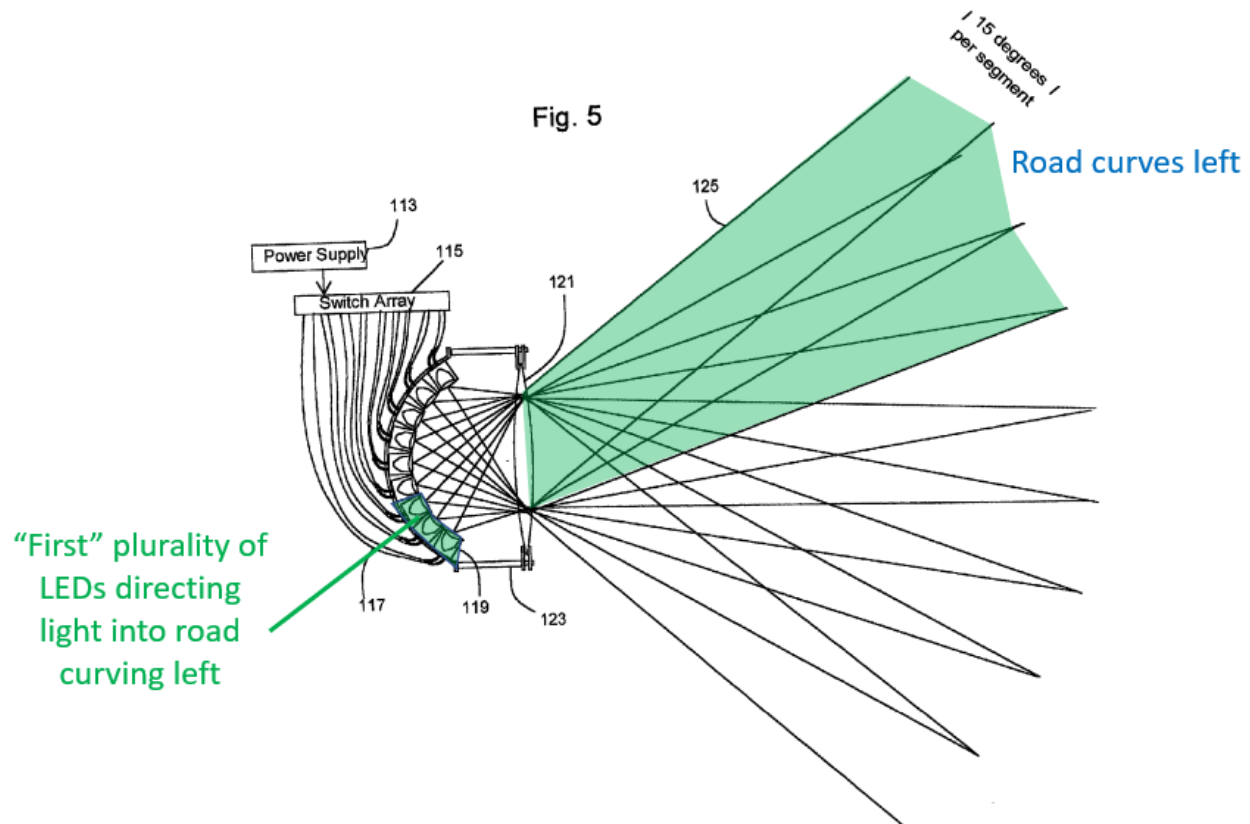
73. Alden discloses Claim 1[E]. First, as I explained above, CPU 71 processes the sensor data and determines a changed “light pattern” to be produced in the headlight distribution area—such as high beam light in sectors where there is no oncoming vehicle and low beam light where there is, or to “direct light” into a

corner of a curve. *See supra* ¶¶59-70 (Claims 1[B]-1[C]). The CPU 71 then controls a “first plurality of LEDs” in the array which direct light into sectors including the detected road curve to produce the “light pattern” and concentrate light into the area of the curve “to look around corners.” (Alden, Fig. 11, [0029], [0036]; *see also* [0026]-[0028], [0033]-[0040], [0061].) In other words, Alden describes controlling the plurality of LEDs to illuminate along the curve in the road: if the road curves left, Alden discloses illuminating the road in that direction.

74. As I also discussed above, Alden discloses that the CPU processes data indicating there is a curve in the road, and instructs control circuitry including a switch array to power the LEDs accordingly. (Alden, Figs. 3-5, [0027]-[0029].) In particular, the CPU and control circuitry adjust the LEDs in the “responding headlights 155” (such as, for example, those shown in Figure 5 that emit light into sectors containing the road curve) so that they produce the changed light pattern to “direct light into the corner to maximize the driver’s ability to see there.” (*Id.*, [0036], [0026]-[0029].) By directing light into the corner, or curve of the road, to maximize the driver’s ability to see there, the system is increasing illumination in the direction of the curve.

75. When one is driving an equipped vehicle, the controlled “first plurality” of LEDs would be those LEDs that are directing light to sectors in the area where the road curves. This can be seen with reference to Figure 5, for

example, where the controlled “first plurality” of LEDs could be those shaded in green, following the curve of a road as it turns left:



(Alden, Fig. 5 (annotated), [0029].) As can be seen from the annotated figure, the three LEDs at the bottom of the array direct light in the sectors towards the left hand side of the headlight distribution area and thus can be controlled to produce the illumination pattern illuminating the curve.

76. Second, with regard to the “prior to the motor vehicle reaching the road curvature” limitation, Alden discloses that this controlled light change takes effect prior to the vehicle reaching the road curvature. (Alden, Fig. 11, [0036]-[0040].) Again, Alden discloses that an upcoming turn can be detected using

sensor data detecting light from reflectors along the side of the road, or from rotation sensors in the steering wheel (*e.g.*, before someone accelerates into a turn). (*Id.*) This sensing would occur before the road curves; for example, the reflectors along the road would be ahead of a vehicle, and the system would “concentrate” light once it detects light from such reflectors. (*Id.*) And once this detection of road curvature ahead is made, Alden discloses “concentrat[ing]” light accordingly before reaching the curve. (*Id.*) Drivers need to be made aware of the curve well before entering the curve, so that they can properly adjust speed and steering to safely navigate the curve. In addition, as shown in Figure 11, Alden’s system uses the road reflectors indicating the curve *ahead* of the vehicle, such that the curve would be recognized and light directed into it before the vehicle enters the curve.

77. In addition, as noted above, Kobayashi similarly includes a controller that controls a headlamp to provide changed shaping of light before a vehicle reaches a curve, when map data indicates an upcoming curve or change in road shape. *See supra* ¶¶64-71 (Claim 1[C]). For example, where map data indicates that a road curves left and then right, Kobayashi’s controller can use this to concentrate or direct light in advance of the curves to the left and then to the right. *Id.* Again, it would have been obvious to modify Alden in view of Kobayashi to control the light sources to implement the changed shaping of light to accommodate upcoming road curvature based on map data. Alden would continue

to perform the same control of LEDs to shape the light pattern to direct light into the curve, only now it would do so based on received map data indicating the road curve (either in place of other sources of information about road curvature or in addition to those other sources).

2. Independent Claim 12

78. As viewed by a POSITA, Alden in view of Kobayashi renders obvious Claim 12.

12[Pre]: *A non-transitory computer-readable storage medium, storing instructions that, when executed by one or more processors of a motor vehicle that includes a plurality of headlamps that each comprise a plurality of LED light sources, enable the one or more processors to:*

79. Alden discloses Claim 12[Pre] to the extent the preamble is limiting to the claim. As I described above, Alden discloses a system, for a motor vehicle, that includes headlamps. *See supra* ¶55 (Claim 1[pre]). Alden’s system contains a processor, logic CPU 71, along with memory and control circuitry (*i.e.*, together comprising non-transitory computer-readable storage media with instructions executable via a processor), and further includes “controlling logic” that enables the processor to execute a method of operating the headlamps of a motor vehicle. *See supra* ¶¶59-63, 73-77 (Claims 1[B], 1[E]). Moreover, Alden’s system includes a plurality of headlamps that each comprise a plurality of LED light sources. *See supra* ¶¶56-58 (Claim 1[A]).

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

80. Alden in view of Kobayashi discloses Claim 12[A]. *See supra* ¶¶64-71 (Claim 1[C]).

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

81. Alden, alone or in view of Kobayashi, discloses Claim 12[B]. *See supra* ¶¶71-72 (Claim 1[D]).

12[C]: 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.

82. Alden, alone or in view of Kobayashi, discloses Claim 12[C]. *See supra* ¶¶73-77 (Claim 1[E]) (likewise reciting “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”).

3. Independent Claim 23

83. As viewed by a POSITA, Alden in view of Kobayashi renders obvious Claim 23.

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

84. Alden discloses Claim 23[Pre], to the extent the preamble limits the claim. As I discuss above, Alden discloses a computer-implemented method for adapting light emitted from the headlamps of a motor vehicle. *See supra* ¶¶55, 59-70 (Claims 1[Pre], 1[B]). As discussed above, Alden’s system includes a computer—namely the processor, along with memory and control circuitry, that enables the processor to execute a instructions or logic for adapting light from headlamps of the motor vehicle to accommodate road shape changes, such as curves in the road. *See supra* ¶¶59-70, 73-77 (Claims 1[B], 1[E]). Alden further discloses that the headlamps each include a plurality of LED light sources. *See supra* ¶¶56-58 (Claim 1[A]).

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

85. Alden in view of Kobayashi discloses Claim 23[A]. *See supra* ¶¶64-70 (Claim 1[C]).

23[B]: *determining a light output, the output adapting a light pattern of the headlamps in at least one of color, intensity or spatial distribution to increase light in a direction associated with the shape change ahead of the motor vehicle and shaping light based on the shape change; and*

86. Alden, alone or in view of Kobayashi, discloses Claim 23[B]. *See supra* ¶¶71-72 (Claim 1[D]).

23[C]: 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.

87. Alden discloses, alone or in view of Kobayashi, Claim 23[C]. *See supra* ¶¶73-77 (Claim 1[E]).

4. Dependent Claims 2, 13, 24

2/13/24: The [system/storage medium/method] of claim [1/12/23], wherein the determination of the light change includes selection of the first plurality of the LED light sources.

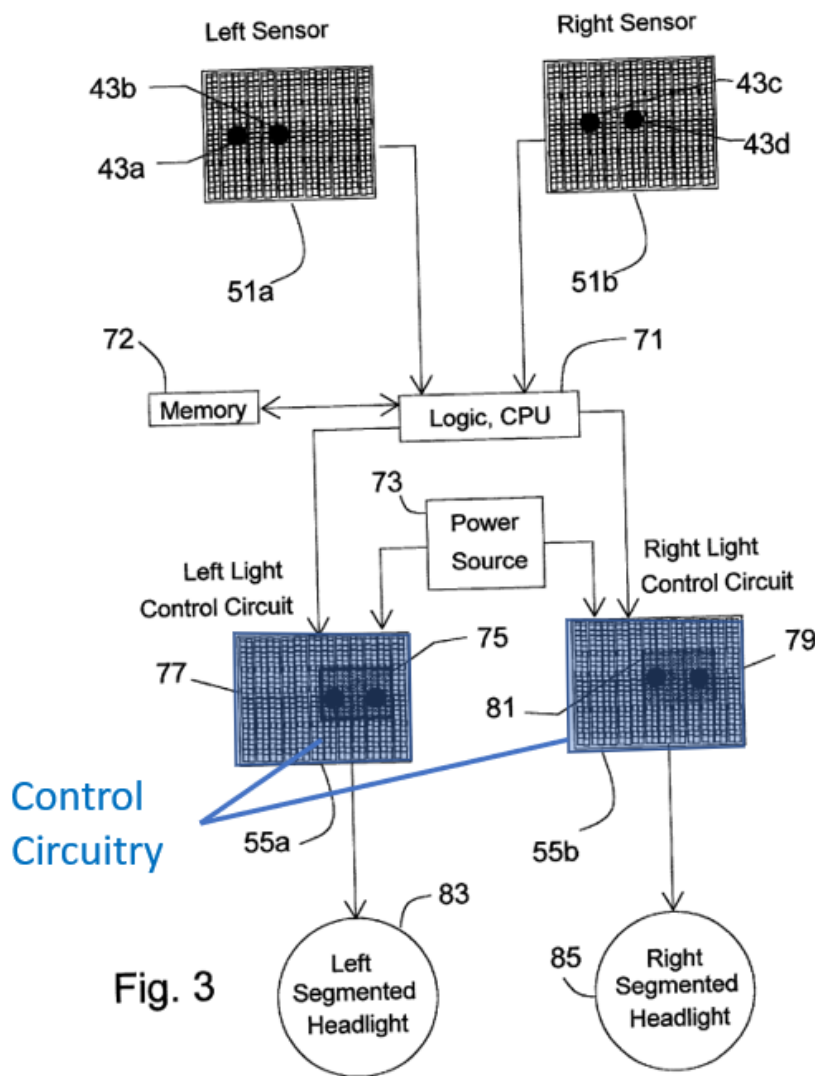
88. As viewed by a POSITA, Alden in view of Kobayashi renders obvious Claims 2, 13, and 24. These claims are substantially similar to Claim 1[E], which recites controlling “a first plurality of the LED light sources to provide light based at least in part on the determined light change.” As I discussed above, the determination in Alden of the light change includes a selection of the first plurality of LEDs in the array that will produce the changed light pattern, and control of those selected LEDs to produce a changed light pattern. *See supra* ¶¶73-77 (Claim 1[E]); *see also supra* ¶¶71-72 (Claim 1[D]). Again, Alden discloses that “directing of light” around corners can be “achieved with the segmented sensing elements and segmented light distribution elements described herein.” (Alden, [0036], Fig. 11.) Alden also discloses that the LEDs in these segmented elements are “on a curve along the focal point of a headlight lens 121, such that the light from each lighting element goes into a specified portion (or portions) of the headlight distribution area.”

(Alden, [0029], Fig. 5.) In determining changes to the light pattern output from the headlights, Alden considers which LEDs direct light into the different sectors of the overall headlight distribution area, including around a road curve. (*Id.*, [0006], [0008], [0028]-[0029], [0036], Figs. 5, 11.) Moreover, in response to sensed changes in environmental conditions, such as a change in the curve or shape of the road, *see supra* ¶¶64-70 (Claim 1[C]), Alden's logic CPU 71 determines the intensity level of the lighting elements, such as the LEDs in Figure 5, to appropriately illuminate different zones of the headlight distribution area. (*Id.*, [0028].) This process is done in real-time, such that LEDs are continuously selected in determining light changes. (*Id.*) *See supra* ¶¶71-77 (Claims 1[D]-1[E]).

89. The illumination requirements for Alden's "headlight distribution sectors" (*e.g.*, "subsections" of the field-of-view) are determined in response to sensor data. (Alden, [0025]-[0027].) Alden describes that its headlight system "emits a low beam illumination 35 in a first headlight distribution sector while concurrently emitting a high beam illumination 37 in a second headlight distribution sector. The low beam illumination in 35 being emitted in response to the detection of an oncoming vehicle 33 (the 33 emitting light which has been omitted for drawing clarity)." (*Id.*, [0025]; *see also* [0026]-[0029].) Alden further describes that this system can be used when directing light around a road curvature. (Alden, [0036] "The directing of light can be achieved with the segmented sensing elements and

segmented light distribution elements described herein.”). *See also supra* ¶¶71-72 (Claim 1[D]).

90. Alden’s headlight system includes a “left light *control circuit*” (55a) and a “right light *control circuit*” (55b) for selection of a plurality of light sources:



(Alden, Fig. 3 (annotated).) These control circuits include “segmented headlight control switch array switches,” which provide power to the different light elements in the segmented headlights, causing certain “portions” of the headlight to “dim”

while other portions are “on high beam.” (*Id.*, [0027].) In particular, based on data from the sensors, the control circuitry “controls the power flow” to the segmented headlights to independently control the lighting elements. (*Id.*, [0026]-[0027]; *see also* [0006], [0008], Fig. 4, [0028].) For example, where data from sensors 51a, 51b indicates the presence of another vehicle 41, the control circuitry “controls the power flow” so the headlight “distributes high beams throughout its distribution areas except in a box in the direction of the 41.” (*Id.*, [0027].)

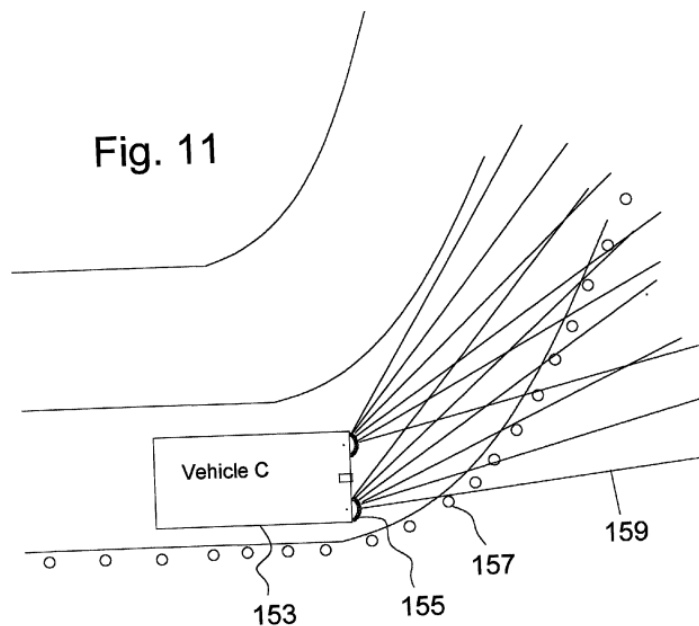
5. Dependent Claims 3, 14, 25

3: *The system of claim 1, wherein the instructions include instructions that, when executed by the one or more processors, enable the one or more processors to reshape light based on the road curvature as the motor vehicle travels at least to or through the road curvature.*

14: *The storage medium of claim 12, wherein the instructions include instructions that, when executed by the one or more processors, enable the one or more processors to reshape light based on the road curvature as the motor vehicle travels at least to or through the road curvature.*

25: *The method of claim 23, further comprising reshaping light based on the shape change as the motor vehicle travels at least to or through the shape change.*

91. As viewed by a POSITA, Alden in view of Kobayashi renders obvious Claims 3, 14, and 25. Alden discloses that the CPU in its segmented headlight system reshapes the light emitted from the headlights as the vehicle travels to or through curves or changes in road shape, so that the light is “concentrated” or “directed” into any new road curves ahead of the vehicle:

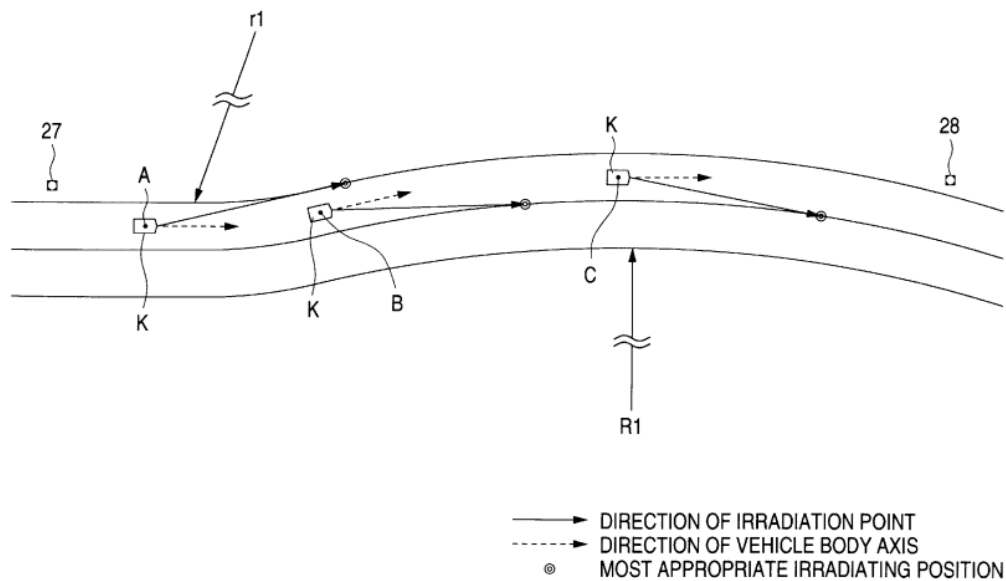


(Alden, [0036], [0039]-[0040], Figs. 11, 13-14.) *See supra* ¶¶71-77 (Claims 1[D]-1[E]). Again, Alden continuously determines the illumination requirements of each LED in the array “so as to be responsive to changing environmental conditions in real time.” (Alden, [0028].) As the motor vehicle travels along the road, and the environmental conditions around the vehicle change, including the curve or shape of the road now in front of the vehicle, Alden’s system would continuously determine new illumination requirements for each LED in the array to reshape the headlight emission pattern. (*Id.*)

92. Additionally, from the perspective of a POSITA, Alden in view of Kobayashi discloses Claims 3, 14, and 25. Kobayashi, like Alden, discloses continuously adjusting (i.e., reshaping) light as a vehicle proceeds along a road using road map data. (Kobayashi, Abstract.) Kobayashi discloses that its controller

(“irradiation control means 4”) receives “road map information” from “road profile calculating means 2,” along with other sensor data, and uses these inputs to automatically adjust the illumination of headlamp 5. (*Id.*; *see also* 2:4-39, Fig. 12, 17:3-61, 2:28-50.) Kobayashi further discloses that as a vehicle moves along the road, the “irradiation control means 4” can “conduct[] irradiation control of the lighting device in accordance with the road profile.” (*Id.*, 4:5-13.) As a result, “when the vehicle turns to left, the left shoulder is irradiated,” and “[w]hen the vehicle turns to right, the right shoulder is irradiated”:

FIG. 10



(*Id.*, Fig. 10, 15:6-28, 17:41-67; *see also* Fig. 9, 11:34-14:52.) In particular, as shown in Figure 10 above, Kobayashi plans and controls illumination—shaping and re-shaping light in the direction ahead of and through curves to improve safety.

(*Id.*, 14:53-15:28.) For example, when vehicle K turns right (point C), the right shoulder is illuminated, adapting the light pattern in intensity and spatial distribution, reshaping light relative to the previous curve based in part on road curvature from map data. (*Id.*, 14:53-15:28.)

93. Moreover, a POSITA would have been motivated to combine the controller of Alden with that of Kobayashi to allow real-time, iterative, shaping of light as a vehicle passes through a road curvature. It would have been obvious to a POSITA to implement the continuous control to reshape the headlight beam pattern as the vehicle travels along the road using road map data as disclosed in Kobayashi in the system of Alden. Both Alden and Kobayashi disclose similar systems controlling headlights to continuously reshape light output in response to data indicating an upcoming change in the curve of the road as the vehicle travels. *See supra* ¶¶64-70 (Claim 1[C]). In particular, Alden's controller, like that of Kobayashi, is capable of performing an "iterative process" to control vehicle lighting "to be responsive to changing environmental conditions in real time." (Alden, [0028] & Fig. 4.) And, as I explained above, Alden already discloses that road curvature can be detected and light correspondingly adjusted using numerous means, including light sensors and reflectors and wheel sensors, and Kobayashi simply discloses an additional known means to detect road curvature: road map data. A POSITA would have thus understood the systems to be complementary,

and would have had a reasonable expectation of success in combining them, as Alden's controller can already synthesize multiple sources of information (e.g., roadside reflectors, steering sensors, oncoming vehicles) and the map data of Kobayashi could be similarly synthesized. Modifying Alden's controller to continuously reshape the light based on map data indicating changes in the shape of the upcoming road would have been nothing more than a routine use of a known technique from Kobayashi to improve Alden's similar lighting system to achieve its purpose of "directing light" into upcoming road curves.

94. Further, a POSITA would have been motivated to combine the teachings of Alden and Kobayashi. Alden details how an LED lighting system can be configured to alter a light beam based on detection of a road curvature using various approaches, including light sensors, reflectors, and wheel sensors. (Alden, Fig. 11, [0036], Fig. 14, [0039].) Kobayashi makes clear that map data can be included as an additional approach in controlling direction of vehicle headlights. (Kobayashi, Fig. 1, 2:4-50, 3:9-50, Fig. 12, 17:3-47, Fig. 10, 15:6-28, Fig. 9, 11:34-14:52.) A POSITA would have thus been motivated to combine the techniques of detecting a road curvature to maximize successful detection in different environments. For example, where a road lacks the reflectors contemplated in Alden, relying on map data would have been preferred. And in environments where map data may have been less reliable, light or steering wheel

sensors may have been preferred.

6. Dependent Claims 4, 15, 26

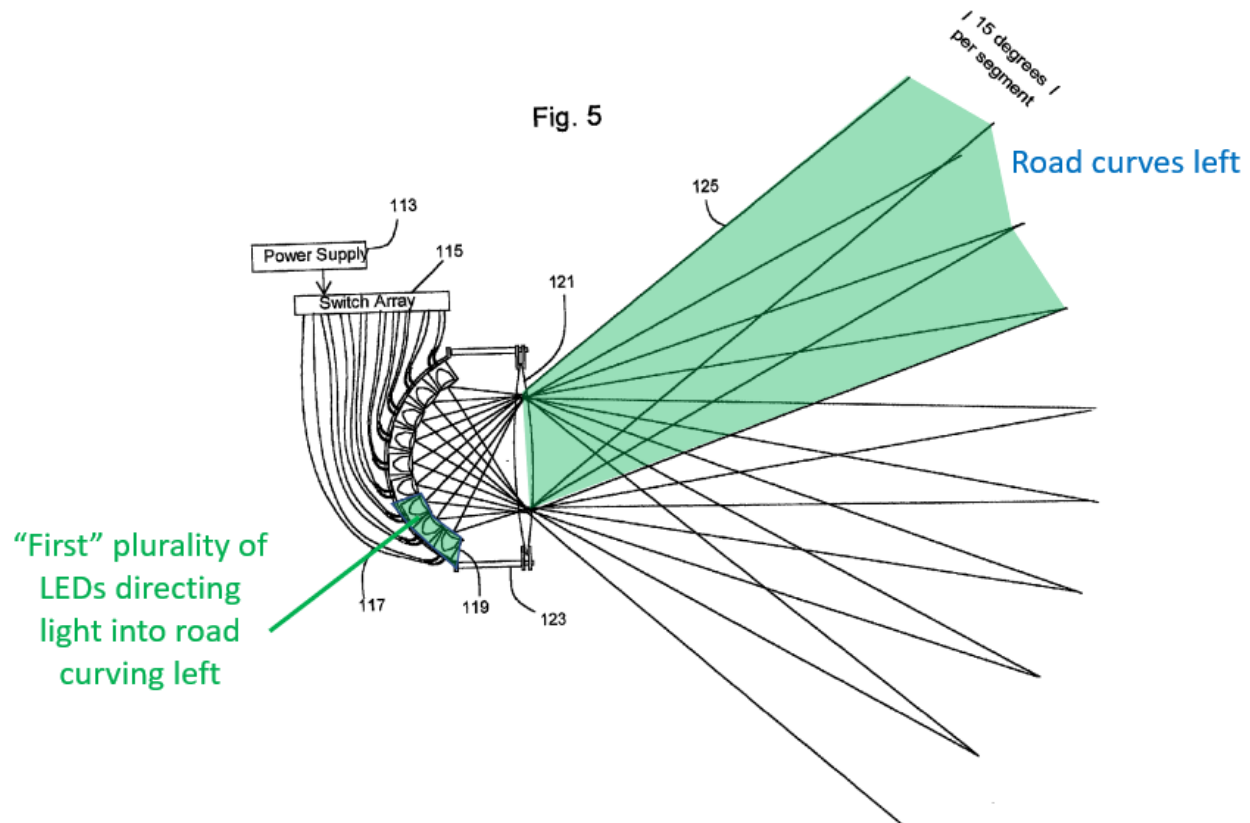
4/15: *The [system/storage medium] of claim [3/14], wherein the reshaping of light further includes control to at least one of the first plurality of LED light sources, or a second plurality of LED light sources, including at least one LED light source different from the LED light sources of the first plurality of LED light sources, to provide reshaped light.*

26: *The method of claim 25, wherein the reshaping light further includes controlling at least one of the first plurality of LED light sources, or a second plurality of LED light sources, including at least one LED light source different from the LED light sources of the first plurality of LED light sources, to provide reshaped light.*

95. As viewed by a POSITA, Alden in view of Kobayashi renders obvious Claims 4, 15, and 26. Claims 4, 15, and 26 add to claims 3, 14, and 25 (respectively), the requirement that at least one LED light source does not overlap as light is “reshaped” when a vehicle travels along a road curve. As I discussed above, Alden, alone and in view of Kobayashi, discloses a controller implementing a real-time, continuous process to “reshape” and change the output of the headlights as the environmental conditions around the vehicle change (such as when the vehicle is traveling along a road). *See supra* ¶¶91-94 (Claims 3/14/25).

96. As I explained above, this real-time process continuously determines new illumination requirements for each LED in the array to reshape the headlight emission pattern. (*Id.*) Thus, as the process continues in “real-time,” different “pluralities” of LEDs will be selected and adjusted. For example, where data

received by the controller indicates that the road curves to the left, Alden selects and controls a “first plurality” of LEDs (shown in green) that direct light into the sectors of the headlight distribution area including the left hand road curve:



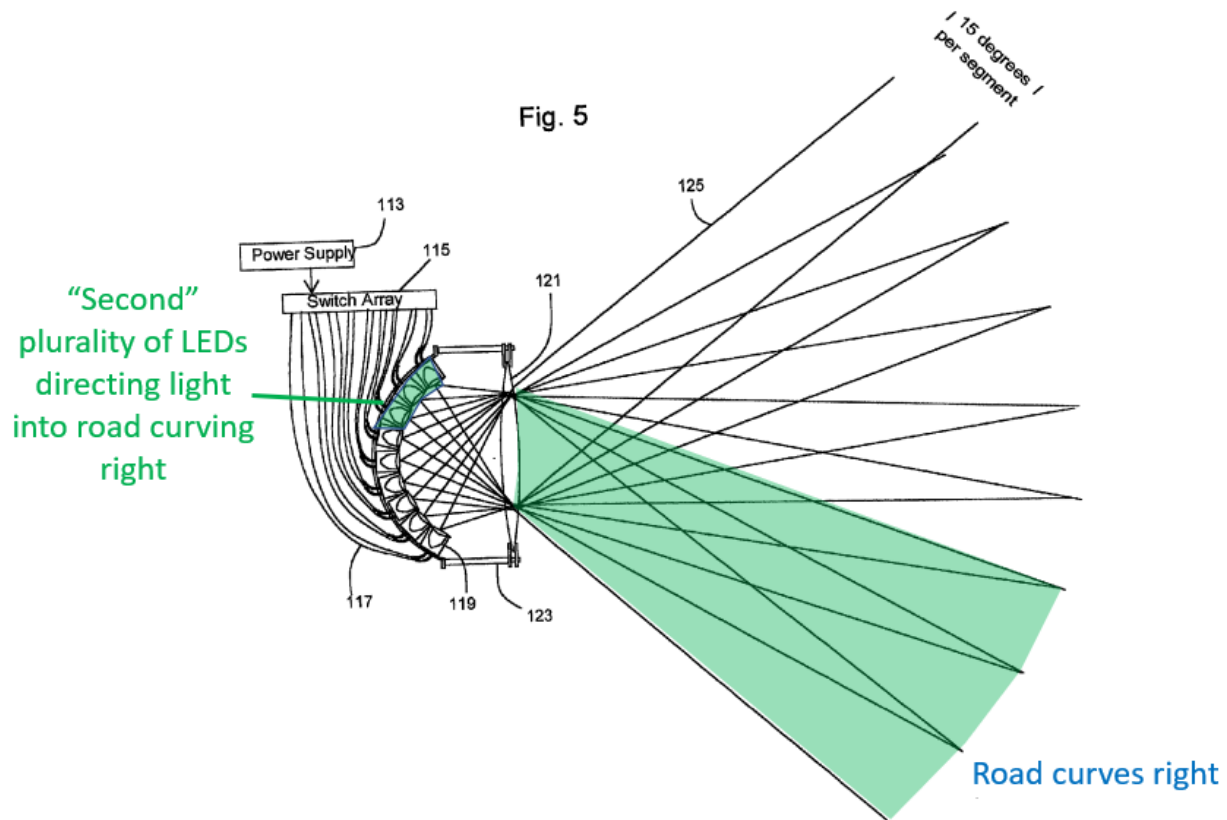
(Alden, Fig. 5 (annotated), [0029]; *see also* [0027]-[0028], [0033]-[0040], Fig. 11.)

See also supra ¶¶88-90 (Claims 2/13/24.) If the road continues to curve left,

Alden’s real-time process can continuously control the output of the same first plurality of LEDs to emit reshaped light that continues to be directed into the left-hand curve. (*Id.*) Alden has full control over where light emitted from the LED array will go, as the mounting of the LEDs on the curved structure around the focal

point of the lens makes it such that light from each LED goes into particular sectors or portions of the headlight distribution area.

97. If, however, the shape of the upcoming road changes such that it later turns to the right, Alden's controller would determine that a different, "second plurality" of LEDs are aimed such that they direct light into the sectors of the headlight distribution area containing the right-hand turn:



(*Id.*, Fig. 5 (annotated), [0028]-[0029], [0036], *see also* [0039]-[0040].) This "second plurality" of LEDs, such as the three LEDs shown in green above at the top of the figure, would be controlled to provide the reshaped light output in the sectors including the right hand curve. (*Id.*) Alden's system will thus select a

second, different set of LEDs to provide the shaped light output as the equipped vehicle proceeds along a road where the curve changes from left to right, for example, to best illuminate the changing road curve.

7. Dependent Claims 5, 16, 27

5/16: The [system of claim 1 / storage medium of claim 12] wherein the increase of light in the direction of the road curvature includes at least an increase of light emitted at a level below high-beam light and directed in the direction of the road curvature.

27: The method of claim 23, wherein the increase of light in the direction associated with the shape change includes at least light output that increases light emitted at a level below high-beam light and directed in the direction.

98. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 5, 16, and 27. As described above, Alden discloses increasing light in the direction of a road curvature or road shape change. *See supra* ¶¶71-77 (Claims 1[D]-1[E]). Alden further discloses that the LEDs are “each operable within a range of intensities between the high beam and low beam state.” (Alden, [0061].) That is, Alden discloses that the LEDs can be operated not only at low beam intensity or high beam intensity, but at a plurality of other intensities (such as a “medium” intensity) in between as a vehicle approaches a curve and the system directs light into the curve to improve driver vision . (*Id.*)

99. A POSITA would have understood that, when approaching a road curvature, an obstacle such as an oncoming vehicle may be present or approaching. (Alden, [0005]-[0006], [0025], [0060]-[0061].) A POSITA would have further

understood from Alden that, when approaching a road curvature, illumination of light at a level in the “operable [] range of intensities” less than high-beam light can be selected. (*Id.*)

100. Controlling the LEDs directed to sectors including the road curvature to emit increased light below high-beam light, such as a “medium” intensity light, would allow the driver to sufficiently see the road curvature, but would not blind potential oncoming vehicles that are not yet visible. (*Id.*) Alden makes clear that it is concerned with reducing glare to oncoming vehicles (Alden, [0005]-[0006], [0026]-[0029]), and thus, a POSITA having read Alden, would want to be cognizant of glare reduction when illuminating a road curve, to minimize the risk of blinding another driver that could be coming around the curve. (*Id.*) For example, if a driver in a vehicle equipped with Alden’s system was on a busy road that is winding, the driver would not want the system to produce full high beam light in the curve because there would be a high risk of other vehicles coming quickly around the curve that could be blinded (which Alden wants to avoid). It would also have been well within the skill of a POSITA to use Alden’s teaching of using intensities less than “high beam light” when illuminating a curve, as Alden already teaches using such intensities to illuminate areas with segmented headlights.

8. Dependent Claims 6, 17, 28

101. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 6, 17, and 28.

6[pre]: *The system of claim 1, wherein the instructions include instructions that, when executed by the one or more processors, enable the one or more processors to:*

17[pre]: *The storage medium of claim 12, wherein the instructions include instructions that, when executed by the one or more processors, enable the one or more processors to:*

28[pre]: *The method of claim 23, further comprising:*

102. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 6[pre], 17[pre], and 28[pre]. See *supra* ¶¶55, 79, 84 (Claims 1[pre], 12[pre], 23[pre]).

6[A]/17[A]: *determine a second light change, the second change adapting the light pattern of the headlamps in at least one of color, intensity or spatial distribution to increase light in a direction of a second road curvature ahead of the motor vehicle, determined based on at least one of the first data or second data including at least second map data, and the second change shaping light based at least in part on the second road curvature; and*

28[A]: *determining a second light output, the second output adapting the light pattern of the headlamps in at least one of color, intensity or spatial distribution to increase light in a direction associated with a second shape change ahead of the motor vehicle, determined based on at least one of the first data or second data including at least second map data, and the second output shaping light based at least in part on the second shape change; and*

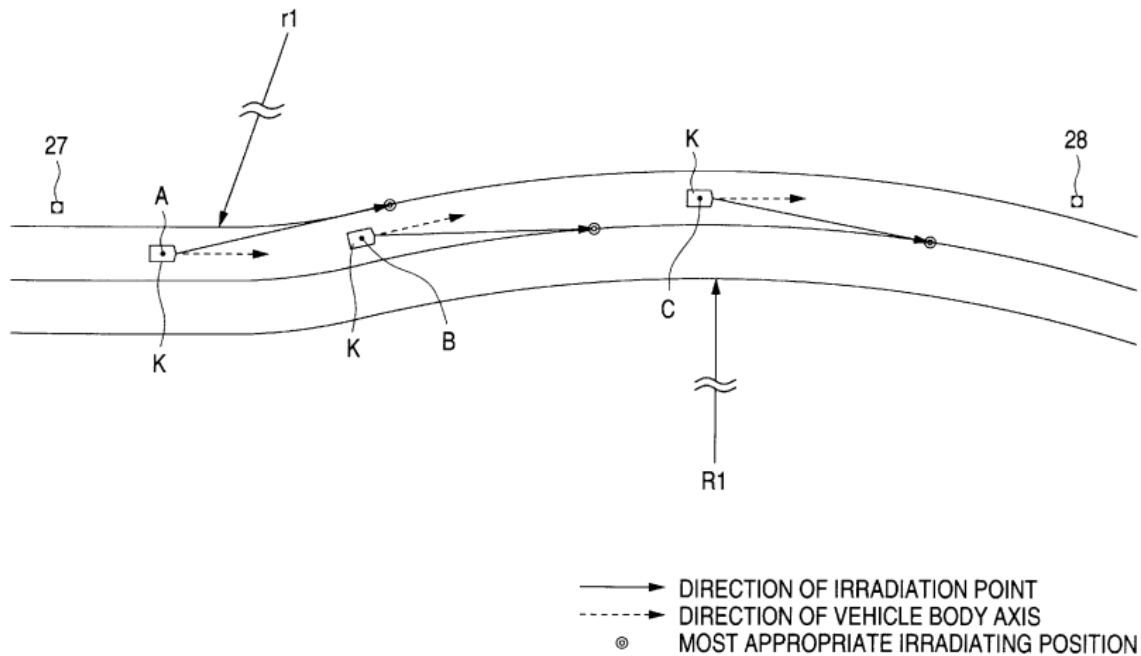
103. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 6[A], 17[A], and 28[A]. As I discussed above, Alden discloses an

iterative process that repeats in real-time, continuously determining the light output for each individually controllable LED in the array. *See supra* ¶¶95-97 (Claims 4, 15, 26). This process would include, for example, determining a second light change (or output) that adapts the light pattern in intensity and spatial distribution to increase illumination in the direction of a new, different curve or shape change of the road ahead of the vehicle as indicated by second, subsequent data from light sensors detecting roadside reflectors or a steering wheel angle sensor. *See supra* ¶¶71-72, 95-97 (Claims 1[D], 4, 15, 26); *see also* Alden, [0028]-0029], [0033]-[0040].

104. In addition, and as discussed above, Kobayashi also discloses determining adapted light pattern outputs to reshape light as a vehicle proceeds along multiple road curvatures based on received road map information (“map data”). (Kobayashi, Fig. 10, Fig. 1, 3:9-5:28, 17:3-67; *see also* Figs. 6, 12); *See also supra* ¶¶64-70, 91-94 (Claims 1[C], 3/14/25). Kobayashi discloses road curves or changes in road shape, such as around a bend in a road or at a branch in the road where a vehicle could take multiple paths, can be detected using “road profile calculating means” that makes determinations based on “road map information.” (*Id.*, 2:9-50, 3:9-5:286.) Initial “road map information” about a portion of the road on which the vehicle is traveling (“first map data”) may include information regarding multiple upcoming curves along the road. (*Id.*, 3:9-5:28,

14:53-15:28, Fig. 10.) For example, initial road map data received by the controller may indicate that, with respect to the road on which the vehicle traveling, there is an upcoming left-hand bend in the road approaching in 200 feet, followed by a 750 foot straightaway, and then back-to-back left-hand and right-hand curves. Another example can be seen with reference to Figure 10 of Kobayashi, where the map data could indicate the shapes and curves of the segment of road as shown. In this situation, Kobayashi's system determines a first light change adapting the light pattern in intensity and spatial distribution to increase light in a direction of the first turn (following position A in Figure 10 below), and then a subsequent second change adapting the lighting pattern to increase light in a direction of the second turn (following position B in Figure 10 below):

FIG. 10



(Kobayashi, Fig. 10.) That is, the light changes for both the first and second road curves are determined based on the initial road map information (first map data), and the adapted light pattern is based on the first and second road curves.

105. Moreover, as the vehicle moves along a road, the road profile calculating means continuously checks road map information to determine an expected advancing direction of the vehicle along the road, and the system can also get new “road profile information” from beacons along the side of the road or from a GPS navigation system. (*Id.*, 3:9-5:28, 14:53-15:28, 17:3-67, Figs. 10, 12.) Thus,

as the vehicle moves along the road, the system can check new road map information associated with the new position and travel direction of the vehicle (“second map data”). (*Id.*) For example, in Kobayashi if the vehicle is determined to no longer be traveling in an expected direction based on the road profile, other sensor data can be used to control the irradiation control means to reshape the headlight beams. (*Id.*, 3:9-5:28.) If, at a later time when the vehicle has been traveling along the road to a subsequent position, it is determined that the “road profile calculating means” using the new road map information (“second map data”) accurately predicts the advancing direction of the vehicle, then the “irradiation control means” will again control the headlight distribution in accordance with a road profile corresponding to the second map data. (*Id.*) That is, the system would switch back to using the map data corresponding to the subsequent location of the vehicle to control the irradiation from the headlights. Controlling the irradiation includes adapting the light pattern from the headlights to change in intensity and spatial distribution to increase light in directions associated with curves or road shape changes indicated by the second map data. (*Id.*)

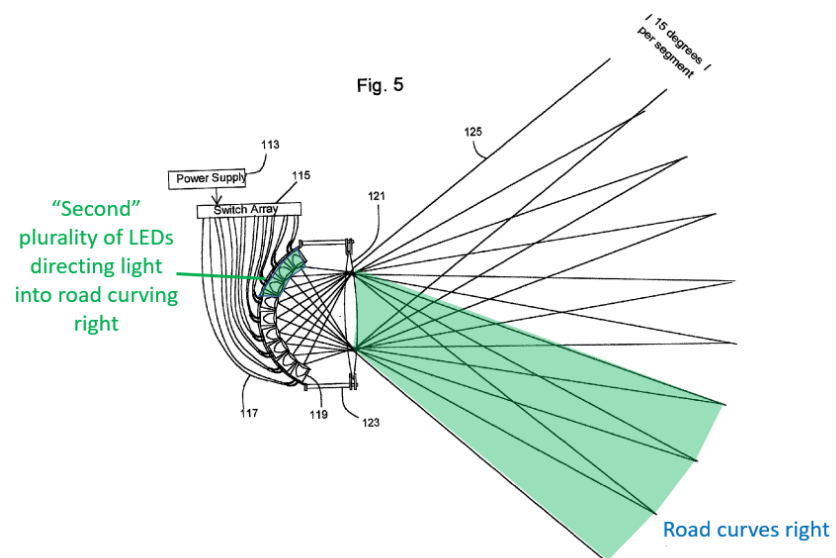
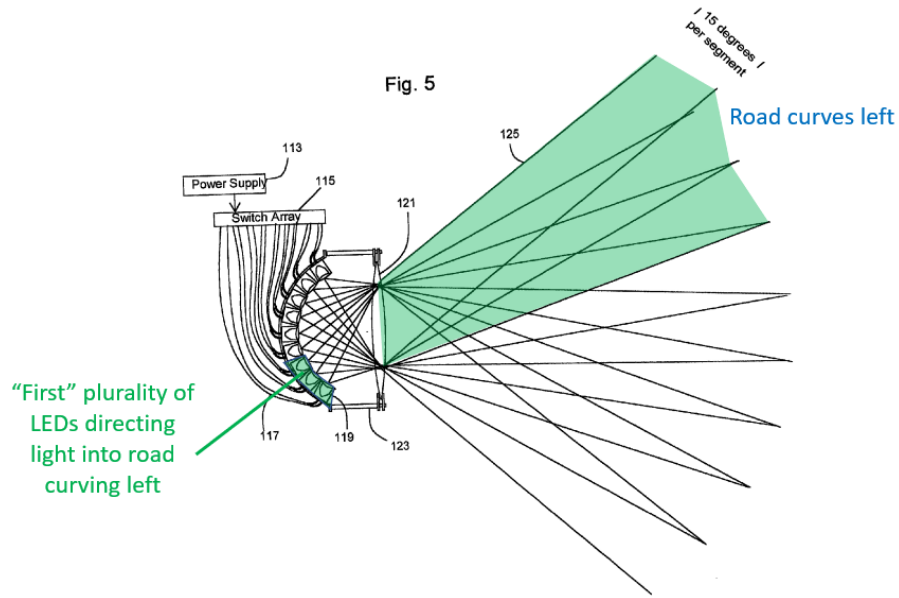
106. Again, it would have been obvious to modify Alden in view of Kobayashi to determine the required changed shaping of light to accommodate upcoming road turns based on first or second map data. *See supra* ¶¶91-94 (Claims 3/14/25 (discussing rationale for using map data of Kobayashi to reshape light

around curves in Alden's system). Alden would continue to perform the same determination of changed light patterns to accommodate multiple upcoming curves or changes in road shape, only now it would make the determination based on received map data indicating the road curves. *Id.*; see also *supra* ¶¶64-70 (Claim 1[C]).

6[B]/17[B]: control at least a second plurality of the LED light sources, having at least one LED light source different from the first plurality of LED light sources, to provide light based at least in part on the determined second light change and prior to the motor vehicle reaching the second road curvature.

28[B]: controlling at least a second plurality of the LED light sources, having at least one LED light source different from the first plurality of LED light sources, to provide light based at least in part on the determined second output and prior to the motor vehicle reaching the second shape change.

107. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 6[B], 17[B], and 28[B]. As I discussed above, Alden discloses that when the received data indicates that the upcoming road changes curve direction or shape, such as going from a first left hand curve to a second right hand curve, Alden's system controls a second plurality of LEDs, with at least one LED being different from the first plurality of LEDs, to provide light based on the determined second light change (or output) prior to the vehicle reaching the second curve:



(Alden, Fig. 5 (annotated), [0029]; *see also* [0027]-[0028], [0033]-[0040].) *See supra* ¶¶95-97 (Claims 4/15/26). As can be seen in the above example, when the Alden system illuminates a left-hand turn, it uses LEDs at the bottom of the array, and when it illuminates a right-hand turn, it uses LEDs at the top of the array. Thus, the LEDs of the “first plurality” and “second plurality” are different.

108. Again, it would have been obvious to modify Alden in view of Kobayashi to control the light sources to implement the changed shaping of light to accommodate upcoming road turns based on map data. *Id.*; see also *supra* ¶¶64-70 (Claim 1[C]). Alden would continue to perform the same control of LEDs to reshape the light patterns to direct light into the curves, only now it would do so based on received map data indicating the road curves. (*Id.*)

9. Dependent Claims 7, 18, 29

109. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 7, 18, and 29.

7[pre]: The system of claim 1, wherein the increase of light in the direction of the road curvature includes at least one of expansion of the light pattern in the direction of the road curvature or an increase to intensity of light directed in the direction of the road curvature; and

18[pre]: The storage medium of claim 12, wherein the increase of light in the direction of the road curvature includes at least one of expansion of the light pattern in the direction of the road curvature or an increase to intensity of light directed in the direction of the road curvature; and

29[pre]: The method of claim 23, wherein the increase of light in the direction associated with the shape change includes at least one of expansion of the light pattern in the direction associated with the shape change or an increase to intensity of light directed in the direction associated with the shape change; and

110. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 7[pre], 18[pre], and 29[pre]. As I discussed above, Alden discloses that the increase of light in the direction of the road curvature (or shape change) includes expansion of the light pattern in that direction and increasing intensity of

light directed in the direction of the curve (or shape change), as Alden controls LEDs to “direct light” into the curve to “maximize the driver’s ability to see there.” (Alden, [0036], Fig. 11; see also [0037]-[0040], Figs. 12-15.) *See supra* ¶¶71-77 (Claims 1[D]-1[E]). For example, the Alden system increases intensity of light directed toward the curve by “concentrating” and “directing” light from a plurality of the LEDs in that direction. That is, Alden can both increase the intensity of light emitted by LEDs directing light into the sectors of the headlight distribution area containing the curve, and control the LEDs so that more LEDs direct light into that area.

7[A]/18[A]: wherein the determination of the light change includes determination of light changes to individual LEDs of the first plurality of LED light sources, at least one of the changes including at least one of:

29[A]: wherein the determining the light output includes determining output for individual LEDs of the first plurality of LED light sources,

111. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 7[A], 18[A], and 29[A]. As I have discussed above, Alden discloses that the LEDs are “individually controllable” and direct light to specific sectors of the headlight distribution area, and that the light output for each individual LED in the array is determined to produce the overall headlight pattern. *See supra* ¶¶71-77 (Claims 1[D]-1[E]); *see also supra* ¶¶56-58, 95-97 (Claims 1[A], 4/15/26).

7[B]/18[B]: *a variation to at least one of intensity or color of individual LEDs of the first plurality of LED light sources, or providing light directed in the direction of the road curvature from an LED not providing light directed in the direction of the road curvature prior to the change.*

29[B]: *the output including providing light directed in the direction associated with the shape change from an LED not providing light directed in the direction associated with the shape change prior to the change.*

112. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 7[B], 18[B], and 29[B]. These claim elements generally recite that the light provided in the direction of a road curve comes from an LED that was not previously providing light in that direction. This can be seen in Figure 11 of Alden, where the light from the LEDs would be focused more directly ahead of the vehicle prior to the curve, before it is then “directed into the curve” (as indicated by the slanting of the light beams to the left in the figure) when the curve is detected. (Alden, Fig. 11, [0036].) Further, as I have discussed above, Alden in view of Kobayashi discloses a controller implementing an iterative process that allows for continuous “reshaping” of the light output, including selecting a second set of LEDs (with at least one LED different from a “first plurality” of LEDs providing light before a road curvature) to provide light in the direction of a subsequent road curvature. For example, as a vehicle travels along a road and goes from a left-hand curve in the road to a right-hand curve, the system would select a different, “second” set of LEDs to direct and concentrate light into the right-hand

curve that were not used to direct light into the left-hand curve. *See supra* ¶¶95-97 (Claims 4/15/26).

10. Dependent Claims 8, 19, 30

113. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 8, 19, and 30. These claim elements generally introduce the concept of the system, in addition to using map data to illuminate road curvature or shape changes, also detecting other vehicles and controlling the light output from LEDs directed towards such vehicles to reduce glare. Alden specifically discloses a system that performs both of these functions—its system detects other vehicles and controls LEDs to direct dimmed, low beam light into areas where those other vehicles are located, *and* it teaches sensing upcoming road curves and directing light into the curves to maximize the driver’s ability to see there. (Alden, [0036], [0061].) Thus, a POSITA would have understood that Alden’s system could use a map to control lights based on upcoming road curves as taught by Kobayashi, while continuing to sense other vehicles and control the lights to reduce glare to those vehicles as taught by Alden and further discussed below.

8[pre]: *The system of claim 1, further comprising one or more cameras positioned to capture data indicating at least one other vehicle ahead of the*

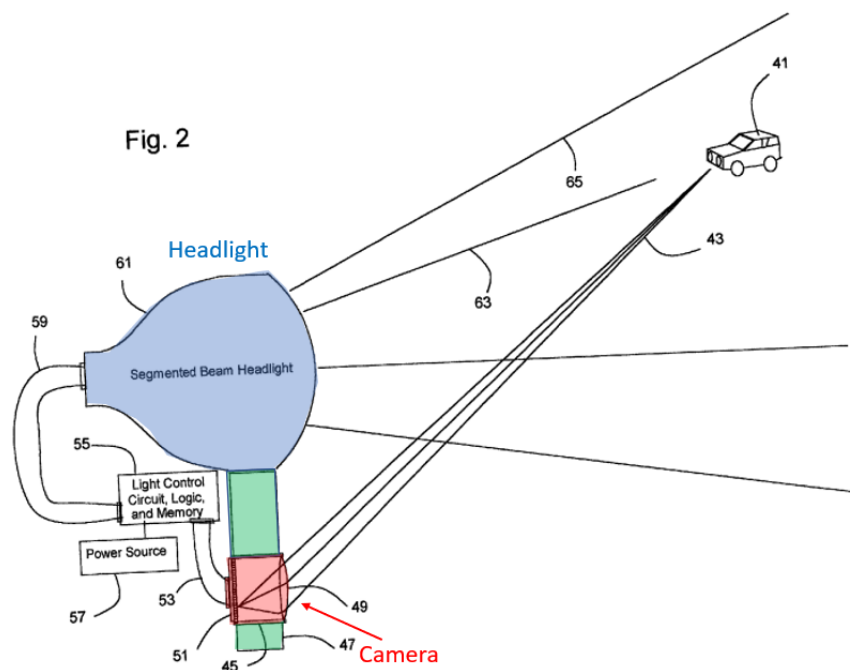
motor vehicle; wherein the instructions include instructions that, when executed by the one or more processors, enable the one or more processors to:

19[pre]: *The storage medium of claim 12, wherein the instructions include instructions that, when executed by the one or more processors, enable the one or more processors to:*

30[Pre]: *The method of claim 23, further comprising:*

114. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 8[pre], 19[pre], and 30[pre] to the extent limiting. *See supra* ¶¶55, 79, 84 (Claims 1[Pre]/12[Pre]/23[Pre]). The only new element here is in Claim 8[Pre]: “one or more cameras positioned to capture data indicating at least one other vehicle ahead of the motor vehicle.” Alden discloses this.

115. Alden discloses one or more “sensors” including “cameras” that are positioned on the motor vehicle equipped with its system to capture image data indicating at least one other vehicle ahead of the motor vehicle. (Alden, [0026]-[0028], Figs. 2-3.) Each headlight includes a “sensor unit 45” (“camera”) mounted on the “vehicle 47” that can detect the presence of other vehicles such as “oncoming vehicles” within the headlight distribution area:



(Alden, [0025]-[0026], Fig. 2 (annotated), Fig. 3.) Alden discloses that each “sensor unit 45” can include a primary *lens 49* and a *detector array 51*, and that the detector array can be a photodiode array or CCD (*i.e.*, camera sensors) that detects photon intensity (*i.e.*, light) and “convert[s] photons to electrons.” (*Id.*) The converted electrons “corresponding to the position and intensity of light” are sent “into a light control circuit 55 including logic and memory 55. 55 is further described in FIG. 3.” (*Id.*, [0026]-[0027].) (Alden, Fig. 2 (annotated), [0026]-[0027], Fig. 3.)

116. Alden further discloses that its system includes a “left sensor 51a and a right sensor 51b” that detect light from headlights of another vehicle at multiple positions 43a-d:

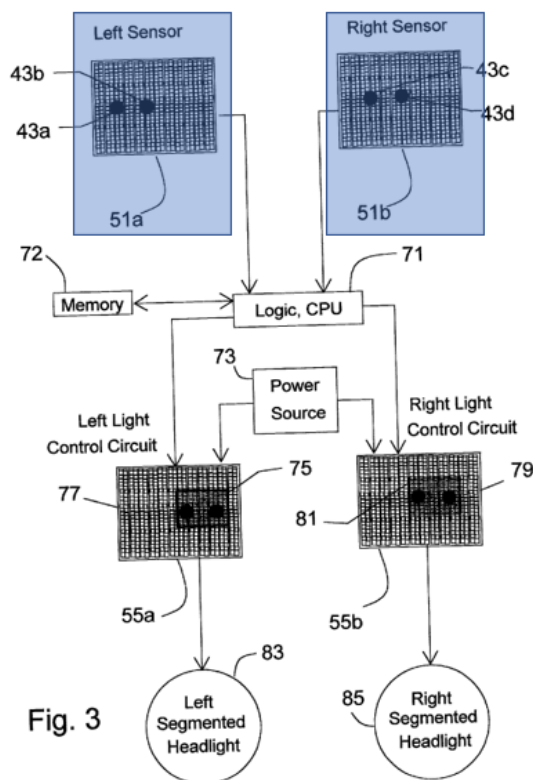
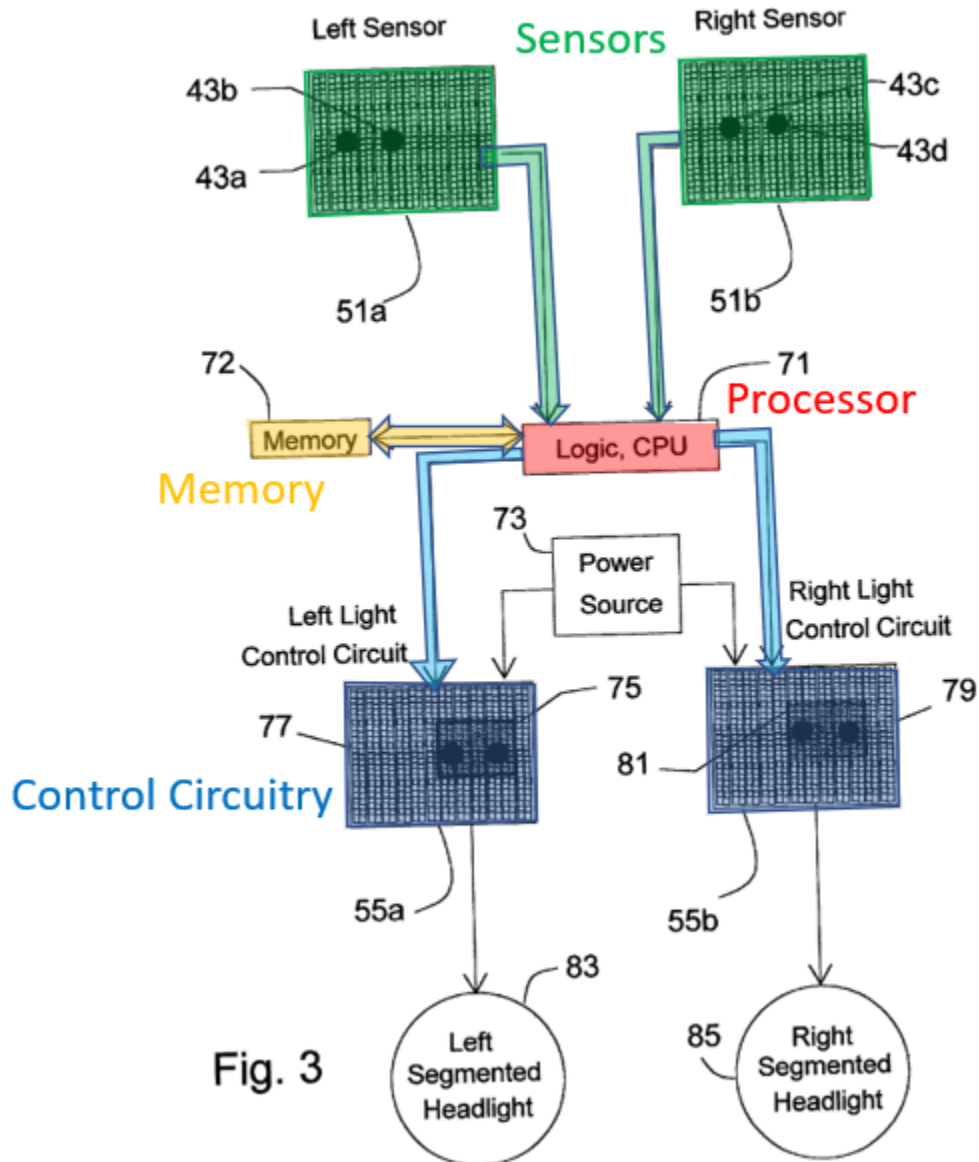


Fig. 3

(*Id.*, Fig. 3 (annotated), [0027]-[0028]; *see also* [0026], Fig. 2 (depicting sensor unit 45 with detector array 51).) Alden discloses that the sensor data includes detection of “illuminated spot[s]” “fall[ing] upon a photon detector array which otherwise doesn’t receive significant light.” (*Id.*, [0027]; *see also* [0026], Fig. 2.) The logic of Alden’s system interprets this data as headlights of an oncoming vehicle ahead of the motor vehicle, and Alden’s CPU selects portions of the segmented headlight system to dim based on this data. (*Id.*, [0026]-[0028]; *see also* Figs. 2-4.)

8[A]/19[A]/30[A]: *[determine / determining] a position associated with at least one other vehicle based at least in part on second data [indicating the at least one other vehicle and] captured by the at least one of the one or more cameras; and*

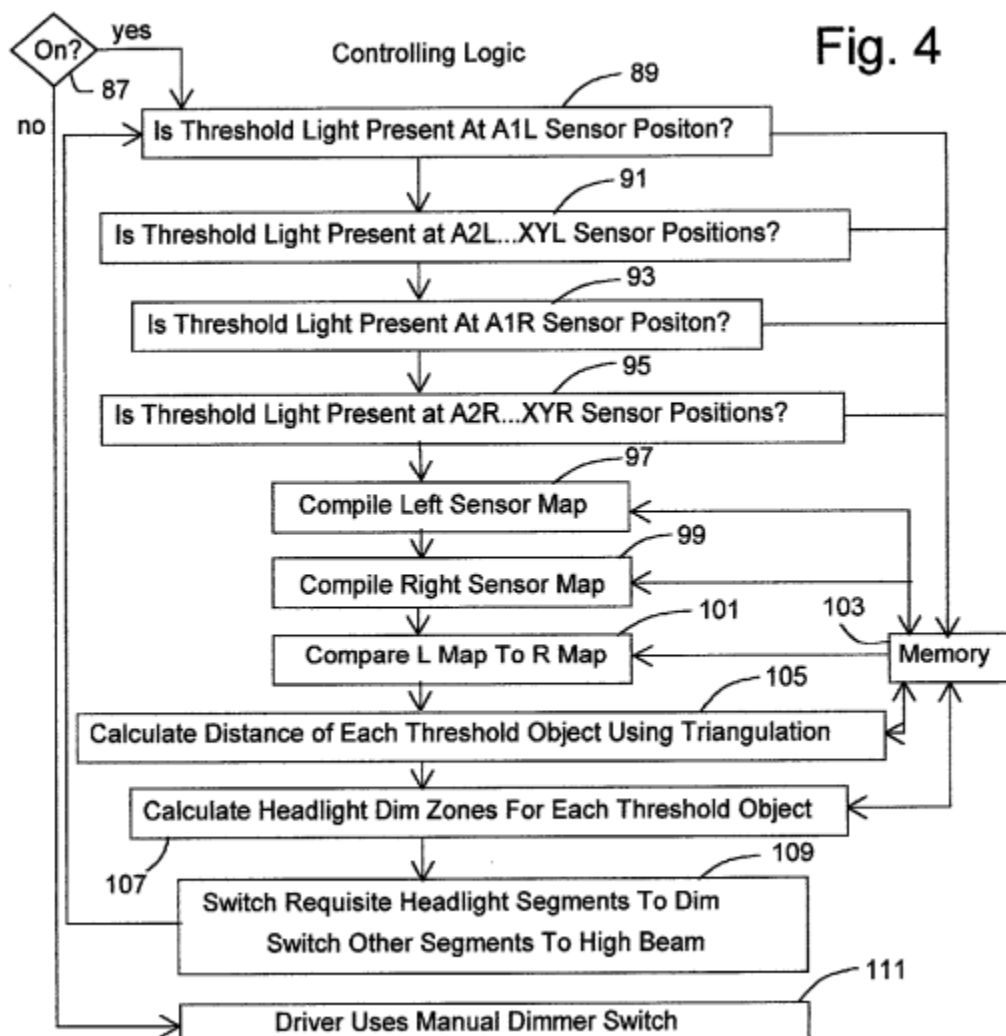
117. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 8[A]/19[A]/30[A]. Claims 8[A]/19[A]/30[A] recite that the processor or method determines a position associated with the other vehicle based at least in part on data captured by one or more cameras and/or data that indicates another vehicle. As discussed above, Alden discloses one or more cameras positioned to capture image data (“second data”) indicating at least one other vehicle ahead of the motor vehicle. *See supra* ¶¶114-116 (Claim 8[Pre]). Additionally, Alden discloses that its logic CPU 71 (“processor”) receives data from the camera sensors:



(Alden, Fig. 3 (annotated), [0027]; *see also* [0026].) As shown in Figure 3, camera sensors 51a-51b are connected to CPU 71, which receives information from the camera sensors regarding sensed light. (*Id.*, [0027].) In particular, each sensor “detects the two headlights of 41 [other vehicle]” at first and second illuminated spots, and “[e]lectrons corresponding to the position and intensity of light are categorized by a logic and CPU 71 and stored in a memory 72” as a “map of sensed

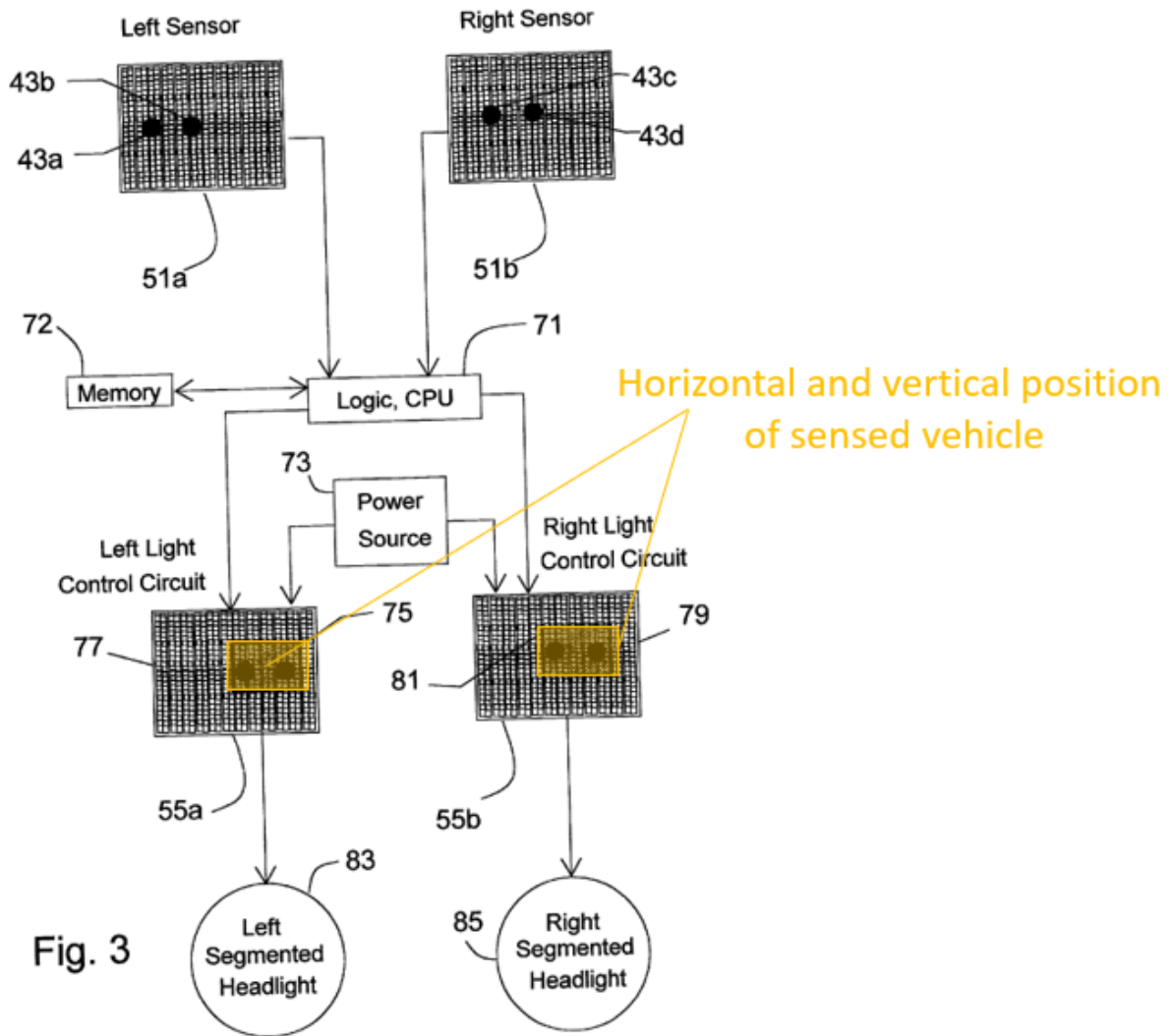
light.” (*Id.*) This map of sensed light containing the “spots” of the detected headlights relates to the position of those headlights, and thus is indicative of the other vehicle.

118. Alden discloses that the processor (CPU 71) is configured to determine a position of the other vehicle based on the captured camera sensor data:



(*Id.*, Fig. 4; *see also* Fig. 3, [0026]-[0028].) As shown, the logic process used by the CPU to determine the position of an object, such as an oncoming vehicle 41 (“other vehicle”) includes: processing sensor data (steps 89, 91, 93, 95); compiling sensor maps (steps 97, 99) which include vertical and horizontal positions of sensed light from an oncoming vehicle; determining the **“distance and intensity of each object sensed in a calculating process 101”**; and **calculating distances to objects using a “triangulation process 105.”** (*Id.*, Fig. 4, [0028]; *see also* Fig. 3, [0026]-[0027].)

119. The distance data is then used to “determine the intensity of light that will be produced by the 61 [headlight] in the corresponding headlight sectors,” as shown in step 107, and signals are then sent to the control circuits to switch some zones to dim and others to high beam, as shown in step 109. (*Id.*, Fig. 4, [0027]-[0028]; *see also* Fig. 3, [0026]-[0027].) Alden indicates that this process controls the light emitting elements (such as the LEDs of Figure 5) so that “the light sent to **the sensed vehicle location** is dimmer than the light sent to all other areas of the headlight distribution area.” (*Id.*, [0028].) Alden discloses that this reduces glare: “the driver of 41 [*i.e.*, the oncoming vehicle] has minimum glare while the driver of 47 [*i.e.*, the vehicle implementing the Alden system] has maximum light.” (*Id.*, [0026]-[0028]; *see also* Abstract, [0005], [0029].)



(*Id.*, Figure 3 (annotated).)

120. Thus, Alden determines illumination for “at least two-subsections”—that is, zones where an oncoming vehicle is present that need to be dimmed (first subsection) and zones where there is no other vehicle that should be high beam (second subsection). (*Id.*)

121. Alden further explains that this is a real-time process that is continuously repeated. (*Id.*, [0028] (stating that the “process then begins again so

as to be responsive to changing environmental conditions *in real time.*”).) Thus, if environmental conditions, including the location of other vehicles, change, the determined light distribution pattern will also change. For example, Alden explains that if threshold light is detected at certain sensor positions such that another object, such as another oncoming vehicle, is present, a determination is made that the intensity of light for the headlight sectors corresponding to those sensor positions should be switched to a different, dim, or low beam light. (*Id.*, Fig. 4, [0027]-[0028]; *see also* Fig. 3.) If, when the process is repeated, the position of the other vehicle changes so threshold light is no longer detected at those same sensor positions, then the system makes a determination to switch the corresponding sectors from low beam to high beam. (*Id.*) In sum, as part of the real-time process, Alden is continuously determining positions of objects such as other vehicles, and whether the light for each sector should be adjusted based on the positions of any other vehicles.

122. Alden further describes, in reference to steps 107 and 109, that “[t]he location of objects is used to calculate which zones of each headlight need to be dimmed in a calculate headlight dim zones process 107. Signals are sent to each of the headlight control circuit zones that need to be dimmed to restrict the amount of current to the corresponding headlight zones such that they are dimmed in a dimming process 109. Zones which are not dimmed remain on high beam. Thus

the light sent to the sensed vehicle location is dimmer than the light sent to all other areas of the headlight distribution area.” (*Id.*, [0028], Fig. 4; *see also* [0026]-[0027], [0029], Fig. 5.)

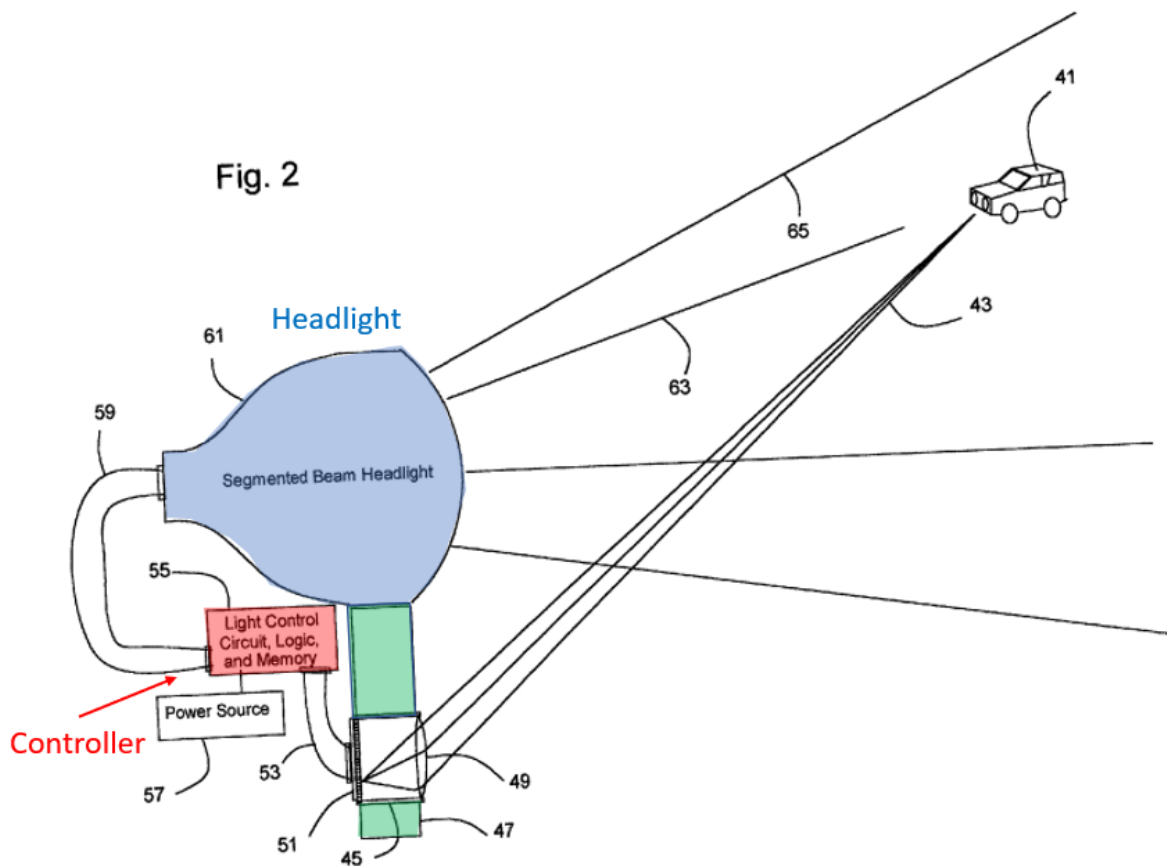
123. Alden further discloses that this feature may be used in combination with its disclosures regarding detecting a road curvature, stating “[o]ne or more methods employed herein may be used in combination to vary illumination in a segmented system.” (Alden, [0061].) Thus, Alden’s system discloses determining a position associated with at least one other vehicle.

8[B]/19[B]/30[B]: [1] [control / controlling], based at least in part on the position, a second plurality of LED light sources providing light directed towards an area including at least a portion of the other vehicle to diminish glare to a driver of the other vehicle by a decrease to intensity of light directed towards and illuminating the area, [2] the light [that is] directed towards and illuminating the area having lower intensity compared to light directed towards points laterally adjacent the area to either side.

124. As viewed by a POSITA, Alden in view of Kobayashi renders obvious Claims 8[B], 19[B], and 30[B].

125. First, Alden discloses controlling its segmented headlights to provide light to an area where a sensed other vehicle is located. *See supra* ¶¶117-123 (Claims 8[A]/19[A]/30[A]). As I discussed above, Alden’s system has a processor that determines the position of objects in the headlight distribution area, like oncoming vehicles, and can illuminate those objects with light, such as low beam light to “reduce glare.” *Id.* In Alden, this illumination is done by controlling certain

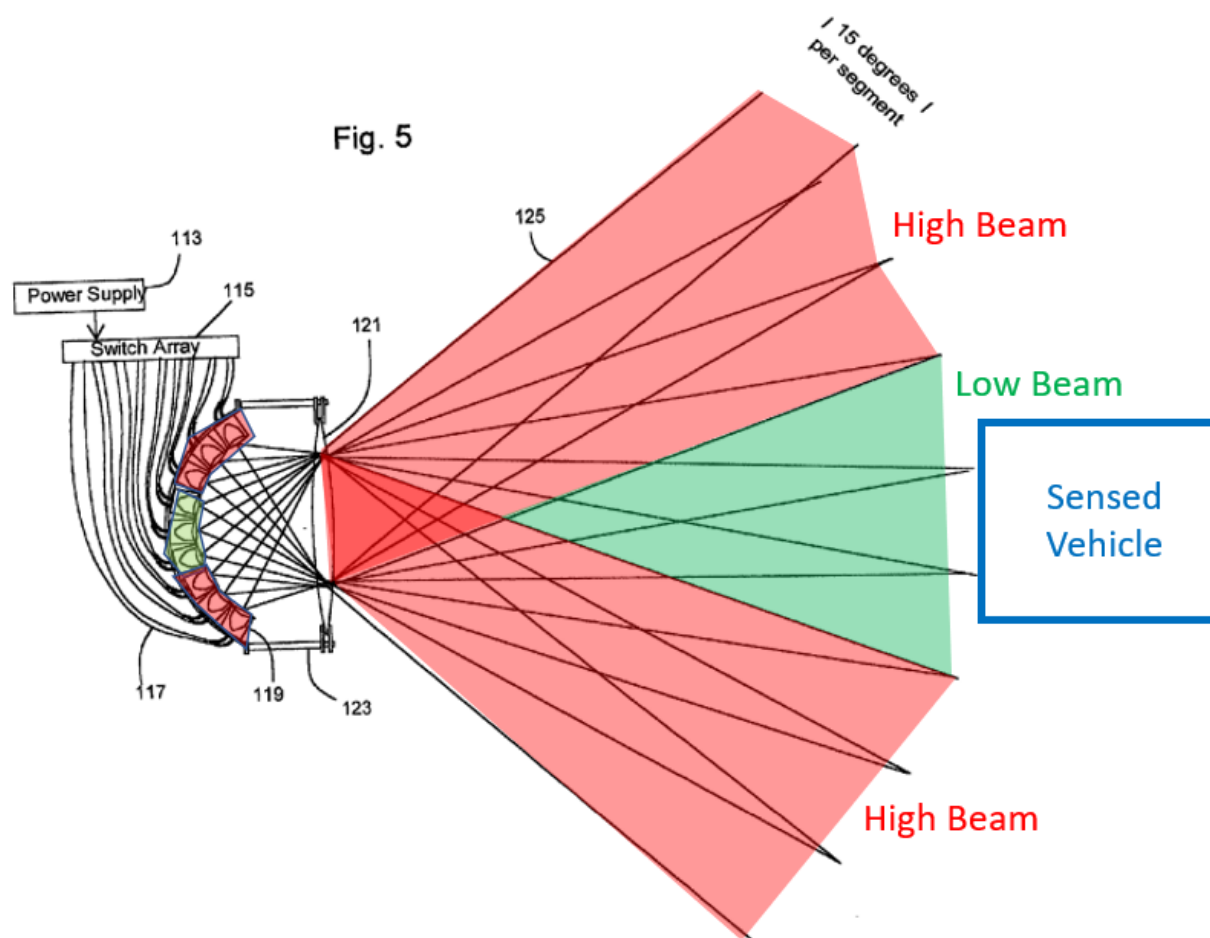
LEDs (“second plurality of LEDs”) that emit light in the areas where the other vehicle is located. As discussed, CPU 71 “processes” the sensor data to determine which LEDs direct light to the area of an oncoming vehicle and causes those LEDs (“second plurality”) to emit a decreased intensity, low beam in the area (63) of the detected vehicle (41), while other LED groups, such as those directed light to areas (65) where no other vehicle is present, are switched to high beam light:



(Alden, Fig. 2 (annotated), [0026], [0027] (noting that “the driver of 41 [other vehicle] has minimum glare while the driver of 47 has maximum light.”).) *See also supra* ¶¶117-123 (Claims 8[A]/19[A]/30[A]). Alden specifies that the selection of

the “second plurality” of LEDs to illuminate the area where the other vehicle is positioned is based on the known directionality associated with those LEDs. In particular, Alden’s lighting elements 119 are “on a curve along the focal point of a headlight lens 121 such that *the light* from each lighting element *goes into a specified portion (or portions)* of the headlight distribution area” ahead of the vehicle. (Alden, [0029], Fig. 5.) Thus, each lighting element is directed to a “specified” area, and when Alden illuminates an area (such as one with an oncoming vehicle) with low beam light, it will select and adjust those LEDs that are directing light into that corresponding area where the vehicle is. *See also supra* ¶¶56-58 (Claim 1[A]).

126. Second, where the position of an oncoming vehicle is detected, for example in a middle area or sector, that area will be dimmed while the light directed to points in the area or sectors laterally adjacent on either side will be switched to high beam intensity (the annotated figure below, and other similar annotated figures herein, should be considered only as high-level representations to illustrate the different low beam and high beam light that characterizes the different sectors):



(*Id.*, Fig. 5 (annotated), [0026]-[0029].) Again, Alden discloses that this reduces glare for oncoming vehicles: “the driver of 41 [*i.e.*, the oncoming vehicle] has minimum glare while the driver of 47 [*i.e.*, the vehicle implementing the Alden system] has maximum light.” (Alden, [0027]; *see also* Abstract, [0005].) That is, based on the sensor data, an adaptive headlight beam is generated that is dimmer, or lower in intensity, in an area where another vehicle is sensed as compared to other areas laterally adjacent to the sensed vehicle that are switched to high beam.

11. Dependent Claims 10-11, 21-22, 32-33

10: *The system of claim 1, further including one or more optical control elements for controlling light from one or more of the LED light sources.*

11: *The system of claim 10, wherein the optical control elements include at least one of one or more reflectors, refractors or lenses.*

21: *The storage medium of claim 19, wherein the instructions include instructions that, when executed by the one or more processors, enable the one or more processors to utilize one or more optical control elements included in the motor vehicle to control light from at least the first plurality or second plurality of the LED light sources.*

22: *The storage medium of claim 21, wherein the optical control elements include at least one of one or more reflectors, refractors or lenses.*

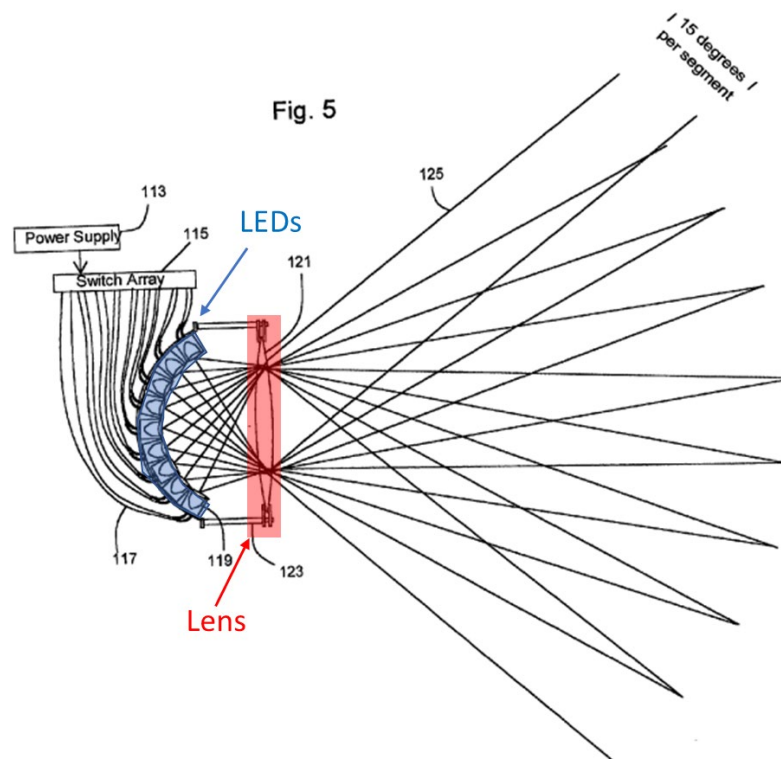
32: *The method of claim 30, further comprising utilizing one or more optical control elements included in the motor vehicle to control light from at least the first plurality or second plurality of the LED light sources.*

33: *The method of claim 32, wherein the optical control elements include at least one of one or more reflectors, refractors or lenses.*

127. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 10-11, 21-22, and 32-33. Claims 10, 21, and 32 are substantially similar: each adds “one or more optical control elements” to control light emitted from the LEDs (or groups of LEDs). (*Id.*) Claims 11, 22, and 23 are all identical and add that these optical control elements can include one or more “reflectors, refractors or lenses.”

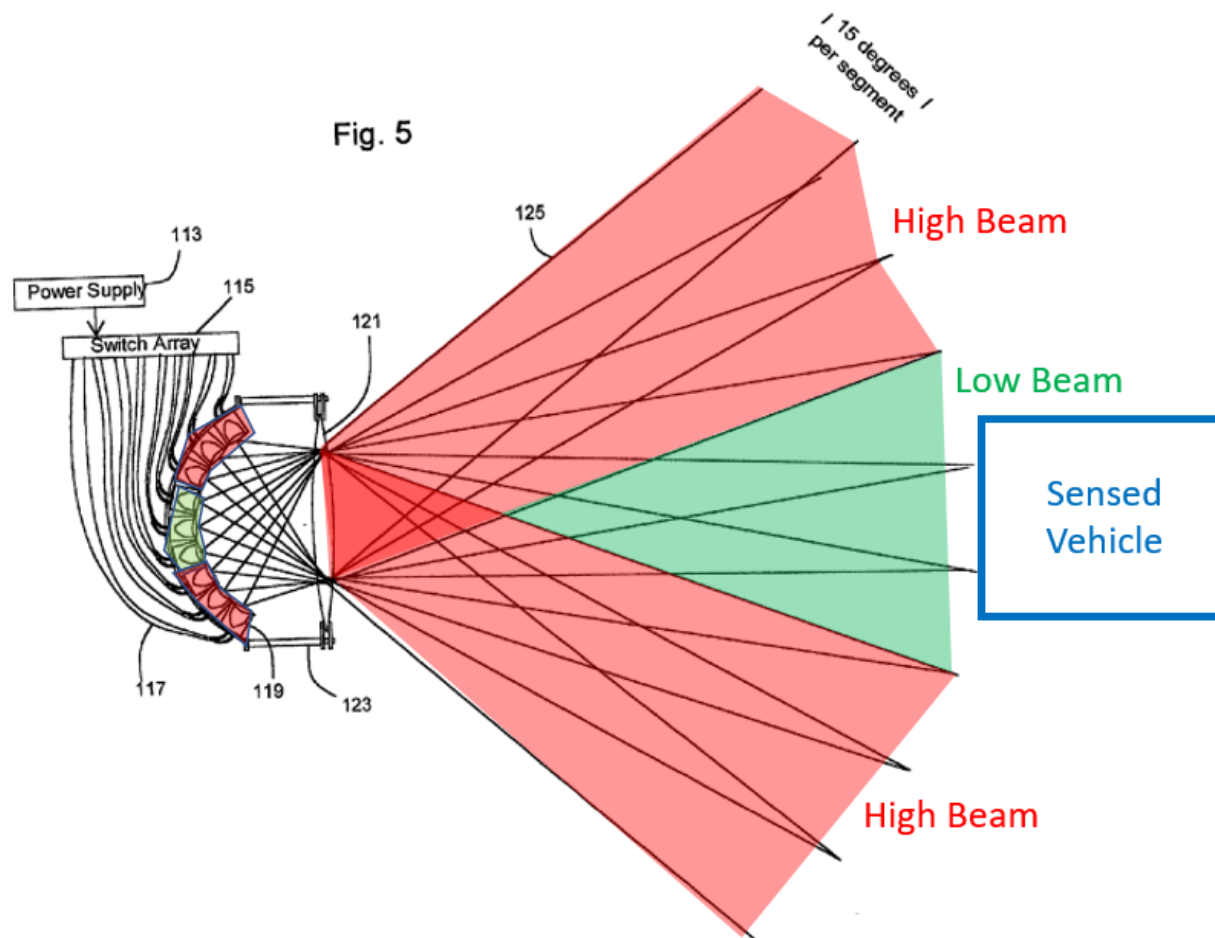
128. As shown in Figure 5 of Alden (below), each headlamp comprises an array of lighting elements, *e.g.*, LEDs. (Alden, [0029], Fig. 5.) Alden further

discloses that these lighting elements “are on a curve along the focal point of *a headlight lens 121* such that the light from each lighting element goes into a specified portion (or portions) of the headlight distribution area.” (*Id.*, [0029].) Thus, Alden discloses that the illuminating device, its vehicle headlight system, further includes an “optical control element” to control light emitted from one or more of the LEDs, such as the headlight “lens 121.”



(*Id.*, Fig. 5 (annotated).) When the processor controls the LEDs to emit light, it utilizes the lens element 121 to direct the light into the desired sectors or segments of the headlight distribution area based on their position on the curve relative to the focal point of the lens. (*Id.*, [0029].) For example, if a cluster of LEDs in the area

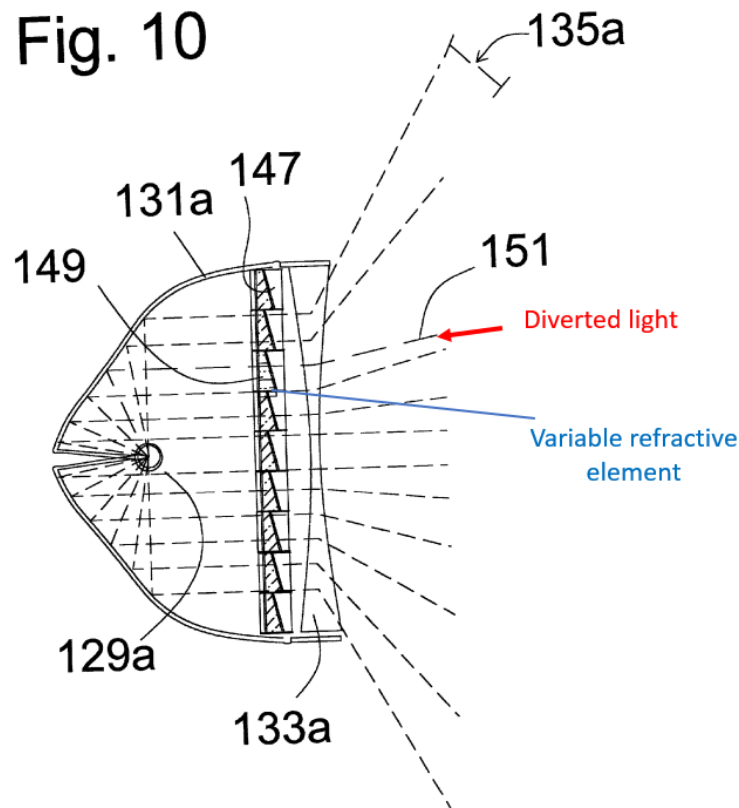
of an oncoming vehicle are to be dimmed to “reduce glare,” light from those LEDs will be directed by the “optical control element” / “lens 121” when passing through:



(Alden, Fig. 5 (annotated), [0026]-[0029].)

129. In addition, Alden’s system can include other “optical control elements,” including a “variable refractive element” in the form of a liquid crystal. (*Id.*, [0033]-[0035], [0061], Figs. 8-10.) This refractor “enables light from an individual headlight distribution sector to be redirected in response to sensed

environmental conditions when used in conjunction with the elements and processes previously discussed herein.” (*Id.*)



(*Id.*, Fig. 10 (annotated).)

130. The liquid crystal has a first refractive state when a circuit is open, such that light passes straight through, without bending. (*Id.*, Fig. 8, [0033].) The liquid crystal then has a second refractive state when the circuit is closed, causing the “light to bend due to refraction after passing through.” (*Id.*, Fig. 9, [0033].) Thus, by selectively closing the circuit, light for a particular distribution sector can be “bent” to redirect the light to a different area.

131. Alden discloses that its use of refractive elements to “bend” light can be included in its headlight system, such as that of Figure 5, and a POSITA would have readily understood how to implement the variable refractive elements in the system. In fact, Alden expressly discloses that “[o]ne or more methods employed herein *may be used in combination* to vary illumination *in a segmented system*.” (Alden, [0061].) Thus, this would be the use of a known optical element (a liquid crystal) in a system having different light distribution sectors that Alden describes the liquid crystal as acting upon. Moreover, a POSITA would have a reasonable expectation of success, as the liquid crystal elements would perform their same function of allowing light to pass straight through when a circuit is open and bending light when the circuit is closed. And a POSITA would have been motivated—as Alden expressly provides above in [0061]—to add this refraction element to its headlight system, such as to the system depicted in Figure 5, so as to provide multiple means of modifying the direction or intensity of individual lighting sectors, including bending the light output in certain desired portions, allowing more variable control of lighting of various subsections of a headlight beam.

132. For example, as disclosed in Alden, the inclusion of variable refraction elements in the path of different beam segments allows for greater control of the light, including allowing a user to “divert” light from one section to become low beam light in areas where a vehicle is sensed. (Alden, [0035].) In addition, a POSITA

would have understood that including the refraction elements would allow for more controlled bending or directing of certain light segments into road curves, as shown in Figure 11. (*Id.*, Fig. 11, *see also* Figs. 14-15, [0039]-[0040].)

B. Ground 2: Alden In View of Kobayashi, or, Alternatively, Alden/Kobayashi in view of Beam, Renders Claims 9, 20, and 31 Obvious

133. As viewed by a POSITA, Alden, alone or in combination with U.S. Patent No. 6,144,158 (“**Beam**”) (Ex. 1007),² in view of Kobayashi renders obvious claims 9, 20, and 31.

9[A]/20[A]/31[A]: The [system / storage medium / method] of claim [8 / 19 / 30], wherein: the first plurality and second plurality of LED light sources include at least one common LED light source;

134. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 9[A]/20[A]/31[A]. As I discussed above, Alden discloses a plurality of individually-controllable LEDs along a curve in a headlamp that can be used to illuminate different areas, including areas where there are detected vehicles and road curvature. *See supra* ¶¶73-77, 82, 87, 124-126 (Claims 1[E]/12[C]/23[C], 8[B]/19[B]/30[B]). (*See also* Alden, [0061] (teaching that features can be “used in combination to vary illumination in a segmented system).) Thus, as a POSITA would

² Beam was issued November 7, 2000. I understand that it is prior art under at least § 102(b).

have understood, the “first plurality” and “second plurality” include “common LED light sources.”³ That is, each LED can be used both to illuminate the light of a curve, such as with a high beam (“first plurality”), and to project dimmed, low beam light when there is an oncoming vehicle (“second plurality”) depending on “environmental conditions.”

135. Further, Alden discloses that its sensing, determination, and adjustment of projected light is a continuous, real-time process. *See supra* ¶¶95-97 (Claim 4). Thus, with the system of Alden, if a vehicle approaches a curve on the left, those LEDs illuminating the curve will project high beam. If, however, the equipped vehicle then encounters an oncoming vehicle, the system of Alden will switch those same LEDs that overlap with the area of the oncoming vehicle along the curve (“common LED light sources”) to dimmed, low beam light.

136. Alden’s system not only controls the LEDs to direct light into upcoming curves, but also senses lights indicating oncoming vehicles and selectively controls the LEDs to reduce those directing light in the area of the oncoming vehicle to dim, low beam light so as to avoid glare for the other driver. In a situation where Alden’s vehicle is approaching or traveling along a curve, such that the LEDs are controlled

³ I note that the term “common LED light source” is only found in the claims of the ’029 Patent.

to direct light into the curve, and an oncoming vehicle is approaching along the same curve, Alden's system can control the LEDs to both illuminate the curve and reduce light directed at the other driver. For example, as explained in Alden, LEDs in the "second plurality of LEDs" directing light at the oncoming vehicle can be dimmed to reduce glare for the other driver, while also be controlled so that they at least direct some light into the curve to illuminate it so the driver can safely navigate around the curve.

137. Thus, Alden's system discloses, while proceeding along a road curvature, illuminating certain sections along the road curve (e.g., containing oncoming cars) at lower intensity while illuminating others at higher intensity.

9[B]/20[B]/31[B]: the control of the second plurality of LED light source[s] is based at least in part on third data received from a non-camera sensor of the motor vehicle;

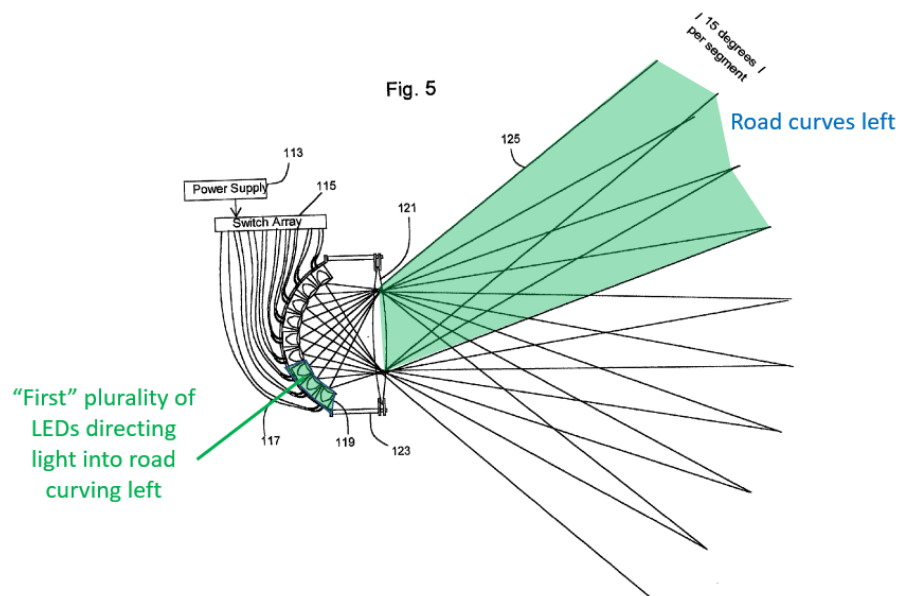
138. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 9[B]/20[B]/31[B]. Claims 9[B]/20[B]/31[B] require that controlling the second plurality of LEDs (i.e., those directing reduced intensity light towards another vehicle) is based at least in part on third data from a sensor other than the camera sensors. Alden discloses several methods of controlling its segmented headlights, including reducing intensity in areas where other vehicles are detected (Alden, [0025]-[0035], Figs. 1-10); concentrating "light to look around corners" by directing "light into the corner" (*id.*, [0036], Fig. 11); concentrating light to look up

or down hills (*id.*, [0027]-[0038], Figs. 12-13); and calculating a new direction of light based on a steering wheel sensor (*id.*, [0029]-[0040], Figs. 14-15.) Alden further discloses that [o]ne or more” of these “methods employed herein may be used in combination to vary illumination in a segmented system.” (*Id.*, [0061] Thus, in controlling the LEDs that direct low beam, dim light in the area of another vehicle (“second plurality” of LEDs), Alden indicates that the control could also be based on other data, such as steering wheel angle (a non-camera sensor), to control the illumination from those LEDs as implemented in the segmented headlight system. (*Id.*)

139. When doing so, Alden would control the “second plurality of LED light sources” to shine along a curve in the road when a driver turns in a direction indicating the presence of a curve in the road. At the same time, the camera sensor would be sensing and detecting any oncoming vehicles’ headlights in the light path of the “second plurality of LED light sources,” so that the light projected toward any oncoming vehicle could be dimmed. A POSITA would understand that Alden could perform these functions in conjunction both because an oncoming vehicle’s headlights may not be visible at the start of a curve, and the driver’s own headlight light path would change in response to detecting the curve.

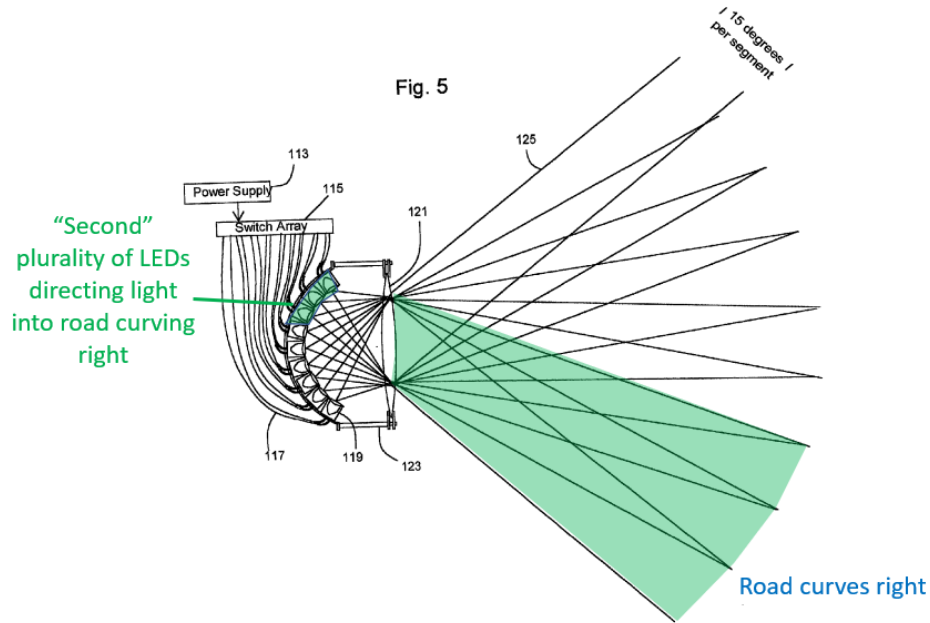
140. A POSITA would also recognize that the risk of causing headlight glare in oncoming traffic when turning into a curve will partly depend on the

direction of curvature. For roads curving to the left, cars driving on right-hand lanes run the risk of shining their headlights into oncoming traffic when Alden's LEDs direct light into the curve:



(Alden, Fig. 5 (annotated), [0029]; *see also* [0027]-[0028], [0033]-[0040].)

Conversely, for roads curving to the right, cars driving on right-hand lanes face little risk of shining headlights into oncoming traffic when Alden's LEDs direct light into the curve, because doing so directs the headlights away from the opposing lane:



(Alden, Fig. 5 (annotated), [0029]; *see also* [0027]-[0028], [0033]-[0040].)

141. To state it another way, a POSITA would have understood that the “control” of the “second plurality” of LEDs can be based on data from other non-camera sensors, such as the steering wheel sensor, while the camera sensors detect other vehicles by sensing oncoming headlights. For example, when a vehicle equipped with the system of Alden is traveling on a straight road and there is an oncoming vehicle, light emitted from the “second plurality” of LEDs in the area of the oncoming vehicle is dimmed to low beam light. However, if the steering wheel sensor detects that the wheel is turned “x degrees,” indicating that the driver will be driving the vehicle into a turn or curve (*see* Alden, Figs. 14-15, [0057]-[0058]), then the “second plurality” of LEDs would be further controlled to “change[] the direction of the headlight output a corresponding $f(x)$ degrees.” (*Id.*)

142. In addition, Alden in view of Kobayashi discloses Claims 9[B]/20[B]/31[B]. As I explained above, Kobayashi indicates that its “road profile calculating means” can be included as part of a **GPS sensor** (“non-camera sensor”) that outputs “map information.” (*Id.*, Fig. 12, 17:3-61, 2:28-50.) It would have been obvious to a POSITA to apply the teachings of Kobayashi and incorporate the GPS sensor with its map data into Alden’s system for the reasons discussed above. *See supra* ¶¶64-72 (Claims 1[C]-1[D]). Again, Alden already contemplates the use of multiple sensors, and the inclusion and use of the GPS sensor and map data would simply add a known element in a similar system. Further, Alden would continue to perform the same control of its LEDs based on changing “environmental conditions,” only now it would be able to consider GPS sensor and associated map data as well. Similar to the steering wheel sensor, data from this sensor could be used to cause CPU 71 to further control the “second plurality” of LEDs, adjusting their direction in view of the map data indicating an upcoming road curve. *See supra* ¶¶64-72 (Claims 1[C]-1[D]).

143. Further, a POSITA would have understood that the driver would give priority first in detecting the curve through the use of reflectors and similar means, and then as they progressed through the curve would look for oncoming vehicles with the objective of controlling the lights of the equipped vehicle and reduce glare for the other drivers. As they would complete the curve, they would correct the

steering again in order to align the vehicle with the new curvature of the road. It should be noted that when the driver would detect an upcoming curve, they would slow down and place the vehicle in a position to safely go through the curve. In sum, a POSITA would have understood that the controlled lighting system (in a way similar to the driver) would have used the reflectors first along with steering sensory information and then would look for the headlights of other vehicles with the objective of reducing glare.

9[C]/20[C]/31[C]: *the position includes at least one of: a distance associated with the at least one other vehicle, at least one elevation associated with the at least one other vehicle, or a position within image data captured by at least one of the cameras;*

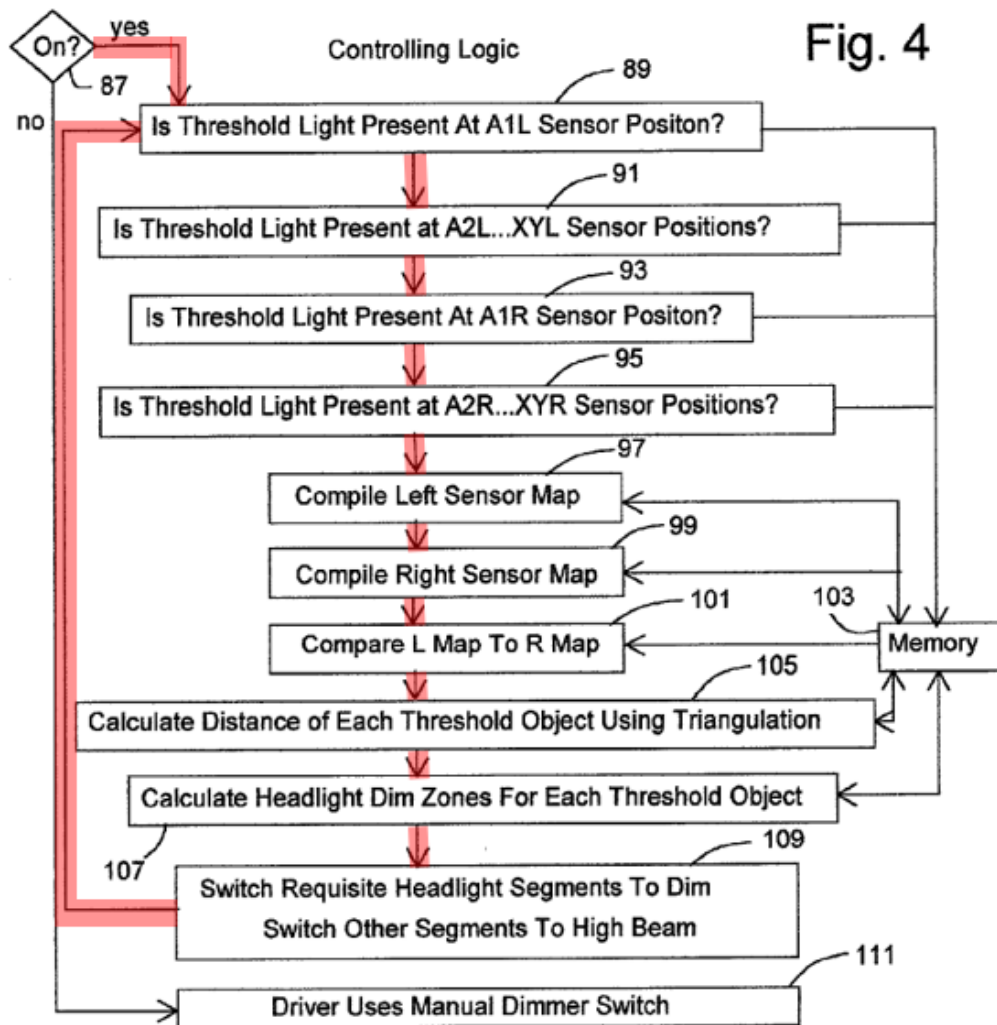
144. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 9[C]/20[C]/31[C]. Claims 9[C]/20[C]/31[C] require that the determined “position” of the detected other vehicle includes at least one of a distance of the other vehicle, an elevation of the other vehicle, or a position with image data captured by the camera sensors. As discussed above, Alden discloses that the position of the other vehicle includes at least a location and distance of the other vehicle as determined by the “triangulation process,” and a position of the two “dots” representing the headlights of the other vehicle within the image data captured by the camera sensors. *See supra* ¶¶113-126 (Claims 8/19/30).

9[D]/20[D]/31[D]: *the first data includes data from a non-camera sensor of the motor vehicle;*

145. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 9[D]/20[D]/31[D]. Alden in view of Kobayashi discloses receiving first data including map and GPS data (*i.e.*, data from a non-camera sensor). *See supra* ¶¶64-71 (Claim 1[C]).

9[E]/20[E]/31[E]: *either one of the control of the first plurality of LED light sources or control of the second plurality of LED light sources is subsequent to and accommodative of the other;*

146. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 9[E]/20[E]/31[E]. First, as I explained above the system of Alden can select LEDs to illuminate a road curve by selecting a first plurality of LEDs. *See supra* ¶¶73-77 (Claim 1[E]). Second, if another vehicle is subsequently detected, then a second plurality of LEDs, directing light to the sectors where the detected vehicle is located, can then be controlled to produce dim, low beam light in the direction of the other vehicle. *See supra* ¶¶124-126 (Claim 8[B]). Alden in view of Kobayashi discloses an iterative control system continuously collecting sensed data, calculating the position of an oncoming vehicle or road curvature based on that data, and determining which portions of the headlights need to be dimmed or illuminated based on the new calculation. Thus, the headlight system is responsive to changing environmental conditions in real time.



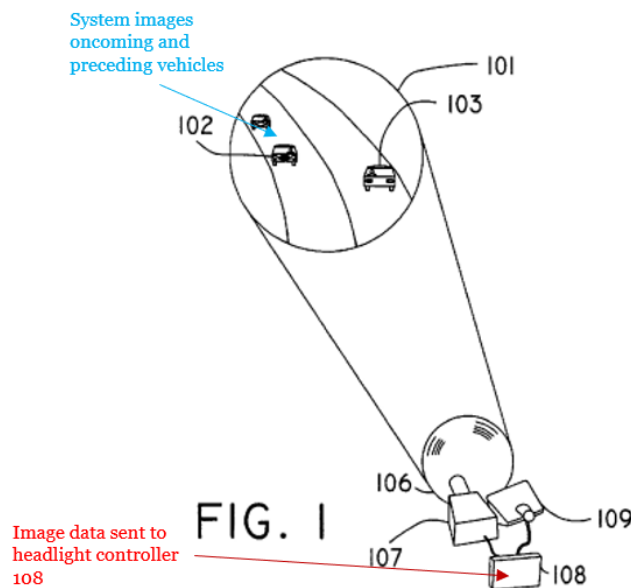
(*Id.*, Fig. 4 (annotated); *see also* Fig. 3, [0026]-[0028].) *See supra* ¶¶95-97 (Claims 4/15/26). This system would operate to allow the first plurality (illuminating a road curvature) and second plurality (reducing glare) light sources to be controlled iteratively, *i.e.*, subsequent to and accommodative of each other. *See id.*

9[F]/20[F]/31[F]: the control of the second plurality of LED light sources additionally includes termination of light from at least one LED providing light directed to the area prior to the termination; and

147. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 9[F]/20[F]/31[F]. As I discussed above, Alden discloses reducing the light emitted from the selected LEDs (i.e., the first cluster of LEDs) to “low beam,” and setting the light emitted from the non-selected LEDs (i.e., the second cluster of LEDs) on “high beam.” *See supra* ¶¶113-126 (Claims 8/19/30). As a result, the driver of the oncoming vehicle has minimum glare while the driver of the equipped vehicle has maximum light. (*Id.*) Alden discloses that the LEDs can be operated in a range of intensities, ([0061]), and a POSITA would understand that this could include operating at zero. A POSITA would understand this would be easily accomplished by, for example, providing no power from the power source to those LEDs (i.e., the first cluster of LEDs). (Alden, [0026]-[0029].) A POSITA would have understood that turning off LEDs that emit light directly at the driver of the other vehicle would effectively accomplish Alden’s purpose of reducing glare to other drivers. That is, if the light outputs of the “second plurality” that emit light directly at the driver of the oncoming vehicle are terminated, no glaring light could ideally reach the eyes of that driver.

148. In the alternative, Alden in view of Kobayashi, and further in view of Beam renders obvious Claims 9[F]/20[F]/31[F]. Like Alden, Beam discloses a

system controlling headlight output patterns in particular areas to eliminate “the blinding of a driver in an oncoming vehicle, while continuing to provide intense forward illumination.” (Beam, Abstract, 1:5-19.) Beam describes a vehicle headlamp system that uses a “sensor 107” to detect light from other vehicles. (Beam, 4:9-59, 5:3-16, Claims 1-6, Figs. 1-2, 4.) The sensor data is used by a controller 108 to adjust the output of a plurality of individually controlled light sources, or “microbeams,” making up the headlight beam in order to attenuate beams directed to detected vehicles. (*Id.*)



(*Id.*, Fig.1 (annotated).)

149. Beam recognizes that headlights can cause glare, or “dazzle,” that impacts not only drivers of oncoming vehicles, but also drivers of preceding vehicles “when reflected by a rear-view mirror.” (*Id.*, 4:9-25, 4:45-59, 6:61-7:8.)

Thus, Beam discloses that lights from both the headlights of oncoming vehicles and light from the taillights of preceding vehicles can be detected, and the output of the headlight is controlled to **darken** light directed to the areas of the sensed oncoming and preceding vehicles. (*Id.*, 4:9-25, 4:45-59, 5:61-6:8, 6:61-7:8.) Beam further discloses that the light can be darkened, as lighting elements can be “blanked (attenuated by being either absorbed or deflected to an absorbing surface.)” (*Id.*, 4:26-52, 5:33-54.) That is, those lighting elements can be switched to terminate light output, where the light is attenuated.

150. For example, Beam’s system “automatically sens[es] the presence and location of headlights and taillights ahead of the car on which it is mounted,” and then controls “the light output” of an overall headlight beam so that “the area of the beam that would dazzle the driver will be **darkened**, while maintaining full intensity elsewhere.” (*Id.*, 2:54-65.) Like Alden, Beam’s system “provid[es] 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.” (*Id.*, 3:11-15.)

151. It would have been obvious to a POSITA to modify Alden to change at least one of the selected LEDs to a terminated output state to dim headlight beam output directed to areas of the oncoming vehicles as taught by Beam. Both Alden and Beam are directed to controlling headlight beams so as to reduce glare for other

drivers by dimming the headlights in areas occupied by detected vehicles. And both accomplish this by detecting lights from other vehicles using a sensor, determining the locations of the other vehicles based on the detected lights, and controlling the output of an array of light sources so that beams directed to the other vehicles are dimmed. Thus, modifying Alden to dim headlight beams by changing at least one of the selected LEDs to a terminated output state would have merely required the continued use of Alden's existing system components for their intended purpose. A POSITA would have recognized that LEDs could be changed into a terminated output state in the same way the Alden system dims the LEDs—by using the left and right light control circuit 55a-55b to control the power supply to the selected LEDs such that no power or current is provided. (Alden, [0027]-[0029].) That is, modifying Alden to change certain LEDs to a terminated output state would require no additional equipment or changes in the processing steps. Moreover, a POSITA would have a reasonable expectation of success, as the system of Alden would continue to perform the same function, using the same components, and would produce the same result—namely, using the control circuits in concert with headlamps to increase illumination for a driver while reducing glare for the drivers of other vehicles nearby that driver. And a POSITA would have been motivated to change the selected LEDs to a terminated output state under certain circumstances

to minimize glare to the driver of oncoming vehicles, as taught by Beam, as this is exactly the same purpose of Alden (Alden, Abstract.)

9[G]/20[G]/31[G]: *the light pattern includes at least one of an illumination pattern or an emission pattern of the headlamps.*

152. As viewed by a POSITA, Alden in view of Kobayashi renders obvious claims 9[G]/20[G]/31[G]. Alden discloses a continuous process for providing an illumination pattern. (Alden, Fig. 4 [0025], [0027]-[0028].) The “light pattern” of claims 9[G]/20[G]/31[G] relates to detection and subsequent illumination of a road curvature. *See supra* ¶¶71-72, 81, 86 (Claims 1[D]/12[B]/23[B]). This light pattern includes an illumination pattern or emission pattern of the headlamps, which are comprised of the multiple LED light sources discussed herein. *See supra* ¶¶71- (Claims 1[D]-1[E]).

VI. CERTIFICATION

153. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and, further, that these statements were made with the knowledge that willful false statements and the like are punishable by fine, imprisonment, or both, under Section 1001 of Title 18 of the U.S. Code.



Dr. Nikolaos Papanikolopoulos

Dated: June 8, 2023

APPENDIX A

Materials Considered

Exhibit No.	Description
1001	U.S. Patent No. 11,208,029 (“ ’029 Patent ”)
1002	File History for the ’029 Patent
1003	Declaration of Dr. Nikolaos Papanikolopoulos
1004	Curriculum Vitae of Dr. Nikolaos Papanikolopoulos
1005	U.S. Patent Application Publication No. 2003/0137849 (“ Alden ”)
1006	U.S. Patent No. 6,049,749 to Kobayashi (“ Kobayashi ”)
1007	U.S. Patent No. 6,144,158 to Beam (“ Beam ”)